Digitized by the Internet Archive
in 2014

https://archive.org/details/missilesrockets5195unse

DISC

MAY 4, 1959

MAY 1959
HOUSTON PUBLIC
LIBRARY
Houston, T



THE 400-MILE BOMARC "B"

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

trategic Reserve for Missiles 13
eath of a Missile 16
ornberger: 'Father' of *Dyna-Soar* 29

AN AMERICAN AVIATION PUBLICATION

ADVANCED FUEL MANAGEMENT ...FROM SMI



The requirements of accurately tanking missiles with propellants is but one of the areas of fuel management in which Servomechanisms, Inc. has demonstrated capability. *Propellant utilization* and *thrust control* are other areas in which SMI has developed highly accurate and precise measuring and control systems.

SMI's LOX Tanking Computer, which has been in production for the past year, accurately measures, controls and indicates the level of liquid oxygen in missile tanks. Loading is accomplished rapidly and accurately due to a unique two-mode control system. The first mode permits extremely high pumping rates until about 98% capacity is reached. The second mode then takes over and controls a precise proportioning valve which adds the necessary LOX to fill the tank within 0.1% accuracy. The second mode also provides continuous topping, thus compensating for LOX evaporation losses during standby.



SMI has currently in development, more advanced fuel management systems to meet the increasingly complex requirements of the next generation of missiles and spacecraft.

SMI would welcome the opportunity to discuss and propose solutions to your fuel management problems. Write for descriptive literature.



Positions are available for qualified engineers and scientists in the areas of:
Systems Synthesis and Analysis—Project Management —Qualification and Environmental Test Engineering—High Vacuum Deposition Techniques.

SERVOMECHANISMS SMI INC.

LOS ANGELES OPERATIONS: *12500 Aviation Blvd., Hawthorne, C*
MECHATROL DIVISION: *Westbury, L. I., New York*
RESEARCH AND DEVELOPMENT CENTER: *Goleta, California*

The products of SMI are available in Canada and throughout the world through Servomechanisms (Canada) Limited, Toronto 15, Ont



What Valves to Choose for Ground Support Operations?

This Guide Gives You the Facts

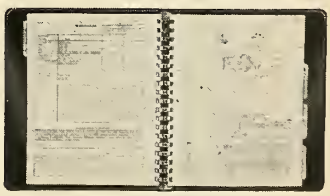


If you're a specifier or buyer of valves for missile handling and support systems, this valve specification guide will help you. It provides basic data on valves for handling rocket and missile fuels, liquefied gases and other fluids required at launching pads, testing stations, and operation bases; also on valves for fuel processing and transporting.

The guide covers gate, globe and check valves, and all data have been condensed into convenient, usable form. You will find it accurate and dependable because it comes from Crane—world's leader in valve engineering.

HOW TO GET YOUR COPY

This guide—"Crane Valves for Rocket and Missile Services"—is yours for the asking. However, because each copy must be registered to its user, please write on your business letterhead. Address the Crane branch nearest you or use the address below.



IT'S CRANE FOR VALVES FOR EVERY SERVICE

Valves for specialized ground support applications are but part of the complete Crane line of dependable, quality valves in bronze, iron and steel for all power, process and utility applications. Consult your Crane Representative for complete information.

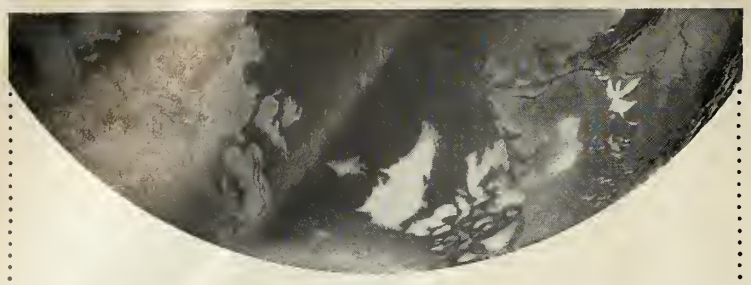


CRANE® **VALVES & FITTINGS**

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas

HYDRO-AIRE Division, Burbank, Calif.—Controls for Every Basic Air-Borne System



Look Over the Challenge of Rocket Research in the Fields of

Advanced Propulsion, Experimental Instrumentation, Research Design, Experimental Operations

The men we're looking for should have a good academic background and extensive industrial experience. They should be mature and adept in contact work with our outside vendors. We particularly need men who have the flexible outlook and the quick mind it takes to make design changes in the field.

Designers of Specialist Caliber. Extensive experience in the design of mechanical components, using a wide range of materials; capable of stress evaluation, with a general knowledge of heat transfer and fluid flow; good background in electronic control equipment, welding and brazing techniques, metallurgy, and precision machine shop practice.

Senior Research Engineer. Degree in electrical engineering or physics, with an electronics major or equivalent and at least four years of experience in servo design and analysis. His work will include: end-element research; study of design criteria regarding dynamic behavior of rocket engine systems; basic research in control system synthesis methods; investigation of various control methods.

Research Engineer. Degree in electrical engineering or physics, with an electronics major and at least one year in instrumentation or an allied field. He will be a research instrument engineer, responsible for creating complete instrumentation systems to derive theoretical and experimental knowledge from research on statistically tested rocket engines and other combustion devices. His ingenuity will constantly be challenged by such problems as measuring high frequency pressure and flow fluctuations, gas temperatures in excess of 5000° F, and various other parameters—including time, thrust, acceleration, displacement, and gas composition—by spectrographic means.

Rotating and Turbo-Machinery Specialists. These men should be senior research engineers with advanced degrees, no less than five years of experience, and a talent for supervising projects or units of engineers. Their work will involve applied and basic research on aerodynamics and fluid flow problems of advanced rocket engine turbo-machinery.

Senior Research Engineer. MS, ME, or PhD. Must be experienced in flow measurements of unconventional type. His work will involve research and analysis of flow measurements and the dynamics of flow problems.

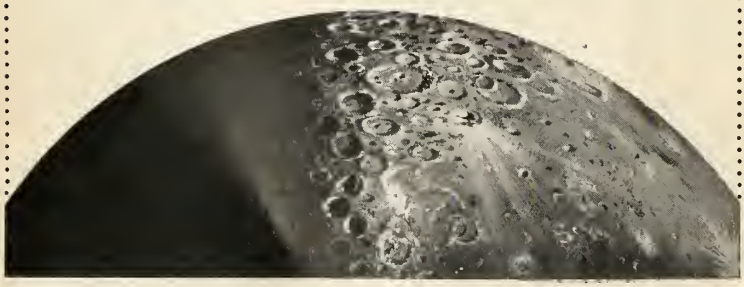
Instrumentation Engineer. BS, MS, PhD in electrical engineering or physics. His experience should be in developing and using instrumentation on problems directly affecting test programs.

Please write to Mr. D. E. Jamieson, Engineering Personnel Dept., 6633 Canoga Avenue, Canoga Park, California.

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

FIRST WITH POWER FOR OUTER SPACE



Executive Editor ..... CLARKE NEWLON
Managing Editor .... DONALD E. PERRY

EDITORIAL STAFF

News Editor ..... REED BUNDY
Military & Defense ..... BETTY OSWALD
JAMES BAAR
Electronics/Support Equipment .. HAL GETTINGS
Electronics Engineering .... CHARLES D. LAFOND
Missile Manufacturing ..... WILLIAM E. HOWARD
Missile Business ..... ERICA M. KARR
NASA ..... PAUL MEANS
Los Angeles ..... FRED HUNTER
RICHARD VAN OSTEN
FRANK MCGUIRE
London ..... G. V. E. THOMPSON
Paris ..... JEAN-MARIE RICHE
Geneva ..... ANTHONY VANDYK
Art Director ..... WILLIAM MARTIN
Ass't Art Director ..... COLLIS CAMPBELL

CONTRIBUTORS

Propulsion Engineering ..... MICHAEL LORENZO
Industry ..... JAMES J. HAGGERTY, JR.
Soviet Affairs ..... DR. ALBERT PARRY
Space Medicine ..... DR. HUBERTUS STRUGHOLD
Astrophysics ..... DR. I. M. LEVITT
Research ..... HEYWARD CANNEY, JR.

ADVISORY BOARD

DR. WERNHER VON BRAUN — ROBERT P. HAVILAND
DR. PETER CASTRUCCIO — DR. ARTHUR KANTROWITZ
KRAFFT EHRICKE — DR. EUGEN SAENGER
R. F. GOMPERTZ — ALEXANDER SATIN

BUSINESS STAFF

Assistant Publisher ..... E. D. MUHLFELD
Advertising Sales Manager ..... W. E. BROWN
Circulation Director ..... L. L. BRETTNER
Research Manager ..... D. T. FOSSEN
Promotion Manager ..... J. E. MULROY
Advtg. Service Manager .. MRS. GLADYS BUSSELL
Production Manager ..... J. F. WALEN
Ass't Production Mgr. ..... ELSIE GRAY
New York ..... 17 East 48 Street
Eastern Advtg. Mgr. ..... P. B. KINNEY
P. N. ANDERSON
A. B. SCHEFFLER
Detroit ..... 201 Stephenson Bldg.
K. J. WELLS
Chicago ..... 139 N. Clark St.
G. E. YONAN
Los Angeles ..... 8929 Wilshire Blvd.
J. A. CLAAR
C. R. MARTZ, JR.
Miami ..... 208 Almeria Avenue
R. D. HAGER
Toronto ..... 12 Richmond St. E.
ALLIN ASSOCIATES
London ..... 28 Bruton St.
NORALL & HART
Paris ..... 11 Rue Condorcet
Geneva ..... 10 Rue Grenus

m/r Volume 5 Number 18

Published each Monday by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C.

WAYNE W. PARRISH ..... *President & Publisher*
LEONARD A. EISERER ... *Executive Vice President & General Manager*
A. H. STACKPOLE ..... *Vice President*
FRED HUNTER ..... *Vice President*
ERIC BRAMLEY ..... *Vice President*
ROBERT R. PARRISH ..... *Vice President*

Printed at the Telegraph Press, Harrisburg, Pa. Second class postage paid at Washington, D.C., and at additional mailing offices. Copyright 1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, $8.00; 2 years, $12.00; 3 years, 14.00. Foreign—1 year, $10.00; 2 years, $18.00; 3 years, $26.00. Single copy rate—$.75. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr., m/r, 1001 Vermont Ave., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

MAY 4 HEADLINES

Strategic Ready Reserve for Missiles

Defense planners considering industry proposals for contractual personnel to staff complex weapon systems in tactical use 13

Improved Bomarc-B Ready for Testing

First four bases will be equipped with 200-mile range *Bomarc* with B-series bird scheduled for remaining bases 15

Project Adam Makes Comeback

ABMA's proposal rejected by DOD last year now is heart of NASA's Project *Mercury* program 49

Dornberger and Dyna-Soar

He's confident that Air Force contract will go to Martin-Bell team 29

Canaveral Operating at One-Fifth Capacity 36

SPECIAL SECTION

Death of a Missile

World-Renown Photographer Cornell Capa tells in pictures the story of an *Atlas* test and its destruction 16

MISSILE ELECTRONICS

Circuitry and Equipment Redundancy

Design engineers question wisdom of unrestrained use in electronic systems 25

ASTRONAUTICS ENGINEERING

Brazed Steel Honeycomb Structures

Martin's new hardened alloy provides structures at low-cost 35

THE MISSILE WEEK

Washington Countdown 9

Industry Countdown .....11 & 36

DEPARTMENTS

Editorial 7

Letters 40

Contract Awards 42

People 44

Propulsion Engineering .. 47

West Coast Industry 48

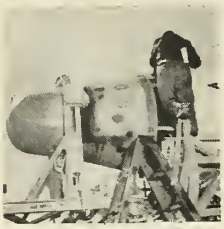
When and Where 50



COVER: Boeing's *Bomarc-B* will take over much of the U.S. air defense job in competition with Western Electric's *Nikes*, (p. 15)



CREW inspects flotation bag used in recent recovery of AF *Thor-Able* nose cone from the South Atlantic.



RE-ENTRY vehicle is attached to afterbody of the *Discoverer II* prior to successful launch on April 13.



LARGEST titanium head shape ever formed was made by Lukens Steel for Wright Aeronautical Div., Curtiss-Wright Corp.



NAVY launches *Polaris* vehicle from Cape Canaveral April 20 in reportedly successful test of primary flight objectives.

The Golden Field of Missile Support

One of the most critical tasks facing the missile procurement people today is making Congress, the Services, the civilian administrators of the military, and the public realize that the tremendous cost of the program lies not in the missile itself but in its support equipment.

Under that hard stand from which the *Thor* or *Jupiter, Atlas* or *Titan* is launched are miles of pipe, tubes and conduits. Under the stand or in the blockhouse and other shelter units are pumps of all kinds for liquid nitrogen, hydrogen and oxygen. There are pumps for gases, high- and low-presssure valves from a quarter of an inch to two feet in size. There are structural steel and sheet steel, tons of concrete, other tons of reinforcement, instruments of all kinds—sensors, recorders, gauges and computers. There are generators for electrical power, highly-automated check-out equipment, tubes, transistors and dials, trucks and hoists and fork lifts and elevators—and on and on and on.

One *Titan* will cost approximately $2 million. A launching complex for a squadron of nine *Titans* will cost about $45 million. Sites for other missiles can be cheaper. Cost of *Atlas* locations will depend upon the degree of hardening, that is, protection. But multiply the cost of ICBM sites under any reasonable formula and you come up with an entirely new segment of American industry which inevitably will run into billions of dollars.

This fact has not escaped the giants of American industry: big steel, aluminum, the automobile colossi, the big foundries, the heavy equipment people. Said a Pentagon colonel in procurement:

"I was at an official party the other night. One of the top officials of U.S. Steel—not a division man but a top official of the parent company—backed me into a corner and questioned me for fifteen minutes on how to get into the support equipment business."

Many of the big companies now looking over this field find themselves handicapped (unlike the big aircraft firms who have had an eye on it all along) by the lack of technical know-how. They are looking around for smaller companies with technical competence. Object: purchase, merger or simply to work as a team.

The services are looking just as hard for this same competence and particularly for new methods, for many of the construction problems they face involve new problems where new techniques are demanded—at least, new techniques would be welcome.

The *Minuteman,* for instance, will be operational in two to three years—but long before that time the Air Force must have trained crews and prepared sites to receive it. The *Minuteman* is a solid-fuel inter-continental missile with an approximate one megaton warhead. Its site is a hole in the ground—an inverted silo, some 100 feet deep, lined with concrete. Under present plans the *Minuteman* will be manufactured (by Boeing) by the hundreds. And each *Minuteman* means a hole in the ground lined with concrete.

Digging that hole in the ground (multiplied several hundred times) is going to be a pretty expensive business. So is lining it with concrete strong enough to protect it up to, say, 100 psi from a near miss.

It can be done with present methods, but the military would like to see someone come up with a new method of producing the hole—maybe by drilling, maybe by reducing the earth to liquid and sucking it out. Anyway—just so it is efficient and cheap. Said another Pentagon official:

"The man who can come up with a way to dig a 100-foot hole 20 feet in diameter for $50,000 is going to be digging more damned holes than this country has ever seen. And—mark my words—he won't be a big guy. He'll be a little guy with an idea."

The same thought applies to lining the silo with reinforced concrete. Come up with a new method, a new idea, a way to do it fast and cheaply and there'll be a golden reward.

It all adds up to the fact that ballistic missile cost is like the iceberg, four-fifths submerged. The weapon itself will get easier and easier to build as the skills in such spacecraft advance, but there is an equal—and for the moment, greater—need for advanced ingenuity in the parallel field of missile support equipment.

Clarke Newlon

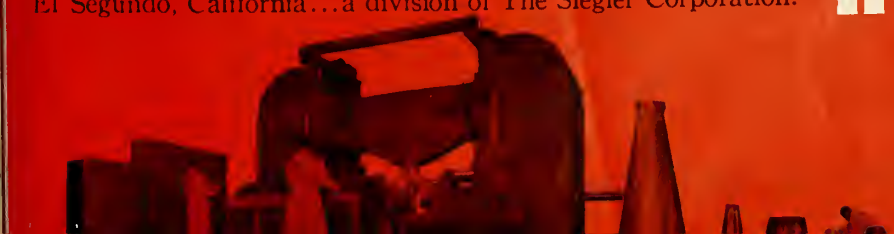
Missiles and Rockets will begin a series of articles shortly relating in detail the problems facing the nation in the building of missile bases, how the giants of industry view those problems and the steps they are taking to deal with them.



SPIN FORGE A MISSILE NOSE CONE IN 7½ MINUTES

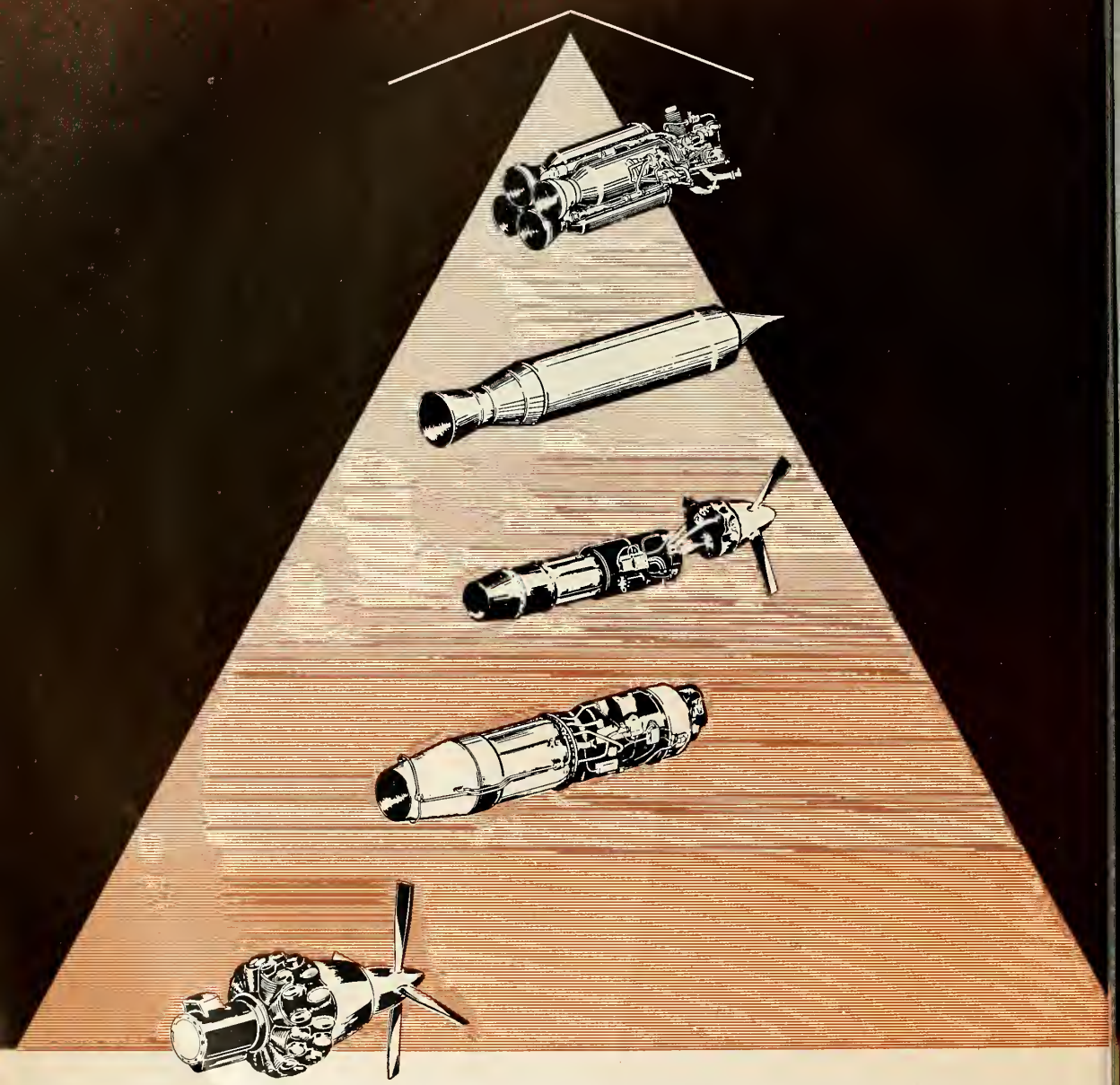
Duplicate that nose cone in absolute detail thousands of times and waste no metal. It can be done; but by no other method and by no other machine than a Hufford Spin Forge. These massive, fully automated, precision tools can produce most surface-of-revolution shapes within a tolerance of—.002, up to a diameter of 6 feet, employing hardest metals of varying or constant thickness from .030″ to 1″. A giant step forward to assist you in meeting urgent production requirements, Hufford Spin Forges may be seen performing daily production schedules at the Marquardt Aircraft Utah facility or at our own El Segundo plant. Additional units are currently in design and construction stages. For detailed information, please write The Hufford Corporation, 1700 E. Grand Avenue; El Segundo, California...a division of The Siegler Corporation.

HUFFORD



CONTROLS

FOR THE FULL SPECTRUM OF PROPULSION SYSTEMS



Bendix* has long been a leader in supplying controls and fuel systems for all types of aircraft engines. Today, Bendix is proving to be a natural for new challenges in related missile fields—on ram jets, rockets, nuclear power, and other advanced propulsion systems. So, when it comes to controls, remember that Bendix has the background—and is anxious to share it in solving your problems. *REG. U.S. PAT. OFF.

BENDIX PRODUCTS DIVISION **SOUTH BEND, IND.**

Bendix
AVIATION CORPORATION

washington countdown

IN THE PENTAGON

ARPA is fighting back to maintain its existence. However, the battle appears to be getting rougher—and more open. Many Pentagon foes of ARPA took heart from the demand by Maj. Gen. Bernard A. Schriever, newly-named Air Force R&D commander, that ARPA be abolished.

• • •

Some experts are betting the best the Navy can hope for in its *Polaris* program is a 1200-mile operational missile by the end of next year. But they say an 800-mile missile is far more likely.

• • •

The Army's satellite detection fence that went into operation in late March is reported to be working perfectly. The fence detected and located the orbit of the *Discoverer II* satellite shortly after it was launched April 13. Informed sources say the fence is capable of detecting any satellite whether or not the satellite is radioing a signal. . . .

• • •

The Air Force has completed a series of pre-contract tests of air-launched ballistic missiles at Cape Canaveral. Award of a contract for an Air Force ALBM is considered imminent.

ON CAPITOL HILL

Congressmen are reading a hair-raising report put out by the House Military Operations Subcommittee. The report—the most authoritative of its kind to date—warns that Russia has a good and steadily improving civil defense system. And it says the better Soviet CD gets the more America's deterrent strategy is undermined. But don't expect Congress to do much about it. The solution would cost billions.

• • •

Watch for a congressional investigation of how much—or how little—about the nation's space programs is being told the bill-footing taxpayers. The House Information Subcommittee can be expected to look into the matter.

• • •

The whole GOP strategy to hold the line on spending hundreds of millions more for ICBM's is being endangered by the White House. The GOP problem: President Eisenhower's insistence that Congress authorize hundreds of millions more for missiles for America's NATO allies. The foreign aid increase—little of it to come in FY 1960—was recommended by the President's own foreign aid advisory committee.

AT NASA

Present schedule for the U.S. man-in-space program is: (1) a short-range flight down the Atlantic Missile range in a *Redstone;* (2) a simple orbital flight in the Project *Mercury* space capsule; (3) an advanced orbital flight in a maneuverable space vehicle; (4) an orbital flight of several days by a maneuverable vehicle manned by seven men; (5) a permanent manned orbiting space lab; (6) a manned flight to the vicinity of the moon; (7) manned landings on and return from the moon; (8) interplanetary flight.

• • •

Systems engineering on the Project *Mercury* vehicle will be done by NASA's Space Task Group and not the Air Force's Space Technology Laboratory as had been reported earlier. STL will be consulted about the *Atlas* booster, but the Space Task Group will do the actual mating of the various components and will recommend to NASA who the subcontractors should be.

AROUND TOWN

Diplomats are speculating on the effect of possible British entry into the East-West space race. The British are considering the possibility of using for satellite launching their new liquid *Blue Streak* missile which is still under development. One reason that some Englishmen are pushing a British space program is to halt the departure of British space experts for America.

• • •

Russia's next bid for leadership in space may not be a manned satellite as many have believed after all. Instead, Russia is reported to have given top priority to launching a spy-in-the-sky satellite—for peaceful purposes, of course.



AEROJET-GENERAL CORP.

THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)

industry countdown

Douglas gets ALBM

Douglas Aircraft Co., Inc., will get the hotly-contested contract for development and prototype production of *WS-138*—the air launched ballistic missile. Air Force selection boards made the decision following a stiff pre-contract competition (Washington Countdown, p. 9). The selection of Douglas was on the desk of Air Force Secretary James Douglas as M/R went to press. The secretary was expected to make the announcement of the contract on his return from a trip away from Washington.

STRUCTURES

To accelerate *White Lance*—an advanced *Bullpup* packing nuclear warhead—Air Force is asking $6.5 million in 1960 FY. Under development by Martin-Orlando, *White Lance* reportedly will have packaged liquid engine by Thiokol. It may also have television-type guidance system, although there are reports this type guidance may be shelved.

• • •

Hypersonic wind tunnel producing speeds up to Mach 10 is being constructed at Army's Aberdeen Proving Ground. New unit is in addition to existing APG Mach 5 installation.

• • •

Expect Chairman Carl Vinson (D-Ga.) of the House Armed Services Committee to muster a strong floor battle for permanent continuation of the Renegotiation Act. Vinson is adamantly opposed to any change in present strict provisions, despite urging of DOD and industry. AIA and EIA say they could live with the law if authority of Renegotiation Board is clipped to keep it from challenging incentive earnings and basic earnings on defense contracts.

• • •

NASA $24 million prime contract for *Delta* launching vehicle goes to Douglas Aircraft Co. With revamped Aerojet-General liquid-fueled first and second stage engines and Allegany Ballistics Laboratory solid third stage, *Delta* is designed to put 250-pound payload in 300-mile orbit or send 110-pound payload on deep space probe in 1960-61.

Nuclear-powered carrier Lexington is deploying to Atlantic fleet with the first operational squadron of aircraft armed with the air-to-surface *Bullpup*. FJ-4B's and VA-212's can each carry five of the 540-pound missiles.

PROPULSION

With the Army, Wyandotte Chemical has developed new solid propellant L-1, said to have 10% to 15% better performance rating than existing solids and a specific impulse of 260+. Composition is nitroglycerine, nitrocellulose, polyurethane, ammonium perchlorate, aluminum, magnesium oxide and 2-nitrodiphenylamine.

• • •

Behind AEC's abrupt start-and-stop buying of quantities of lithium and lithium compounds, principally from Foote Mineral Corp. and the Lithium Corp. of America, is this explanation: AEC was using lithium hydroxide in cooling loops of *Kiwi* reactors—and suddenly shifted back to sodium hydroxide when it couldn't lick the corrosion problem.

ELECTRONICS

Present concepts of radio propagation may be revised on the basis of Ohio State University's measurements of *Sputnik III* signals, which indicate ionosphere depth of thousands of miles. If electron density diminishes at such a low rate with distance outward from the earth, as researchers have concluded, then ionoscatter path lengths may be increased significantly. DOD and NATO may find itself with a surplus of its newly-established ionospheric scatter mode stations around the globe.

• • •

Breadbox to sugar cube size reduction is visualized in Westinghouse breakthrough in growing germanium crystals as thin, flat ribbons for miniaturized electronic space vehicle equipment. ARDC has awarded the company a $2 million contract for further molecular electronic development.

ASTROPHYSICS

New theory has been proposed by Dr. Harold C. Urey that the moon may have molten interior with erupting volcanoes giving off gas and changing its exterior surface. The theory gives support to Russian observations, previously greeted with skepticism, of gaseous eruption from the lunar Crater of Alphonse.

RUMFORD DEWAR
FARADAY LINDE
CARNOT BOLTZMANN
JOULE ONNES
RANKINE NERNST
HELMHOLTZ CLAUDE
KELVIN KEESOM
GIBBS SIMON

CRYOGENICS
in the Space Age

CRYOPUMPING
and the problems of space travel

To simulate the conditions on the fringes of the Earth's atmosphere, engineers must produce ultra-high vacuums (10^{-8}mm Hg or greater) and cryogenic temperatures approaching absolute zero (−459.69°F). Such conditions, until recently, were laboratory curiosities produced on a limited scale.

Today, by using *cryopumping*, large hypersimulation chambers can be designed and built to test both men and equipment under these extreme conditions.

Cryopumping involves freezing out the atmosphere in a chamber to create both the ultra-high vacuums and the cryogenic temperatures required. Although its principle has long been known, only recently was *cryopumping* developed for practical, large-scale use by the University of Southern California Engineering Center and Arthur D. Little, Inc.

The special ADL refrigerating unit used in USC's new hypersonic, low-density wind tunnel can *cryopump* more than 4 million cubic feet of nitrogen per minute at 10^{-4}mm Hg; at lower pressures, this pumping rate increases. It uses only 50 horsepower. Conventional vacuum pumping would require 500,000 horsepower!

Arthur D. Little, Inc.

24 Acorn Park, Cambridge 40, Massachusetts

CAMBRIDGE • CHICAGO • SAN FRANCISCO • NEW YORK • WASHINGTON • SAN JUAN • EDINBURGH

You may be interested in some of the following publications.
Please indicate below those you desire and attach to your letterhead.

☐ "*Cryopumping for High Vacuum with Low Power,*" Bruce M. Bailey & Raymond L. Chuan, Fifth National Vacuum Symposium.

☐ "*High-Temperature Research in Space Vehicle Design,*" P. E. Glaser.

☐ "*Atmospheric Heat-Transfer to Vertical Tanks Filled with Liquid Oxygen,*" F. E. Ruccia & C. M. Mohr;
"*Methods of Gaging Liquid Oxygen,*" R. C. Reid et al;
"*Pressurized Transfer of Cryogenic Fluids,*" D. C. Bowersock et al;
"*Pressurized Cooldown of Cryogenic Transfer Lines,*" J. C. Burke et al, 1958 Cryogenic Engineering Conference.

☐ "*Superconductive Switching Circuits,*" A. E. Slade & H. O. McMahon, Proceedings of the National Electronics Conference.

☐ "*Helium Refrigerators.*"

Your request will receive the prompt attention of
Director of Public Relations, Arthur D. Little, Inc. • 24 Acorn Park, Cambridge 40, Mass.

MAY 4, 1959—VOL. 5, NO. 18

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Strategic Ready Reserve Studied

Contractual personnel would maintain and operate complex weapon systems even in tactical use under proposed plans

by Donald E. Perry

WASHINGTON—Top Defense planners are seriously studying highly classified missile industry proposals which, among other things, would involve creation of what may be known as a Strategic Ready Reserve of trained and experienced contractual personnel to substitute for uniformed servicemen in firing complex missile hardware in event of war.

At least three prime weapon system contractors have submitted views which are being studied by the Joint Chiefs of Staff, Pentagon manpower utilization branches and the war colleges of the principal services, M/R has learned.

If a decision were made for retaliatory "button pushing," contractual personnel would immediately become military personnel subject to current Armed Forces regulations. The military-missile forces conceivably could be reduced to a skeleton force of technologically competent career officers.

An ultimate goal in the proposals is future weapon systems contracts including tactical staffing and operation in addition to design, development, manufacturing and testing.

All but the first are now done by weapon system prime contractors, many of whom feel that if war comes tomorrow contractor personnel will have to do the firing because of lack of sufficiently trained service personnel.

The dollar volume of prime contracts would swell to super-high figures, but on the other hand, industry spokesmen have told M/R, standing Armed Forces, their training and subsistence would be reduced far below the present 1.5 million manpower figure.

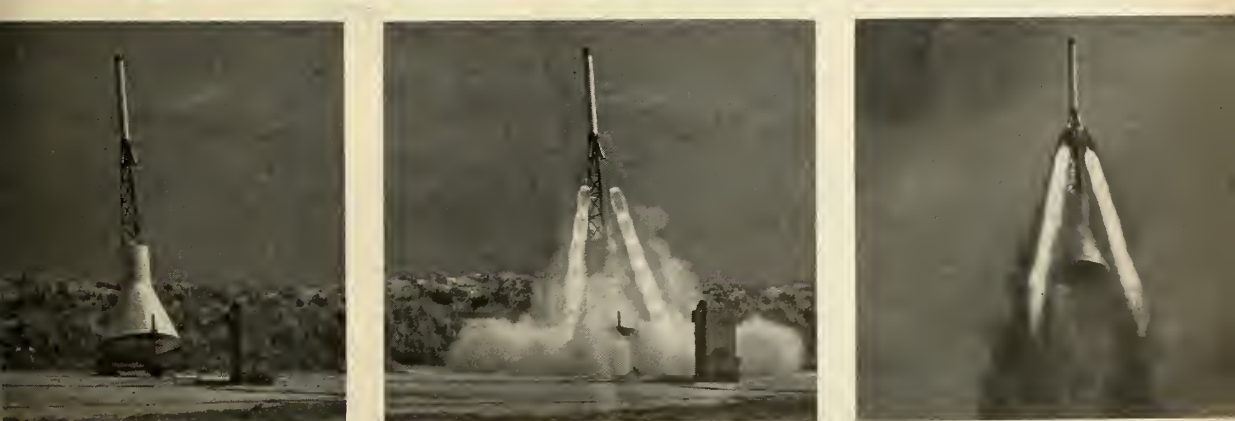
• **The problems**—Defense planners are seriously worried about the ability of military personnel to maintain and operate complex weapon systems. Training costs of service personnel climb to astronomical new highs each year. Coupled with this is the problem of service personnel turnover. After costly expenditures for training, servicemen join the ranks of industry when they are trained and experienced, thus depriving the military of their services at a time of maximum usefulness.

Another problem area is mobilization of reserve forces. Planners are ruling out any quick mobilization during all-out missile warfare. The time factor will not permit recruitment and training in complex weaponry or transport to aggressive warfare stations and duties. One proposal for utilization of manpower in reserve programs would be assignment to minor defensive roles and responsibilities and to take over duties presently vested in the virtually ineffective Civil Defense organization.

These reserve forces would thus be used in a point defense concept with the Strategic Ready Reserve force manning critical posts.

• **When will it come?**—Industry spokesmen believe that the first test of the Strategic Ready Reserve Force could come in the fleet ballistic missile program. The Navy is quietly wondering whether service personnel can be trained—and retained—with the technological qualifications to operate and service the hardware and support equipment necessary for instant retaliation.

MERCURY CAPSULE TESTS AT WALLOPS ISLAND



ESCAPE MECHANISM of the Project *Mercury* manned orbital capsule is tested at NASA's Pilotless Research Station at Wallops Island, Va. Mechanism is in the tripod arrangement on full-scale model weighing about one ton. Escape rockets lifted the capsule to 2250 feet where the tripod was ejected and a parachute lowered the capsule to the water where it was recovered by helicopter.

It's great to be proud of the place you work

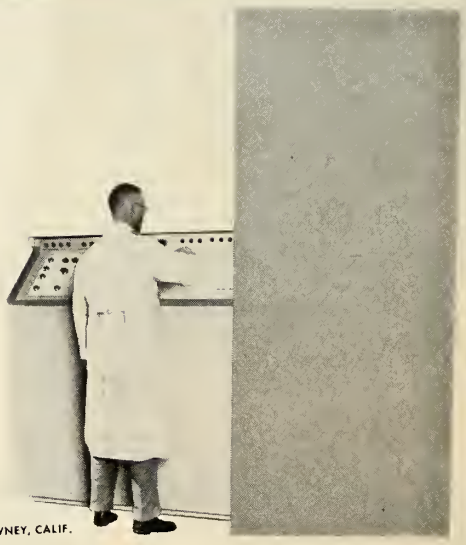
What makes a successful engineer?

Initiative—experience—imagination—intelligence are all important factors. But there is at least one more—enthusiasm.

Young engineers at Autonetics are *enthusiastic*. They're fired up about the projects they work on, such as the advanced inertial-navigation systems for the Polaris-carrying subs, and the guidance and control system for the Minuteman missile.

Variety sparks their enthusiasm. Autonetics' young men also designed RECOMP II, a general purpose, all-transistor, digital computer; NUMILL, a completely automatic, machine tool control system; BACE, high-speed automatic checkout equipment; and many other industrial and military products.

Today at Autonetics there is room for engineers and scientists who seek unusual creative problems in electronics and electromechanics. Please send your resume to Mr. N. E. Benning, 9150 East Imperial Highway, Downey, California.



Autonetics A DIVISION OF NORTH AMERICAN AVIATION, INC., DOWNEY, CALIF.

INERTIAL NAVIGATION / ARMAMENT CONTROL / FLIGHT CONTROL / COMPUTERS AND DATA PROCESSING

Among the achievements of Autonetics' young men: The first successful airborne all-inertial navigation system . . . first navigation system accurate enough to guide the USS Nautilus and Skate on their historic voyages beneath the Arctic ice . . . first successful automatic star tracking by an inertial navigation system during daylight flight . . . first inertially stabilized gyro platform proved operable in any kind of maneuver . . . first successful completely automatic landing system for supersonic missiles and aircraft . . . first transistorized portable digital computer with "big computer" capabilities.



COVER STORY:

Bomarc Will Soon Move into U.S. Air Defense Role

Boeing surface-to-air missile goes to first base this fall, may displace Nikes

by James Baar

WASHINGTON—The Era of the *Bomarc* is almost at hand.

In less than six months the first base for the Boeing surface-to-air missile is scheduled to be opened at McGuire AFB, N.J.

At any time now the first greatly-improved *Bomarc-B* will streak from Cape Canaveral where the new model will begin undergoing flight tests.

Within the next year to two years squadrons of nuclear warhead-packing *Bomarcs* will be stationed across the nation at from seven to 14 air defense bases—most probably more.

The first two will be equipped with the more than 200-mile range *Bomarc-A*. The rest will be equipped with the more than 400-mile range *Bomarc-B*.

• **Air Force vs. Army**—The final number of bases to be set up hangs on the outcome of the bitter competition between the Air Force's *Bomarc* and the Army's Western Electric *Nike-Hercules*.

Gen. Thomas D. White, Air Force chief of staff, has said 40 *Bomarc* bases could protect the entire country from attack by manned aircraft.

The first two *Bomarc* bases are expected to have 60 launchers. The rest are expected to have about 30.

Bomarc-B's at any one base will be able to hit targets within a half-million square mile area. The entire area of the United States is about 3 million square miles.

However, any *Bomarc* base-building program of such magnitude would be certain to mean the end of the *Nike-Hercules* program. And, at least at present, nothing of the sort is being planned by the Defense Department.

• **Defense in depth**—Defense Secretary Neil H. McElroy told Congress only recently that both weapon systems are needed: the 75-mile range *Nike-Hercules* for point defense; the much longer range *Bomarc* for area defense.

McElroy said the *Nikes* and *Bomarcs* used in combination with manned interceptors provide the nation with "defense in depth."

Richard E. Horner, Assistant Air Force Secretary, said the *Bomarc* could be used to do "the *Nike* job." But he said it "would not give its greatest defense capability per dollar in that kind of task."

However, a recently completed report by former Assistant Defense Secretary Louis Furnas gave the *Bomarc* an enthusiastic boost. The result is expected to be a speed-up in the program —including the release of more funds for base construction and possibly the naming of three more base sites.

• **Bases to date**—At present a total of 14 base sites have been chosen. The first four and the order in which they are scheduled to be completed are: McGuire; Suffolk County AFB, N.Y.; Otis AFB, Mass.; and Dow AFB, Maine.

The 10 others chosen are: Langley AFB, Va.; Kinross AFB, Mich.; Niagara Falls Municipal Airport, N.Y.; Truax Field, Wis.; Duluth Municipal Airport, Minn.; Paine AFB, Wash.; Camp Adair, Oregon; Travis AFB, Calif.; Vandenberg AFB, Calif.; Ethan Allen AFB, Vt. But of the last 10 funds have been released only for Langley, Kinross and Duluth.

By the end of next month the Army is scheduled to have 62 battalions of *Nikes*—both the 35-mile *Ajax* and the *Hercules*—protecting key targets around the country.

• **Ten-year program**—The *Bomarc* program dates back to 1949. The first production unit of the *Bomarc-A* was completed in December, 1957.

The *Bomarc-A* is powered by an Aerojet-General liquid rocket and two Marquardt Aircraft ramjet engines. The *Bomarc-B* is powered by a Thiokol solid propellant rocket and improved Marquardt ramjets.

Both models travel at speeds greater than Mach 2.5. Both fly at altitudes of about 70,000 feet.

The appearance of both models is the same. They are 47 feet long, have an 18-foot wing span and weigh about 15,000 pounds.

More than a year ago much more advanced "C" and "D" models were contemplated by Boeing, but the plans were scrapped on grounds that they were not feasible.

• **Guide and Guided**—The *Bomarc* is integrated with the IBM-SAGE computer system which is used to fire the missile and guide it to the vicinity of its target. The computer then releases control and the missile's target-seeker homes on the target.

No actual collision is necessary. The *Bomarc* is armed with a proximity fuse.

A test *Bomarc-A* has been launched from Cape Canaveral by a SAGE computer 1500 miles away at Kingston, N.Y., and successfully guided to its target.

Bomarc-A's also have been fired in salvos at different targets from the Air-Proving Ground at Eglin AFB, Fla.

The *Bomarc-B's* are scheduled to be tested for about a month at Cape Canaveral. Then the testing will be switched to Eglin. The Air Force anticipates little difficulty.


The Story Behin

THE DEATH OF A MISSILE



One of 40,000 parts fails and a 75-foot bird of space blows up to end a rare association between man and machine—as photographed exclusively for Missiles and Rockets by Cornell Capa

by Erica M. Karr

A two-inch newspaper story, datelined Edwards Air Force Base, March 27, gave this explanation of the explosion opposite: *A captive Atlas missile exploded on its test stand here today. There were no casualties. The same Atlas—Model 60—had completed numerous other test firings at the base. The missile was destroyed. Cause of the accident was not disclosed. The missile had performed most of its test objectives when the accident occurred.*

Story behind this story developed in the blockhouse where famed photographer Cornell Capa was set up to snap "the new breed of young white-collared engineers" who build on man's space hopes. The "routine test," after two days of false starts, had ended in the worst ground disaster ever suffered by an *Atlas*, and the new breed of men, after months of working closely with their massive steel bird, suffered with it. Capa catches the spirit of the blockhouse story from the first "pep talk" briefing, through the moment when the deafening explosion shook the ground and blew up $2-million worth of missile.

At first the Air Force reported only that "nothing fundamental or systematic" was involved in the blow-up but—as later pieced together from Air Force and other sources—the complete story is both human and dramatic.

The captive test firing was first attempted on March 26 after completion of prefiring preparations. This try was called off when electrical difficulties were encountered in the propellant system and traced to "excessive moisture in an electrical connector." The connector was replaced and countdown operations for the firing started at 10:55 the next morning. All went well until T-minus 55 minutes when a hold was called to check the booster engine's auto pilot null position. All clear again, and the count was recycled to T-minus 60 minutes and continued without further difficulty.

At 1:35 p.m.—T-minus O—a normal engine start and the transition to main stage operation were achieved. Then one of the tubes in the "spaghetti" tube network of the engine cracked, spewing out a small stream of fuel, and causing a fire followed by a small explosion in the engine's thrust section. This was recorded at 43 seconds. At 54 seconds, a larger explosion and fire destroyed the missile.

"Disabling of equipment and controls," resulting from initial explosion, was given by the Air Force as the cause of the final explosion. It was later reported by other sources that the sensor for the ground pressurization system had stopped indicating, allowing an excess of pressure to build up.

Air Force ended its report with this statement:

(*Continued on page* 20)



PRE-TEST BRIEFING has air of a before-the-game pep talk as all hands get a run-through on aims, roles, timing and a bid for close cooperation.



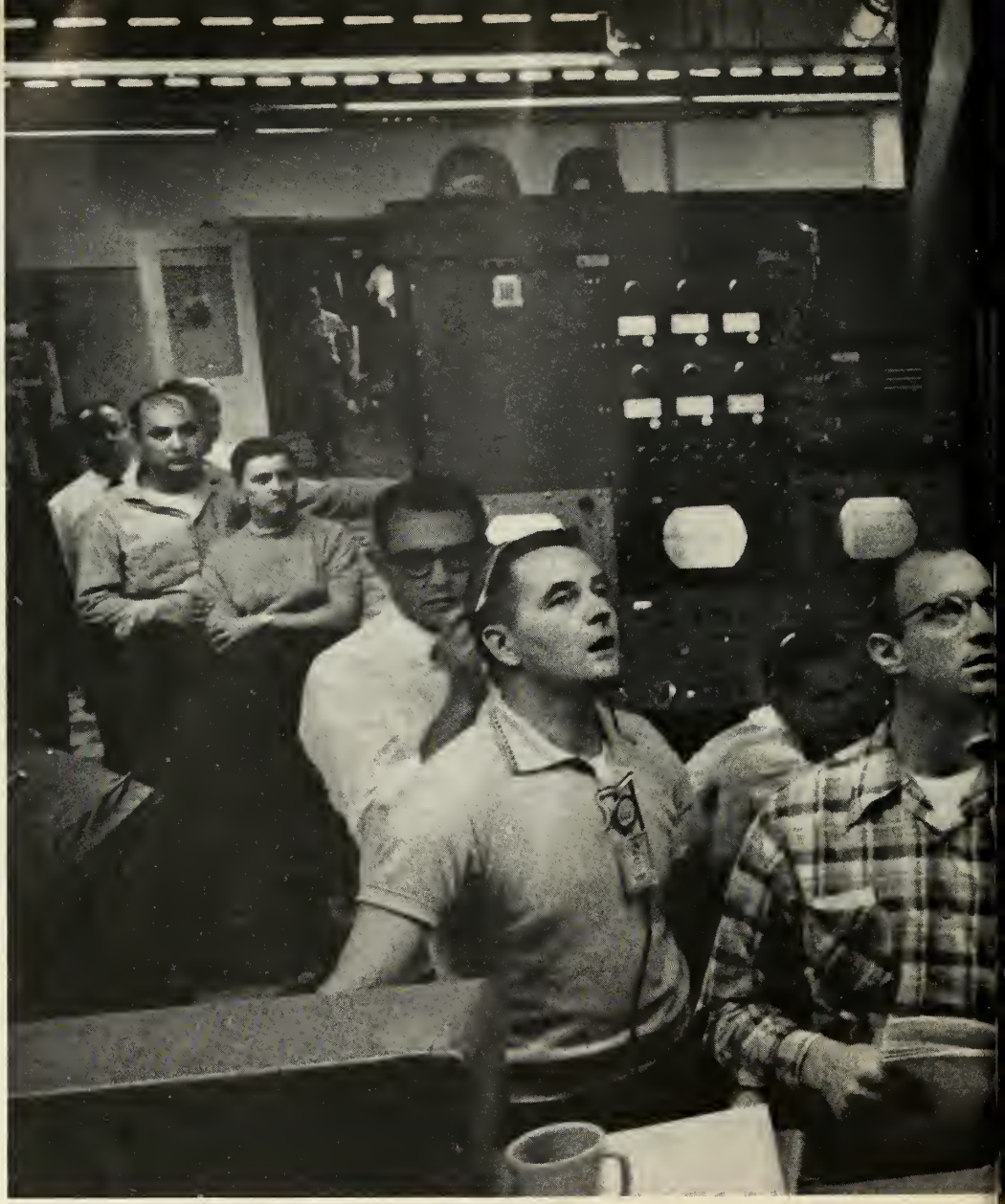
YOUNG MEN with big decisions. A new industry gives birth to a new breed of crew-cut, white-collared, creative engineers to man the drawing boards, run the checkout and countdown consoles, decide whether or not to call off, and later to analyze test results.





SORRY SQUATTERS get word that electrical d ties in propellant system will hold up test. Next d was delayed again to check booster engine's null po





BAD NEWS at 1:35 p.m. explosion, recorded on the television monitors is reflected in the faces of the blockhouse crew as the reality of the catastrophe sinks in.

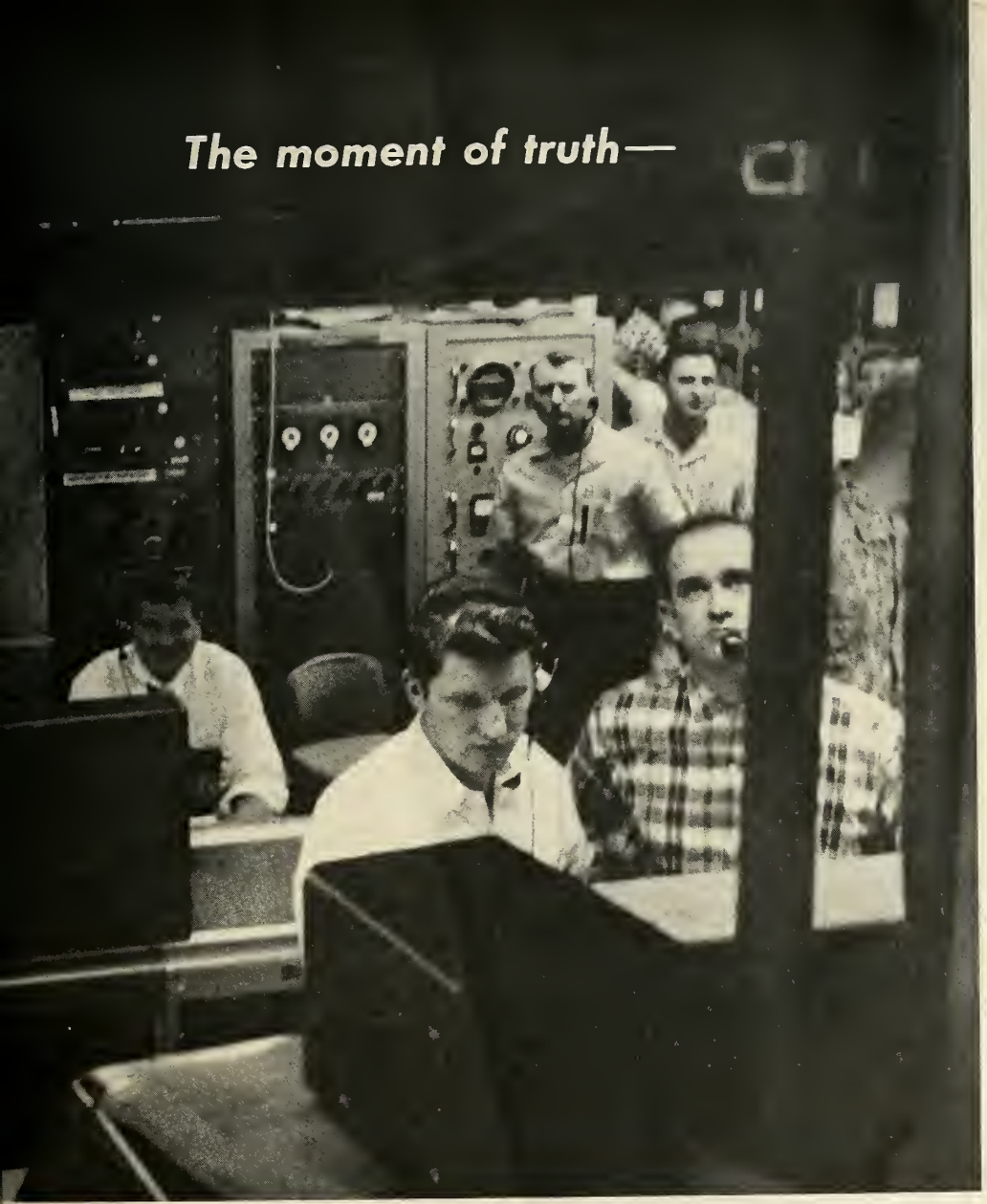
"Because of elaborate safety precautions, no personnel were injured and damage was confined to the test stand and superstructure and nearby ground support equipment."

Questioned after the explosion, spokesmen at Convair Division, General Dynamics Corp., where the missile is under production, said the *Atlas* had undergone "hundreds" of such tests and that this was the first time one had exploded on the ground. "We've been real lucky for quite a while on engines," a spokesman said. "When you're dealing with thousands of parts (more than 40,000 not counting subsystems), any one of these can fail. But that's what the tests are for—to find any weak spots."

He pointed out that in *Atlas* tests the same failure has never shown up more than twice. "By the third run, we have always had that particular bug licked."

A top Convair official expressed "high confidence" in *Atlas'* reliability. "The *V-2* achieved 80% reliability out of 4000 flights," he said. "I have no doubt we will achieve at least this. We are awfully close to that now and this is still a development program."

The moment of truth—



Reason why failure of one missile part can end in such a major catastrophe is the amount of energy involved. An *Atlas* burns in 15 seconds about the same amount of fuel as that of a DC-7 on an entire cross-country trip.

While the explosion rocked the countryside it also rocked the men in the blockhouse. Even more than the representatives of Convair; Rocketdyne, which builds the *Atlas* engine; the Air Force's Ballistic Missile Division, and Space Technology Laboratories, the technical men who had worked closely over a period of many months were visibly affected. Said one: "I knew every pore of that bird."

That theirs is not "just another job" is quickly evident to the blockhouse observer. The challenging needs of the new space field have given rise to a new type of technician and engineer determined to meet them. Sporting crew cuts, white collars, bow ties and a sense of purpose and dedication, many of them live with their jobs 24 hours a day. Some admit waking up out of a sound sleep to ponder a problem. Others dream about them. Emotional involvement with their machines is common among them and when one fails there is a sense of personal



CAPT. DAVID FRAZER, BMD representative, and Donald Fagan of Convair confer with fire marshal.

disappointment. When one disintegrates before their eyes, as in this case, it is taken like the passing of an old friend.

A rare team spirit pervades the blockhouse. It is keenly felt first during the pre-test briefings, when all hands, including the outside crewmen, are given a run-through in an atmosphere of a before-the-game pep talk. Every eye is riveted on the test conductor as he explains aim of the test, timing, roles and asks for a perfect record with everybody giving it everything he has: "Your full cooperation and attention is essential."

It would be in keeping with the tenor of the scene if he wound up the meeting with the rousing admonition: "Our team must win!"

In this *Atlas* test things moved like, and by, clockwork until the first delay, then picked up again until the second holdoff broke the tension. As the countdown started again, from a relaxed beginning, the technicians were soon busy again directing their full attention to the job at hand.

NOTHING LEFT but the beak of the bird in its nest. Ground crew man takes last look. Another will one day lift the first U.S. manned capsule spac

At T-O, all eyes were on the television monitor.

First reaction, as the moment of truth hit, was one of complete disbelief, then reluctant recognition followed by speculation on the cause of the explosion. The fire marshal gave assurances that no one was hurt and the job of gathering up the yards of recording paper that charted each minute phase of the operation was begun.

Last to leave the blockhouse was test conductor Donald Fagan of Convair. The men filed out leaving him slumped behind his console and went to take a last look at the smoking and torn hulk of what was left of their once proud space machine.

Atlas has now undergone 23 test flights. Out of the last 14, which had complete systems, nine were reported to have been completely successful with four of the 14 recorded from 25% to 90% successful.

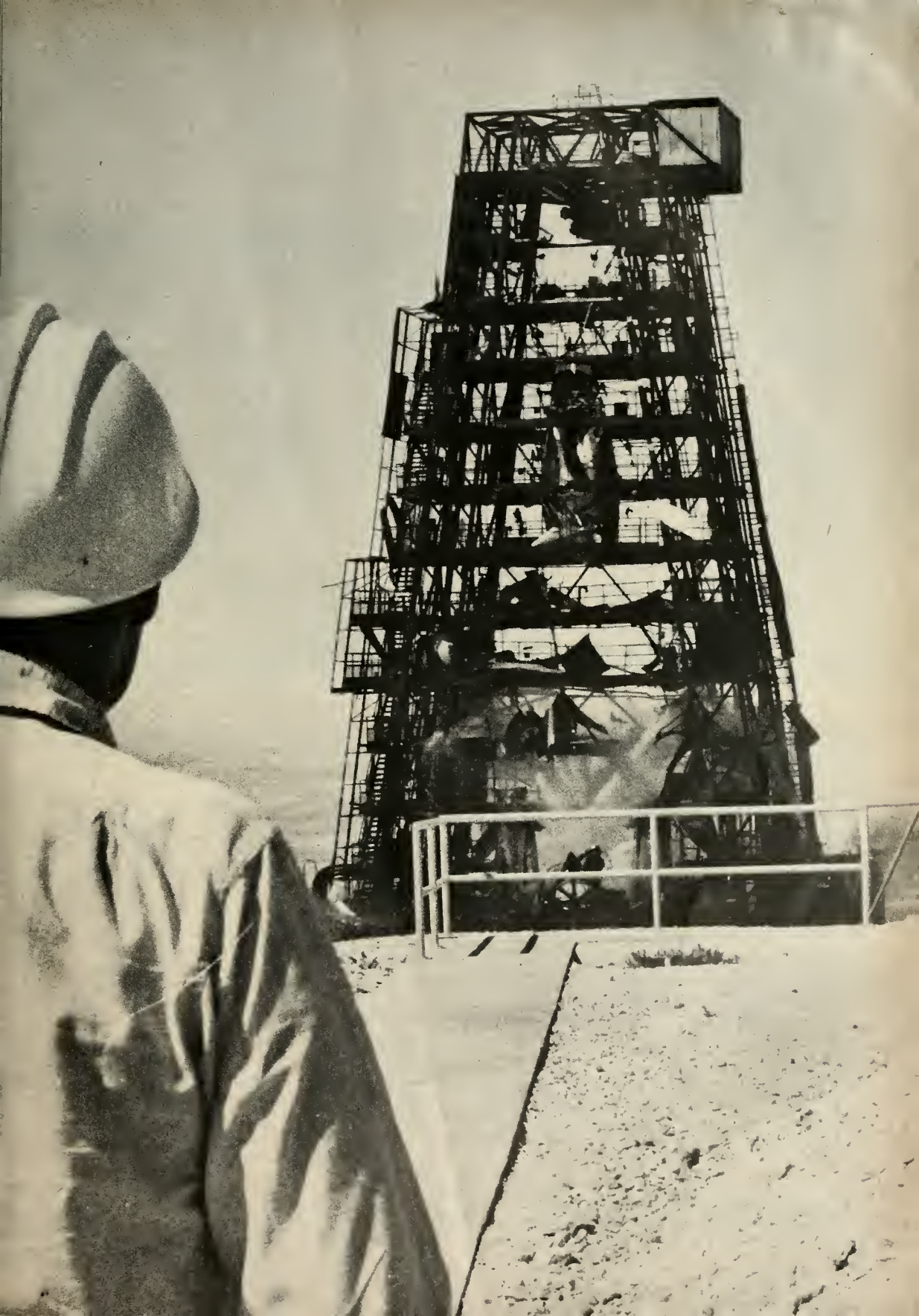
An *Atlas* powered by Rocketdyne engines will lift the first U.S. manned space capsule, *Mercury,* under contract from the National Aeronautics and Space Administration.

Atlas fabrication began in San Diego in 1955 with first engine tests run at Edwards in June 1956. Completed missiles were delivered to Sycamore and Cape Canaveral that fall.

Convair's associate contractors, in addition to Rocketdyne, include General Electric Co. and the Burroughs Corp., radio-inertial guidance (to be followed by American Bosch Arma Corp., all-inertial guidance), General Electric Co. and Avco, nose cone; and Sundstrand Turbo Division (formerly American Machine and Foundry), airborne accessory power supply.



EPITAPH for a missile is written on yards of recording paper which closely charted each test step.

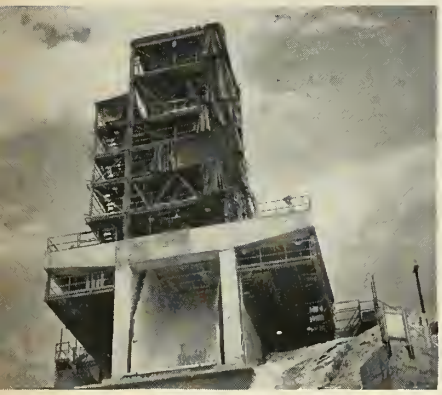




(left) Navy Polaris AX-1 flight test vehicle at beginning of launch. Lockheed's Polaris fleet ballistic missile is more than a year ahead of original schedule.

(below left) One of the Santa Cruz test stands with dynamic thrust mount to simulate flight environment. Vibration oscillator functions during static firings.

(below right) Large centrifuge for environmental testing has unique shaker attachment to provide vibration simultaneously with high G-loadings.





TEST / Expanding the Frontiers of Space Technology

Testing is a vital part of every stage in the development of missile and space programs at Lockheed Missiles and Space Division.

The Division maintains one of the most completely equipped missile and space test laboratories in the world. Equipment includes: altitude, temperature and humidity chambers; shaker and vibration systems; G-accelerators; and apparatus capable of performing chemical, metallurgical, plastic, heat transfer, hydraulic, pneumatic, shock, acceleration, sinusoidal and random vibration, structural, electrical, and electronic tests. Static field testing; research and development testing on controls; testing in ordnance and hydraulics and high-pressure gas and propulsion systems are conducted at the 4,000 acre, company-owned test base in the Ben Lomond mountains near Santa Cruz, California.

Flight testing is conducted at Cape Canaveral, Florida; Alamogordo, New Mexico; and Vandenberg AFB near Santa Maria, California; in a unique manner. All components and sub-systems of a new project are initially tested on known-performance, production missiles. Thus, when the final system is ready for first flight, its individual components already have flight-tested reliability. This new concept of flight testing has enabled Lockheed to produce extremely complex missile systems in record time and at greatly reduced expense.

Underwater launch tests—including studies of cavitation, wave simulation and skip motion—are carried on at the Sunnyvale facility and at the Navy test base on San Clemente Island. In addition, structural and other tests are performed at Hunter's Point Naval Shipyard, California.

If you are experienced in any of the various phases of testing, we invite your inquiry. Positions also are available in physics, mathematics, chemistry, or one of the engineering sciences. Write: Research and Development Staff, Dept. E-29, 962 W. El Camino Real, Sunnyvale, California. U.S. Citizenship required.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics." NATIONAL MISSILE INDUSTRY CONFERENCE AWARD

Lockheed / **MISSILES AND SPACE DIVISION**

Weapons Systems Manager for Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; Air Force Q-5 and X-7.

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

How Far to Go with Redundancy?

Duplication seems to be on the increase in industry, but many experts call for limits on the expensive and risky practice

by Charles D. LaFond

WASHINGTON—Many design engineers are questioning the wisdom of unrestrained or unnecessary use of circuit and equipment redundancy. It is admitted that by careful investigation and analysis, weak spots in an electronic system can be predicted and should be strengthened or compensated for. But how far should this be permitted to go?

Is it better for the design engineer to duplicate relatively high-fail-potential equipment or circuit elements without limit—or should more time and effort be spent in creating better circuit design with more reliable and longer-lived components? This is not meant to imply that redundant configurations should not be used, but that their use should not be the excuse for avoiding the betterment of conventional circuits.

The use of redundant circuitry for achieving higher equipment reliability appears to be on the increase. Just how much industry is using it at present is not known, but certainly a great deal of time, effort, and money is being spent in studying the feasibility of duplicating equipment and circuits in electronic systems.

The requirement for redundancy is based on the sometime need for systems in which no single component failure can be permitted to cause a system failure or even severe performance degradation.

For those not too familiar with the term, there are several kinds of redundancy:

• Parallel-redundancy involves the use of two (or more) identical units or "chains" of equipment. If a unit fails, its counterpart still provides adequate performance. With proper design, some of the unit pairs produce an additive output; that is, together they achieve a higher-than-minimum performance.

• This same system, employing parallel-redundancy, may have some units that cannot be operated together. Here, standby-redundancy can be employed. The duplicate equipments are connected in such a manner that one is in operation while the other is a "hot" operating spare, or standby. Some type of failure-detector switching device is included for control.

• Circuit-redundancy is an internal type of duplication. As a result of careful analysis during developmental stages of an equipment, the failure probability of some subsystem circuitry may be determined to be too high. To correct this, an additional circuit is added (where possible) for each weak link. Necessary relay or switching circuitry must be included also.

Since redundancy is a method for improving reliability, the latter should be explained. Reliability can be defined as the probability of a unit performing its function as designed for a minimum time period and under given operational environments.

• **Past use**—Parallel and dual back-up equipments have been employed successfully—albeit expensively—for many years. Commercially, the radio and television industry has utilized extensively the philosophy of operating standby systems. Equipment and maintenance costs are far outweighed by the potential losses in advertising money and audience in case of station failure or rapid transmission degradation. The military currently is a principal advocate of this concept for obvious reasons.

Because equipment reliability is

Antennas for BMEWS



GIANT RADAR tracking antennas are being built by Goodyear Aircraft for the Air Force BMEWS installation. Mounted on 30-foot pedestals in 140-foot diameter radomes, the antennas are among the largest ever made. They will provide a radar fence in the Far North to detect and track enemy ICBM's as they appear above the horizon.

The work is being done by Goodyear under a multi-million-dollar contract with RCA, system prime contractor. Air Force AMC has primary responsibility for the project.

not always high enough for their needs, the extra costs must be weighed against such factors as the saving of human lives and achieving minimum warning time for retaliatory offensive operations.

• **Redundancy studies**—Studies performed at Hughes Aircraft Company have shown that internally redundant systems using standard parts are considerably more reliable than conventional systems using specially chosen components. But they have indicated that although the failure probability can be reduced by a factor of "hundreds or more" system redundancy should be used with great discretion.

These systems, said S. Nozick of Hughes, are heavier, larger, and require more maintenance. He stated that internal redundance should be favored only when system failure is very critical in terms of human life or money. External functional redundance—the technique of relying on all or part of another system to replace functionally the failed system—should be considered by designers as an alternative to internal redundance.

Speaking of a well-integrated developmental team designing a highly reliable system with a suitable redundant configuration, Nozick said: ". . . a closely coordinated group with high morale can invent its way out of the problems that usually arise." He also warned that consideration must be given to the fact that parallel or redundant circuitry might relax the control required on components or subsystems during equipment construction and component specification.

• **Future reliability**—In the present state of the art of redundant circuit design, the requirement for specially trained engineering groups needed to develop these systems is paramount. Although reliability can be improved substantially, redundancy is always expensive and frequently inadequate.

The answer to achieving higher reliability seemingly does not lie with redundant design as we know it, but the technique is an effective and existing tool.

One potential source for increasing circuit redundancy, especially in missilery, is in the future use of semiconductor "solid-circuitry" developed by Texas Instrument Co. and Westinghouse. Because of the small size and weight and very low power needed, these functional circuits may offer a vastly different kind of redundancy in years to come.

New Way to "Grow" Germanium

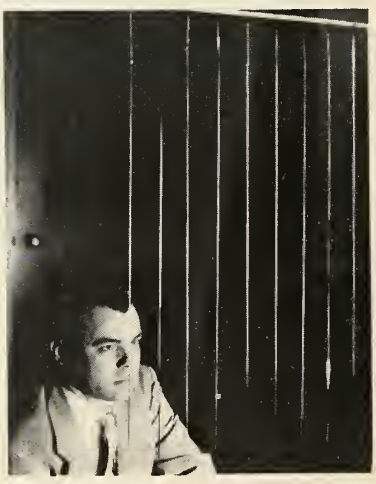
ANDREWS AFB, Md.—Westinghouse Electric Corporation's process for "growing" germanium crystals in uniform, thin, flat ribbons has earned it a $2-million development contract from the Air Research and Development Command. In addition, Westinghouse's use of this material to create "functional" solid state circuits is another step toward revising current electronic design concepts.

In announcing the contract award by Wright Air Development Center, Maj. Gen. John W. Sessums, Jr., commander ARDC, said it was part of a broad program effort in this new field of molecular electronics.

The development centers on the method of growing the crystals, since the final product eliminates the need for tedious and costly slicing and polishing heretofore required. Westinghouse scientists said the manufacturing technique permits growing the material in the exact form in which it can be used for practical application in transistors and other semiconductor components.

A result of a new knowledge of the structure of material, the company believes the new method will radically improve existing transistor manufacturing processes. Westinghouse already envisions machines turning out finished transistors at high speed directly from on input of raw germanium and the two or three other materials needed to complete the device.

The new technique for growing germanium was the work of two Westinghouse research physicists, Dr. R. L. Longini and Dr. A. I. Bennett, both of the laboratories' solid state physics department.



DR. BENNETT, codeveloper of new growth process, and the new germanium ribbons.

"The ease of processing dendritic germanium into usable form contrasts sharply with present practices," the Westinghouse scientists said. "To process conventional germanium ingots into useful form, they must be sliced into thin wafers somewhat like a loaf of bread is cut into slices. Because germanium is so hard and brittle, the cutting is done with a diamond-tipped saw, and each slice has to be three to five times the desired thickness simply to keep it from shattering.

"The slices must then be ground down to the required thickness, further cut into small squares, and finally polished. Only then is the germanium ready to be fashioned into finished transistors or other devices. As a result of all this cutting and polishing, about 80% of the original ingot is thrown away as germanium 'sawdust.'"

Not only is dendritic germanium of the proper thickness for direct use, said the scientists, but its ultra-smooth, mirror-like surfaces need no grinding or polishing of any kind.

• **Functional circuits blocks**—Research results to date indicate that the new process and the use of functional semiconductor circuits may lead to the development of outer-space electronic equipment 1000 times smaller and lighter than anything now in existence. In describing foreseeable products resulting from the Air Force's development program, Col. Clarence H. Lewis, director of ARDC's Electronics Directorate, said the concept could take the average pocket-sized transistor radio circuitry excluding the power supply and speaker down to the size of the head of a match."

In use, these very small pieces of crystal could perform the functions that now require as many as a dozen present-day components using conventional circuitry, Col. Lewis said. He added that two possible functions of the minute equipment are the sensing of environmental conditions and transmitting the data to any desired location. Feasibility studies are being conducted on infrared, reconnaissance, flight control, communications, and other military applications.

As an example of the size and weight reductions possible under the

ıew concept, Col. Lewis said that thc nost modern system used today to neasure the intensity of light in space ıas a volume of about one cubic inch ınd a weight of approximately seven grains.

The Air Force has conducted demonstrations with a Westinghouse light elemetry subsystem which has a volume of 0.001 cubic inch and a total veight of 0.2 gram. This equipment ıot only measures change in light intensity but also produces a signal capble of transmission to relate the degree of change in intensity.

The number of component parts in he telemetry subsystem was cut from 4 to 1 and the number of soldered connections was reduced from 15 to 2, hereby offering a tremendous potential o reliability, Col. Lewis said.

Ohio State Team Makes Low-Cost Radio Telescope

WASHINGTON—A unique radio telescope being built by a "professor-student" team of Ohio State University will permit mapping the sky at a minimum cost.

Scheduled to be ready for operation in 1960, the telescope will consist of a fixed paraboloidal antenna, a flat tiltable reflector, and associated radio receiving equipment. Both 360 feet long, the fixed dish is 70 feet high and the tiltable antenna is 100 feet high. Collecting area of the latter is equivalent to that of a 170-foot diameter steerable dish and it costs about 90% less.

Under the direction of Dr. John D. Kraus and three non-student assistants, the system is now in construction. The project is supported by three National Science Foundation grants totaling $272,650 and two university grants totaling $21,600. A 20-acre site has been donated by Ohio Wesleyan which also will control the surrounding land to prevent any operational interference.

Radio waves from the sky area under observation will be received on the tiltable antenna, reflected horizontally to the fixed dish, and then directed to the receiver system for recording.

All components of the telescope will be in fixed position on the ground. The earth's rotation brings new radiation sources in the sky into the field covered by the telescope. In a 24-hour period, a narrow band entirely across the sky can be "mapped." Changing the angle of the tiltable reflector will move the band of observation up or down, so that eventually a large part of the sky can be fully mapped.

The design of the telescope is sufficiently flexible to capture and identify radiation from a wavelength of 21 centimeters up to about 20 meters. The geometry of its design provides that regardless of the angle of the tiltable reflector, radiation striking it will be deflected via the fixed antenna to the receiver. Structural problems arising from mounting receivers high in the air on movable antennas are also avoided in Dr. Kraus' cost-saving design.

This telescope will not be able to follow an object across the sky as well as steerable dish antennas can, but will depend primarily upon the earth's rotation for its collecting area.

hush-hush?

If you're now involved, or becoming involved, in hush-hush projects, you know how vital it is to have sources who can deliver on time, to rigid specifications. That's why it's important to constantly investigate and compare **new sources — to be sure!**

Cleveland Tool and Die Company has the capacity, ability and facilities* to insure your success. We're precision **specialists** in the manufacture of component mechanisms, sub assemblies, gages and fixtures . . . in custom machining, boring and grinding.

We've performed an important part in such exotic projects as the Shippingsport atomic reactor, the U.S.S. Nautilus, Redstone Arsenal, and Princeton's new synchrocyclotron. **When you talk to CTD, you know you're talking to qualified, dependable people.**

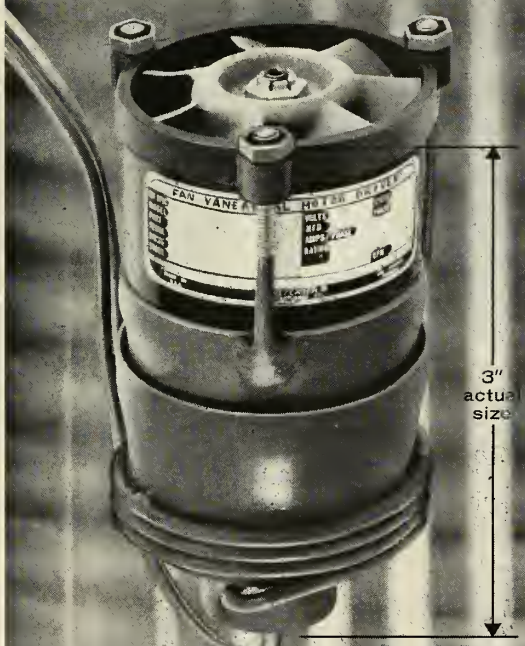
Please include CTD when getting your next quotations . . . **to be sure!**

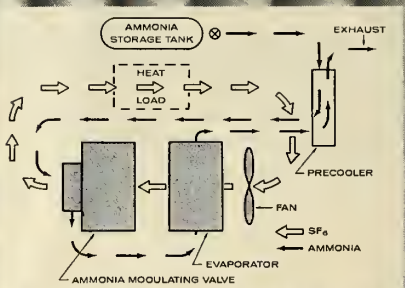
George Banko
President

CLEVELAND TOOL & DIE CO.
1740 Eddy Road • Cleveland, Ohio

*We've prepared a little brochure for your files, telling the CTD precision story, and listing our equipment. Drop us a line.

LIGHTWEIGHT airborne electronic cooling package





PERFORMANCE CHARACTERISTICS–
Heat Rejection: 200 watts... Inlet Gas Temperature to Component Housing: 130°F.... Weight of Fan, Evaporator and Controls: 1.25 lb.

Spans the gap between direct ambient cooling and closed cycle systems

● *This AiResearch open-cycle cooling unit* is designed for environmental conditioning of electronic and electromechanical equipment in problems of low total heat dissipation aboard aircraft and missiles.

Much lighter and less complex in operation than closed cycle systems, this compact package is recommended when required total heat dissipation is low... large heat loads for short periods of time, or small heat loads for long periods of time. It also replaces direct ambient cooling systems when ambient sink is not low enough or not easily available.

Ammonia in this expendable evaporative system cools sulfur hexafluoride (SF_6) which passes over the hot electronic components. The SF_6 then recirculates for cooling, and the ammonia is dumped overboard.

Applications of this system include: inertial guidance system cooling, missile transient cooling, and spot cooling where ambient sink is not available.

AiResearch has designed and manufactured cooling systems of all types ... direct ambient, closed and open-cycle systems handling all magnitudes of cooling loads and utilizing various working fluids. We invite you to send us details of your problem.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

'Quite sure' Bell-Martin will land contract . . .



BELL'S Dr. Walter Dornberger, "a man of stereophonic sound."

'Father' of *Dyna-Soar* Awaits AF Decision

by Erica M. Karr

WASHINGTON—An Air Force Source election Board is sifting data to de- ide which of two pooled-company eams will get the *Dyna-Soar* contract. Optimistic reports say the decision will e made by mid-June. Others close to he project indicate a more realistic et is after July 1.

During the last two weeks of April, AF evaluation teams, numbering close o 100 technical experts, descended on The Martin Co. in Baltimore and the Boeing Airplane Co.'s Pilotless Air- craft Division in Seattle for an on-the- pot appraisal to guide the 20-man election board. Winner of this two- way contest will walk off with a con- tract which may eventually total $650 million to develop *Dyna-Soar* (from dynamic soaring).

The Air Force has asked Congress or $109.8 million in new obligational uthority for *Dyna-Soar* in Fiscal Year 960, with actual expenditures to run o $73 million in that period.

The manned boost-glide vehicle will ave a global capability. Initially, it vill be developed as a prototype test ystem to explore the flight region eyond that of the *X-15*, and extend- ng to near-satellite velocities and alti- udes.

It will be a ground-launched, step- ype vehicle, initially boosted to very igh altitude and speed by ballistic mis- ile boosters which fall away from the npowered, man-carrying last-stage lider. It will be a "laboratory" for athering information needed in later pace development work.

One military role envisioned for ater versions is in the "missile storage n space" concept. Idea would be to ave earth continually ringed with or- iting hydrogen-missile-carrying *Dyna- Soars* which would be controlled from space station, eliminating the need for vulnerable ground facilities and advance warning systems. These could be unleashed for instant retaliation wherever needed. It is estimated that $1.2 billion annually could maintain such a defense network.

• **Line-ups**—Each of the two competing industrial giants is backed up by a group of companies ready to pool their technical resources in a new approach to system building—the company team concept as opposed to the prime-subcontractor systems. On the Martin-Bell team are Bendix, Minneapolis-Honeywell, AMF and Goodyear Aircraft. Boeing, which also has Goodyear on its team, has in addition North American Aviation, Aerojet, Chance Vought Aircraft, General Electric, RCA, and Ramo-Wooldridge.

Dr. Walter Dornberger, originator of the *Dyna-Soar* project, and recently named as engineering director of Bell Aircraft's Niagara Frontier Division, is sure that the contract will go to the Martin-Bell team. If so, the ex-German rocket expert will direct work on development of the glider vehicle. Asked "If not?", Dornberger replied: "Then we will work on another version of *Dyna-Soar* or satellite interceptors, rescue ships, maintenance and supply ships, a shuttle rocket to space stations or the final stage of a moon rocket."

• **Dornberger's vision**—Dr. Dornberger is a longtime booster of the team approach to space flight and raised some eyebrows during last year's meeting of the National Missile Industries Conference when he said in a speech: "We cannot afford competition for contracts to build space ships.

"In the coming years we will see only a few industrial combines able to develop big space ships. By pooling facilities, brains and manpower, they alone will provide the necessary capability and productive power to which the nation may hand the technological responsibility in the Space Age."

Dornberger is an old hand at new concepts, dating back to 1930 when he found himself heading a small group in Germany's Army Ordnance Division which had been directed to make modern weapons out of rockets. Later, the man who was to become Wernher von Braun's boss directed the 17,000-man Peenemunde rocket operation which developed and launched the *V-2's* during World War II.

Dornberger began pushing the idea of the rocket-boosted glider soon after he came to Bell Aircraft in 1950. Bell, in turn, started pushing it with the Air Force in 1952 when it was called *Bomi* for bomber-missile; but it was not until Russia launched *Sputnik I* that the Pentagon worked up any enthusiasm and got the ball rolling.

• **Forceful**—The father of *Dyna-Soar* is a man of strong opinions who expresses them in clipped, colorful, German-accented pronouncements illustrated with forceful gestures. Said one science reporter after a Dornberger press conference: "He's the world's only human who speaks in technicolor and stereophonic sound."

Although his Prussian manner and opinionatedness rub many newspapermen the wrong way, his sweeping assertions always make lively copy. Sample quotes:

Education—*Our system is all wrong. Everyone who has the brains and guts should get a higher education despite lack of money.*

Vanguard—Vanguard was a mistake. We should have used existing hardware. We would have had a satellite up sooner.

Goals—*The future problem is no longer to bring a couple of tons of payload into orbit but to bring 20, 30 or even more tons at any spot in space with the correct direction and speed.*

Manned vs. unmanned—*Space can only be utilized effectively by manned vehicles. An automatic space vehicle would necessarily have to be so complex that the possibility of its failure in space would be tremendous. Space will be conquered by man and not by machines.*

Anti-missile missiles—*Practically useless. Out of 100 ballistic missiles shot at us, 90 would get through with the present state of the art on anti-missile missiles.*

Long-range planning—*We should agree on a line of priorities for the next 20 years to survive as a free nation. Priorities should run in this order: (1) long-range ballistic missiles; (2) data-gathering research vehicles for cis-lunar space; (3) all weapon system, manned or unmanned, in cis-lunar space; (4) data-gathering research vehicles for trans-lunar space; (5) space vehicles for commercial application; (6) prestige flights; (7) stunt flights.*

Space Race—*Russia may put a man-carrying satellite into orbit within the next year. It may take us three years to do this.*

Royalties for scientists—*Creative thinking and imaginative engineering should be paid for . . . the government should guarantee a share in the profit of later production for the original creative mind.*

Need for speed in the space race—*I have lost two world wars. I did not come to this country to lose World War III.*

• **Nazi failure**—If the Nazi wheels had listened to Dornberger, the history of World War II might well have been different. But despite Dornberger's urging, Germany's rocket-weapon program went into high gear too late.

Getting it off the ground had been for a long time literally a go, no-go proposition. Gen. Prof. Dr. Karl Becker, head of the Board of Ordnance, had trouble laying his hands on the money needed to launch this "outlandish" idea; finally in 1932 he ordered all Ordnance divisions to contribute 10% of their budget to Dornberger's project.

In all it cost $300 million to develop the *V-2*.

There was not much in the way of previous rocket research and the team had to start from scratch: How big? How much payload? What distance? "I sat down with Von Braun and an artilleryist and we arbitrarily decided to make the payload 100 times that of the Parisian 10-pound gun with over twice its distance of 50 miles. Size was determined by the tunnels and streets through which it would be transported."

First successful firing of the *V-2* was not until October, 1942, and there were 36 more before they achieved a second successful firing—"A lot exploded on the ground; we had no telemetering system, either, to tell us what was wrong."

When problems came up, Dornberger said, "I put my men in a room and told them 'You get nothing to eat until you come to a conclusion.' By 1943 they had achieved 50% reliability, by 1945—78% and they were firing 30 a day.

Von Braun, now director of the Army's missile development at Redstone Arsenal, recalling his early years with his old chief, told M/R:

"Dr. Dornberger and I first met in 1932 when I was a student at the Technical University of Berlin, and it marked the beginning of 13 years of close association and the beginning of a rocket development program with far-reaching implications.

"Selling the new ideas of rocket propulsion and promoting and fighting for the support of adequate programs to fully develop its potentials, was a tremendous undertaking. It required courage, dedication and passionate perseverance. Dr. Dornberger led us from the shortcomings of our 1932 presentations and transformed our youthful enthusiasm into sober engineering plans.

"He is a man of profound technical knowledge, imagination and the ability to combine the technically feasible with the militarily sound and practicable. These, together with his personal tolerance and warmhearted understanding for the capabilities, limitations and personal problems of his associates, made Dr. Dornberger the greatest single force behind German rocket development. And he shared with his younger associates the deep fascination for the limitless challenge of future space exploration.

"He was to me a courageous, fatherly friend who, in many dangerous and critical situations, in particular during the declining months of Hitler's Germany, never let me down. On more than one occasion he helped me at considerable risk to his own safety."

After the war Dornberger came to the United States as a missile design consultant for the Air Force at Wright-Patterson AFB, and in 1950 joined Bell in a similar post.

He was appointed technical assistant to Bell's president in 1957, and was named to his new post April 13th this year.

Today, Dornberger, whose life for the most part was focused high above the clouds, has completed long-range plans for ending it there: "I want to be the first man buried in space. When I die I want my ashes put in a glass urn and carried up by a manned space capsule to orbit in eternity." "Von Braun said he will take them up there," said Dornberger, eyes twinkling. He added mischeviously: "Von Braun says it will be an urn with a hook and every year on the anniversary of my death he will soar up and hang a wreath on it."

Dyna-Soar: First Maneuverable Spacecraft

Dyna-Soar's early explorations through the atmospheric fringes will erase many of the question marks confounding man as he plans for space exploration. The rocket-boosted glider will be a bridge between aerodynamic and space flight. It could be used for bombing, reconnaissance and scientific and commercial missions.

The domain of the *Dyna-Soar* will be that area between the ceiling for air-breathing engines—almost 19 miles up—and the floor for satellites—slightly over 93 miles up. Excursions out of this area will pose some problems, not the least of which will be temperature.

The glider's return to earth will be controlled from the ground, as will positioning in orbit.

In its early flights, *Dyna-Soar* probably will be unmanned and will be recovered after several orbits by an automatic system already demonstrated by Bell Aircraft. However, even when manned, it will be brought back by automatic control.

Presentation of information may offer a stiff challenge. Re-entry involves velocities from satellite down to sonic, aerodynamic lift varying from 1 or 2% to 100% of weight, and accelerations and temperature changes which are limited by the structure and payload. Processing this information to adjust the re-entry path will be an important system requirement.

Accuracy requirements for the boosted phase can be greatly diminished if the vehicle has the maneuvering capability to modify or correct an initial orbit or trajectory. This would reduce the amount of ground or airborne information needed, and the sophistication of components. The correction would be pilot-controlled



ARTIST's conception of a later-day *Dyna-Soar* with lentil configuration entering the earth's atmosphere at a 90° angle.

• **Configuration**—What will *Dyna-Soar* look like? The work of Julian Allen and A. J. Eggers indicates that blunt shapes with high-pressure drag would be most efficient for skip gliding since these characteristics minimize aerodynamic heating, particularly for relatively light vehicles. Later variations of this concept include the lentil configuration which would enter the atmosphere at an angle of attack of 90°. in this way acting as a blunt shape. Another possibility is a blunt-nosed vehicle, which after achieving entry would rotate to 180° so that a low-drag "tail" becomes the leading element. Bell's *Dyna-Soar* reportedly will have the blunt-nosed Allen configuration.

Dyna-Soar will not skip as it glides down at slow deceleration and its shape will be based on a high lift-over drag factor. The Lentil configuration will probably emerge in one of the later *Dyna-Soar* versions.

Bell Aircraft's mock-up of *Dyna-Soar*, still under security wraps, was viewed by the Air Force's evaluation team on its appraisal visit to The Martin Co., Baltimore, last week.

• **Human factor**—Keeping the pilot comfortable under the space-equivalent conditions he faces in *Dyna-Soar* means that for the region near or below the glider's flight planners must cope with the vapor pressure of body fluids in mammals—47 mm Hg (63,000 ft.). Oxygen supply will not be as much of a problem as in orbiting vehicles because flights can be short.

Acceleration and vibration will be similar to those in the launching and flight of a satellite and can be kept to similar levels during re-entry. One aim is to allow the crew to function without confinement of pressure suits or thermal shields.

• **Power**—Early versions of the glider could be satisfactorily launched by existing rocket boosters—*Titan*, for example. However, later versions will be larger and heavier to achieve maneuverability in space; hence increased booster capability will be necessary. Thought must be given to recoverable boosters, apart from the already recoverable final stage, for economy reasons. An air-breathing first stage might be used; then re-use would be a necessity.

• **Rendezvous**—To meet orbiting objects in space, the glider will need vernier adjustments in velocity. If the orbiting vehicle is radiating elctromagnetic energy, homing on this source could be achieved within the vehicle.

The power required for the glider to "jump" orbit is comparable to that in the original launch. In time these vehicles will be large enough to carry adequate propellants for making major modifications to orbits.

A vehicle weighing 11,000 pounds coming from a satellite orbit must dissipate 1.58 x 10^{10} kgm of energy (11.45 x 10^{10} ft. lbs.) before it lands. According to Dr. Everett T. Welmers of Bell Aircraft Corp., most of this must be achieved by radiation.

"A solution to this design problem which has been developed at Bell is the use of the 'double wall' structure," Dr. Welmers reports. "The outer wall, exposed to the airstream, is allowed to heat up to very high temperatures. Radiation from this surface back to space is approximately proportional to the fourth power of the temperature. The inner wall, which carries the structural loads, is shielded from the hot outer face by a layer of insulation and is further cooled by liquid passing through tubes attached to its surface. In this way all but a small percentage of the aerodynamic heating is re-radiated, the load-carrying structure is subjected to temperatures of about 200°F and thermal problems for equipment and crew inside the double wall become very simple."

The outer wall is of Inconel and can take over 2000°F. The inner wall is of aluminum.

Atmospheric density at 328,000 feet is such that the vehicle could maneuver at less than .01 g through aerodynamic forces. At 246,000 ft., aerodynamic pullout will be about one-third g's; at 180,500 ft., a maximum of about 2.5 g's. Below this altitude, structural limitations are likely to be more influential than aerodynamic forces.

• **Landing**—Between the time the pilot decides to land and actual touchdown *Dyna-Soar* will have traversed from one quarter to several times the earth's circumference. If re-entry and slowdown come off as scheduled, the vehicle, brought in by the automatic landing system, will be able to land within a rectangle of 2 x 5 miles. Tests at Bell Aircraft have achieved this with planes and guided missiles.

Both the Air Force and Navy have proposed that a coordinating body be set up for the Atlantic and Pacific missile range tracking networks—first for the *Mercury* project, then for *Dyna-Soar*. This is currently being discussed, at least by the Air Force and NASA.

• **Background**—Before the *V-2* program roared into high gear and halted work on it, the glide vehicle conceived by a German team under Dornberger's direction worked like this: The *A-9*, a variation of the *V-2*, was to carry under it another vehicle weighing 191 thousand pounds. Termed the *A-10*, this rocket booster would have a 50 to 60-second thrust to 440,000 pounds and a velocity of 2700 mph. At the *A-10's* burnout, the *A-9* would ignite. It would begin its supersonic glide at 35 miles altitude and travel a distance of 2500 miles.

This was based in part on the earlier work of E. Saenger and I. Bredt. Russia's glide-bomber work has resulted in the three-stage *T-4A* test vehicle. It is believed to have a 264,000-lb. liquid rocket first stage supplemented by two solid-propellant rockets. The second stage used the same liquid rocket and the third stage a 77,000-lb. rocket. It is estimated that take-off weight is over 231,000 lbs. and that it reaches a maximum altitude of 235 miles with ranges of 500 to 12,500 miles with top velocities of 5000-6500 m/sec. (16,400-21,300 ft/sec.)

Just how far the Russians have carried this program to date is not known.



Light,
reliable
Clary valves...

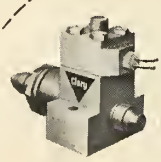
accurately control all types of gases and liquids under the most stringent environmental conditions

Helium, air, corrosive liquids, nitrogen, LOX, hydrogen peroxide – you name it, and these Clary valves will handle it, surely and capably. Their reliability is assured by manufacturing tolerances that frequently reach seven millionths of an inch, and by Clary's complete facilities for extreme environmental conditions testing.

When you want light, reliable, versatile, precision-built valves, come to Clary – one of the nation's largest manufacturers of valves in all types and sizes for aircraft and missiles.



SOLENOID VALVE
3-WAY, NORMALLY OPEN OR CLOSED
features:
hermetically sealed coil, low current consumption and rotable solenoid.
Rated Operating Pressure: 3000 PSIG
Voltage: 18-30 DC · Burst Pressure: 7500 PSIG
Connector: CD 3102-12S-3P · Leakage: Zero
Seals: "O" rings compatible with media
Ambient Temperature Range:
–65°F. to 160°F.



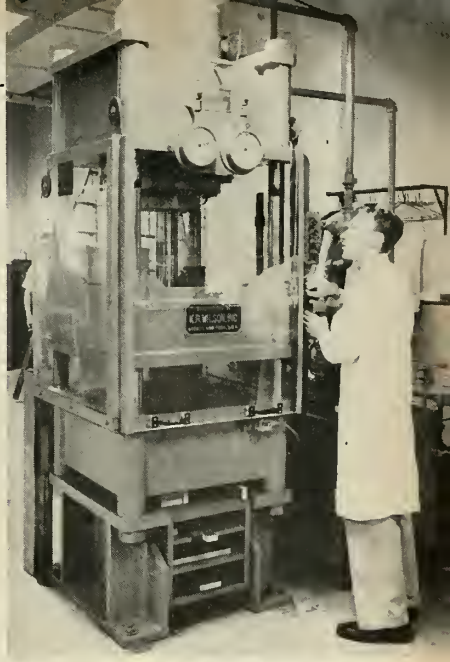
EXPLOSIVE VALVE
features:
positive on-off action, trigger release and protected seat.
Re-usable – just replace squib without disconnecting valve. Ball or poppett type construction. Standard sizes up to 2"– larger to specific requirements.

Clary Dynamics
San Gabriel, California

Manufacturers of business machines, electronic data-handling equipment, aircraft and missile components

Low-Cost Brazed Steel Honeycomb Structures

Martin's new hardened alloy solves problem of uneven filleting in brazing and allows opening of tolerances



200-TON PRESS is used to press the reduced powders of Al_2O_3 and matrix metal.

by Clarence A. Boyce, Jr.*

BALTIMORE—Brazing alloys available until now have made production of brazed steel honeycomb structures both difficult and expensive. The chief problem: uneven filleting caused by rapid flow of the alloy and its poor resistance to corrosion.

These limitations have been overcome in a new dispersion-hardened alloy developed by the Baltimore Division of the Martin Co.

The alloy is produced according to established powder metallurgy techniques. The initial distribution of the aluminum oxide in the metal matrix follows a method developed by R. H. Read while he was investigating the properties of dispersion-hardened copper. Read dispersed the aluminum oxide in copper oxide by wet milling the appropriate mixture.

This method is superior to mixing copper directly with alumina, because the latter method yields a smeared matrix and a non-uniform mixture. Since the oxide is harder than the parent metal, it is broken up readily without noticeable plastic flow and smearing.

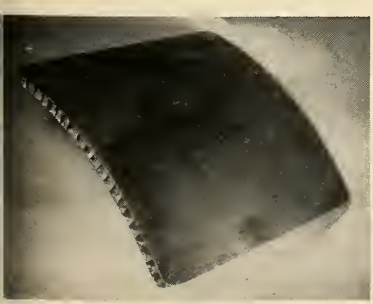
Following the milling operation the mixture is heated in a hydrogen atmosphere where the copper oxide is reduced to copper while the alumina, being very stable, remains unaffected. The powder is then pressed and processed by the usual powder metallurgy techniques.

• **Fine screening**—In the development of the Martin brazing alloy, the copper oxide was replaced by another oxide. The mixture was ball-milled wet in a conventional mill for two to three weeks.

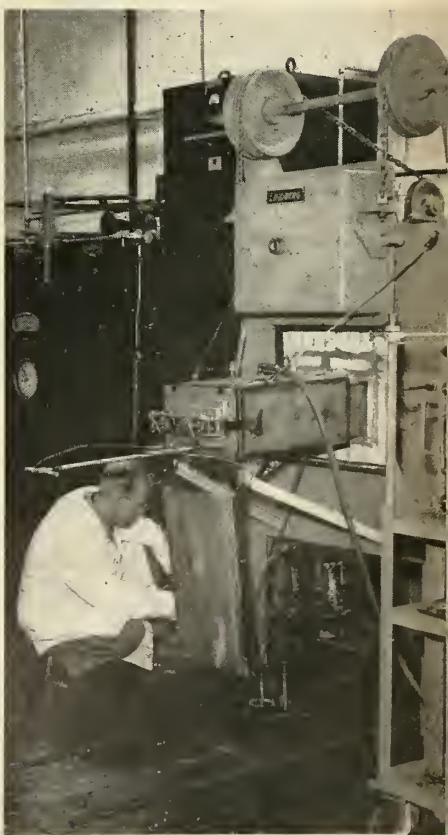
After drying, the powder was screened through a −180 mesh sieve to eliminate any large particles and treated in a hydrogen atmosphere at 75°-100°C for 2½ hours to reduce the oxide of the matrix to the metal, the alumina remaining unchanged.

The power was screened again through a −100 mesh sieve in preparation for briquetting. It was poured and leveled at a depth of 0.029 inches in a "push through" die having a rectangular opening of 1 3/8 x 4½ inches and

*Research Institute for Advanced Studies, The Martin Co.



COMPLETELY BRAZED panel using aluminum oxide dispersion-hardened brazing alloy.



SMALL FURNACE is used to sinter briquetted powders at Martin Company's Baltimore facility.

STRIKE OF THE HAWK!



RAYTHEON-DESIGNED Hawk missile annihilates radio-controlled F-80 jet fighter at 500 ft. altitude.



ARMY'S HAWK MISSILE is fired from mobile launcher. Missiles, launcher and support equipment can be air-lifted or quickly transported by Army or Marine ground forces.

NEW ARMY MISSILE DESTROYS LOW-FLYING AIRCRAFT

This *proven* anti-aircraft missile operates even at tree-top heights, in the blind zone of other radar-controlled missiles.

Raytheon is prime contractor for the U.S. Army Hawk weapon system—now in production and slated for use with fast-moving Army and Marine Corps ground forces as well as for the defense of U. S. cities.

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY, Waltham, Mass.

pressed at 200 tons. The most desirable size for the finished briquette prior to sintering was 0.050 inch thickness. The briquettes were then sintered at 1700°C for two hours and reheated prior to the rolling operations for a minimum of five minutes at 1700°F.

With the roll opening set 0.008 inches less than the briquette thickness, each briquette was hot rolled in a mill. The roll opening was subsequently reduced 0.004 inches prior to each heating and rolling operation and each briquette was given three passes through the rolls after each heating cycle. The heating and rolling operations stopped when the material reached a thickness of 0.020 inches. It was subsequently cold rolled.

• **Fluxing agent needed**—By continually decreasing the roll opening until the rolls were completely closed, eventually the material was reduced to a foil 0.001 inches thick. The finished foil was then ready for evaluation as a brazing alloy.

In the preliminary tests the aluminum oxide dispersion-hardened alloy would not wet steel very readily at 1800°F and 1900°F. It was thus evident that a fluxing agent was required in conjunction with the new filler alloy.

A foil of 99.7% silver alloy containing 0.3% lithium was placed in contact with the dispersion-hardened foil and the combination placed between the skin and the honeycomb. During the brazing cycle the lithium in the silver-lithium foil was concentrated enough to flux the core and the skin very thoroughly. Thus a successful brazed joint was achieved.

• **Psi increased**—A difference was noted between the flow of the silver-lithium and the composite alloy consisting of a layer of silver-lithium and the dispersion-hardened alloy. Specimen of 17-7PH stainless steel brazed with the silver-lithium showed slightly more flow than the other specimens brazed with the composite material.

Secondly, evaluation tests indicated the strength of the lap joints containing the dispersion-hardened silver was around 17,000 psi, whereas the silver-lithium joint yielded shear strengths of 11,500 psi. Thus a definite strength increase was shown which prompted further investigation and application.

Honeycomb panel brazed with commercially available brazing alloy produced areas of no brazing caused by starvation of the top surface. However, no starvation appeared after brazing with silver dispersion-hardened material.

The Martin Company is proceeding to braze larger and more complex panels. It is continuing the investigation of other fluxing agents and techniques and adding particles other than aluminum oxide as the hardening medium.

• **No adhesive**—Extremes of high and low temperatures in the environment of supersonic weapons systems have clearly shown the need for new materials and manufacturing processes for the fabrication of aircraft and missiles that can endure this environment.

The design of the weapons systems that will be operational in the early 1960's is far ahead of the industrial ability to manufacture them. The selection of stainless steel as the material to be used in these systems, because of its characteristic resistance to extremes of temperature, has brought on the problem of how to join the parts of an assembly.

With slower flying aluminum planes, adhesive bonding was adequate since the operational temperatures were never high enough to affect the adhesive bond. But with temperatures high enough to require the use of stainless steel, an adhesive bond is rendered useless. The only solution is to use a metal joint capable of enduring such an environment.

Brazing seemed to offer the answer until experiments showed that available brazing alloys flowed too readily. This caused the bottom joint to be too heavy and the top joint too light or to have no braze at all. Also these fillers showed a poor resistance to corrosion which could not be tolerated.

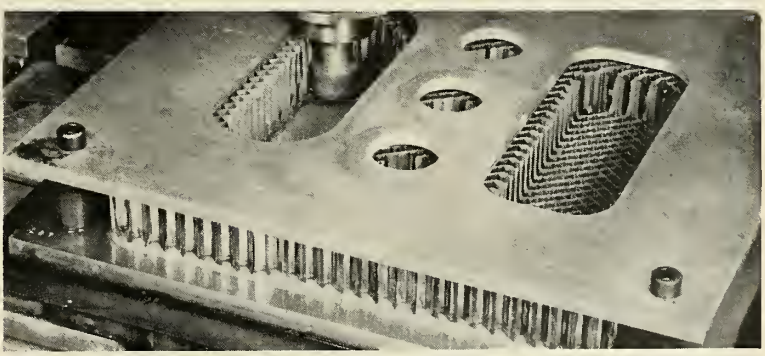
It was these deficiencies in the existing brazing alloys that convinced Martin that development of a new alloy was imperative.

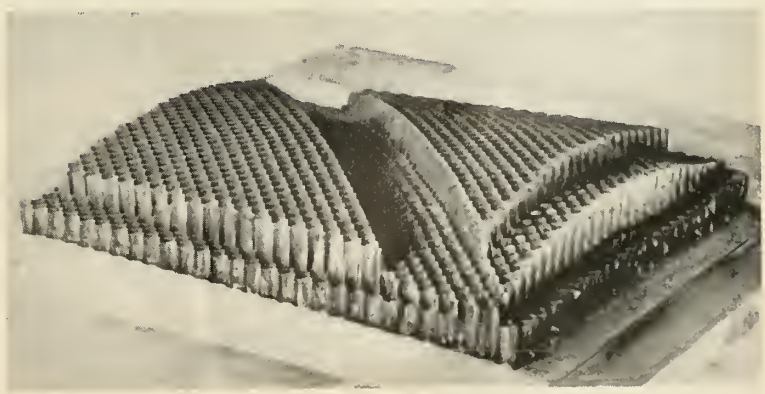
• **Future significance**—Brazing accomplished with this new alloy shows that a sound, strong brazed structure with even filleting can be attained with none of the defects attendant on the use of other alloys. It also allows an opening of the tolerances since the sluggishness of the melted alloy allows it to stay where it is placed and bridge the increased gap between skin and core.

These properties were first suspected by Dr. Howard R. Peiffer during basic metallurgical experiments with silver at the Research Institute for Advanced Studies.

Important as this development is at present, its use in the missiles and space ships of the near future will show the real significance of this process.

Methods of Machining





DIAGONAL CUT on stainless steel honeycomb is made by using overlay template for cavity machining. Lower picture shows how spiral cut is made in contour machining.

Board Chairman George M. Bunker continues as Martin Co.'s chief executive officer. But under management realignment, former executive vp William B. Bergen becomes president and principal operating officer. Move frees Bunker for long-range planning.

In a top management reshuffle, Frank Pace, Jr. has been named chairman of the board of General Dynamics Corp. Succeeding Pace as president is former executive vice president Earl Dallam Johnson. Carleton Shugg, a senior vp and general manager of the Electric Boat Division, moves up to president of Electric Boat. Elevated from general manager to president of the General Atomic Division is Dr. Frederic de Hoffmann.

Page Communications Engineers has become a wholly-owned subsidiary of the Northrop Corp. The company, engaged in Army and Navy communications, says it is working on a system to produce long-range, highly reliable air-to-ground and point-to-point communications over distances up to 3000 miles.

MIT's Dr. C. S. Draper, pioneer inventor of inertial guidance systems, is taking over the vacant chairmanship of the National Inventors Council. He succeeds the late Charles F. Kettering. Homer H. Ewing of Du Pont's development department has been named council secretary.

New fast tax write-off certificates issued by the Office of Civil and Defense Mobilization include: Thiokol Chemical, Bristol, Pa., 70% of $1.3 million; Sylvania Electric Products, Mountain View, Calif., 60% of $920,000 and Aeronutronic Systems, Calif., 60% of $401,000.

Missile stress factors will be featured at the Society for Experimental Stress Analysis meeting starting May 20 in Washington.

United Aircraft Corp.'s Hamilton Standard division is creating a new department for the design, development and production of specialized missile ground support equipment. Heading up the new organization is Edwin D. Eaton, formerly chief of experimental operations . . . Temco Aircraft Corp. is establishing a new electronics division and separate divisions for missiles and aircraft and aircraft overhaul. And B. F. Goodrich Co. and High Voltage Engineering Corp. have joined in the formation of Goodrich-High Voltage Astronautics Inc. to produce ion propulsion engines for space vehicles.

AF's *Hound Dog*—supersonic jet-propelled guided missile—was launched successfully for the first time April 23 from an Eglin AFB B-52 bomber. A two-stage *Cree* test vehicle fired the same day at Eglin went to an altitude of 70,000 feet to test a deceleration parachute for the *Mercury* manned space vehicle. A malfunction after ignition April 28 stopped a scheduled *Titan* stage separation test just as the vehicle was to leave the launch pad.



NORTH AMERICAN's *Hound Dog* air-to-ground missile carried by a Boeing B-52 jet of the Strategic Air Command. The new missile is currently in operational test.

Cape Operating at One-Fifth Capacity

WASHINGTON—The Cape Canaveral Missile Test Center—one of the key elements in the nation's space and missile program—is operating at only one-fifth of its current capacity.

Maj. Gen. D. N. Yates, commander of the half-billion-dollar test center, told M/R that Canaveral's present overall facilities could handle five times the present number of rocket launchings "without spending another dime."

Some critics have charged the test center's capacity for handling rocket launchings was a roadblock to speeding up the nation's space program.

Yates said there are only two reasons why the center isn't launching more rockets:

- More launchings are not called for in particular rocket development programs.
- Or, additional rockets are not available.

Moreover, he said the center has room for increasing possibly 15 to 20 times the amount of testing including many new type rockets in the years ahead.

"We already are planning for test programs that we only are imagining," he said. "Huge rockets for space exploration projects that so far aren't even programmed."

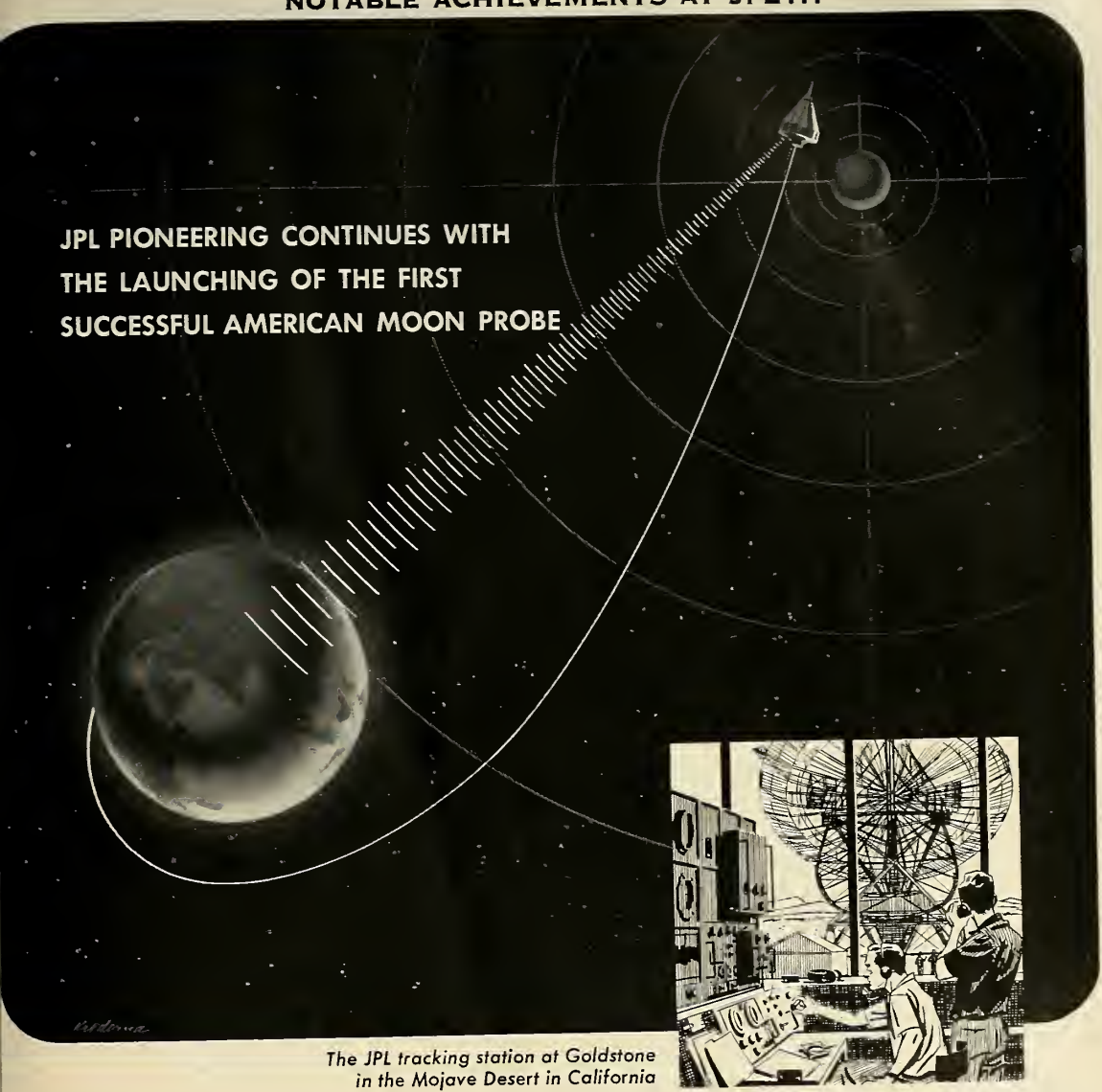
Yates also said he thought the day is fast coming when both the U.S. Atlantic and Pacific Missile Ranges along with other missile ranges around the world must centrally coordinate their tracking and monitoring facilities.

"This type of coordination will be essential for such programs as Project *Mercury* and *Dyna-Soar*," he said.

On other developments, Yates said:

- The United States can have a man in orbit within a "year or so" under the current man-in-space program. However, much remains to be done before the goal can be achieved.
- U.S. engineers have developed a successful method for cutting off operation of solid propellant rockets in flight. The method being used is classified.
- The Boeing *Minuteman*, when ready for testing from the Cape, will be fired from a model of the inverted silos that will be used later to house *Minutemen* at hardened ICBM bases.
- Planning is underway for building facilities for testing the Martin *Pershing* and the 1.3-million-pound-thrust *Saturn* at the Cape.

JPL PIONEERING CONTINUES WITH THE LAUNCHING OF THE FIRST SUCCESSFUL AMERICAN MOON PROBE



The JPL tracking station at Goldstone in the Mojave Desert in California

Early on March 3, 1959, Pioneer IV space probe was launched from Cape Canaveral, Florida to become America's first deep-space vehicle capable of escaping the earth's gravitational pull. On its way past the moon and out into orbit around the sun, this new man-made planet sent back valuable information on the radiations present in space. Several Free World tracking stations clearly received its transmitted signal and helped to establish its distance, velocity, and direction.

Under the sponsorship of the National Aeronautics and Space Administration, JPL designed and built not only the conical payload of Pioneer IV but also the three upper stages of the Juno II launching vehicle, containing new high-performance JPL solid propellant rockets.

Over a year ago the same JPL team, in cooperation with ABMA, gave America its first earth satellite, Explorer I, using a similarly reliable vehicle—the Jupiter C.

Now, more advanced space vehicle programs are under way at JPL — programs which include development of guidance and propulsion systems for accurate maneuvers many million miles from the earth.

jpl

CALIFORNIA INSTITUTE OF TECHNOLOGY
JET PROPULSION LABORATORY
A Research Facility of the National Aeronautics and Space Administration
PASADENA, CALIFORNIA

OPPORTUNITIES NOW OPEN IN THESE FIELDS ▶ APPLIED MATHEMATICIANS · PHYSICISTS · SYSTEMS ANALYSTS · CHEMISTS · IBM-704 PROGRAMMERS
ELECTRONIC, MECHANICAL, CHEMICAL, PROPULSION, INSTRUMENTATION, MICROWAVE, AERONAUTICAL AND STRUCTURAL ENGINEERS

EXPANDED RESEARCH

to advance new concepts of SPACE FLIGHT

Expanded Research programs to meet the most complex technological requirements of the Space Age are only one of the far-reaching objectives of the new multi-million-dollar Lockheed Research Center, near Los Angeles. Destined to become one of the nation's major research installations, its programs are broad in scope and designed to investigate new frontiers of space flight.

A primary consideration in planning the new Research Center was to provide environment for scientific freedom and ideal research conditions —using the most advanced equipment available. This modern, integrated research facility will touch almost every aspect of aviation and transportation—leading toward exploration into completely new or relatively undeveloped fields of science and industry.

On completion, most of Lockheed's California Division's research facilities will be located in this single area. The Center will provide complete research facilities in all fields related to both atmospheric and space flight—including propulsion, physiology, aerodynamics and space dynamics; advanced electronics in microwave propagation and infrared; acoustics; mechanical and chemical engineering and plasma/magnetohydrodynamics; thermal electricity; optics; data communications; test and servo-mechanisms.

The first phase of the advanced research building program has already begun—with initial construction of a $5,000,000 supersonic wind tunnel and high-altitude environmental test facilities.

Scientists and engineers of high caliber are invited to take advantage of outstanding career opportunities in this new Lockheed Research Center. Openings now exist for thoroughly qualified personnel in: Electronics; aero and thermo dynamics; propulsion; servo-mechanisms; materials and processes; structures and stress; operations research; research in optics, infrared, acoustics, magnetohydrodynamics, instrumentation, mechanics and hydraulics; mathematics and in all phases of design.

Write today to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 17051, 1708 Empire Avenue, Burbank, California.

LOCKHEED

CALIFORNIA DIVISION

BURBANK, CALIFORNIA

NASA Names Hagen to Coordinate Programs

WASHINGTON—John P. Hagen, Director of the *Vanguard* Division since its inception, has been appointed Assistant Director for Program Coordination of the National Aeronautics and Space Administration.

Hagen will serve as operations manager of NASA's Office of Space Flight Development, coordinating and reviewing the progress of the office's various scientific and technical programs.

The *Vanguard* program, which Hagen directed first for the Navy and then for NASA, is being phased out. The rest of the *Vanguard* staff will be integrated into the Beltsville Space Flight Center.

NASA Space Flight Center Named for Goddard

WASHINGTON—NASA Administrator T. Keith Glennan has announced that the agency's new 550-acre, 450-man Space Flight Center near Beltsville, Md., will be named for Robert H. Goddard, American pioneer in rocket research.

The Goddard Space Flight Center will perform NASA's basic space research and will be responsible for the development of satellites, space probes and vehicles, tracking, communications, and data reduction systems.

The Center's 100,000 square feet of laboratory and office floor space will be ready for occupancy in mid-1960. Its staff is now housed at the Naval Research Laboratories, at the Langley Research Center.

Organization of the new Center includes a director, not yet appointed, three major research and development groups headed by assistant directors, business administration and technical service departments.

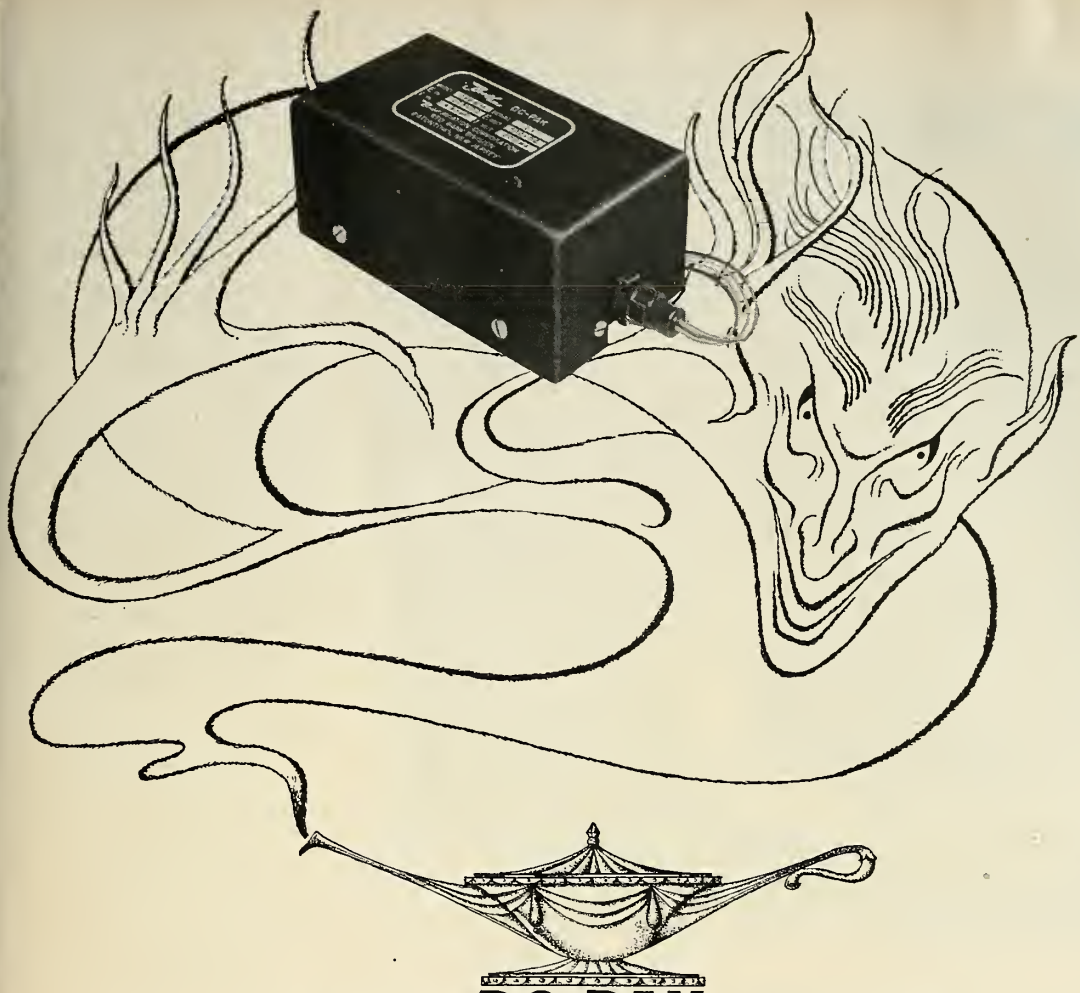
The three major research groups, and their Assistant Directors, are:

Space Science and Satellite Applications—Directed by John W. Townsend, Jr., includes the Space Sciences, Theoretical Satellite Applications Systems, and Payload Systems Divisions.

Tracking and Data Systems—Directed by John T. Mengel, includes the Tracking Systems, Data Systems, and Support Divisions.

Manned Satellites—Directed by Robert R. Gilruth, includes the Flight Systems, Engineering and Specifications, and Operations Divisions, and also the *Mercury* manned space flight project.

Michael J. Vaccaro, former personnel director at the Lewis Research Center, has been appointed business manager of the Space Center.



New Bendix DC-PAK is like magic

REMENDOUS POWER OUTPUT IN A TINY STATIC PACKAGE

Vith its new line of DC-Paks*, Bendix now offers the latest in atic power supplies for the aircraft and missile industries. Light-eight and compact, the DC-Pak provides reliable power packaged the most practical manner for those industries where weight nd space are at a premium.

The DC-Pak is built to give thousands of hours of efficient, rouble-free operation. Made with only four major parts (and no ioving parts), it requires an absolute minimum of maintenance. or example, even a dead short across the output for a full hour ill not harm the DC-Pak. Also input surge protection can be rovided.

Units can be supplied with either single or multiple output, epending upon the needs of the customer. For full details on ese transistorized units—and how they can be tailored to your xact voltage and amperage requirements—write BENDIX AVIATION ORPORATION, EATONTOWN, NEW JERSEY.

*TRADEMARK, BENDIX AVIATION CORPORATION

Specifications of Typical DC-Pak Units

Power Output	100 Watts	50 Watts
Output Voltage	500—5% VDC, 200 MA	250—5% VDC, 200 MA
Input Voltage	24—30 VDC, 27.5 Nominal	24—30 VDC, 27.5 Nominal
Voltage Regulation	5%; half to full load	6%; half to full load
Max. Operating Temp. (Ambient)	+60°C.	+71°C.
Max. Mounting Base Temperature	+71°C.	+80°C.
Min. Operating Temp. (Ambient)	−40°C.	−40°C.
Storage Temperature	−65°C. to +100°C.	−65°C. to +100°C.
Max. Surge Voltage	80 V. Peak	80 V. Peak
Ripple	1% RMS	1% RMS
Efficiency	80% at 25°C.	80% at 25°C.
Weight	1 lb. 8 oz.	1 lb. 8 oz.
Size	5⅝ x 2⅞ x 2¼	5⅝ x 2⅞ x 2¼
Electrical Connection	Four-Pin Connector	Four-Pin Connector
Accessibility	All parts are completely accessible and interchangeable.	All parts are completely accessible and interchangeable.

West Coast Office: 117 E. Providencia, Burbank, Calif.
Expart Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliate: Aviation Electric, Ltd., P. O. Box 6102, Montreal, Quebec.

Red Bank Division — Bendix AVIATION CORPORATION



what's happening in Tucson?

TUCSON IS FREE of the tensions and hustle of big cities. Tucson offers its residents a truly cultural atmosphere in a dry healthful climate with an average of 11 hours of sunshine every day.

The University of Arizona, with an enrollment over 15,000, functions as the center of cultural activities—offering a variety of orchestral, choral and dance programs. The fine Tucson Symphony plays regularly at the famed Temple of Music and Art.

The Fine Arts Show and Photo Workshop climax the year's activities in the visual arts with exhibitions and symposiums. Tucson's reputation is attracting many fine artists who make this their home. The Fashion Fiesta in February displays the latest work of the Southwest's top designers.

Spring Training activities of the Cleveland Indians...the Saturday Evening Forum (the nation's largest community forum)...the world famed rodeos and Spanish celebrations...these and more make Tucson a stimulating, rewarding place to live...and work.

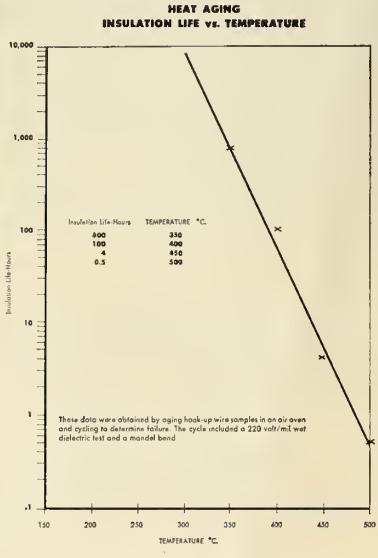
(For more details see opposite page.)

Teflon Insulation

To the Editor:

In a recent issue you published a letter from J. G. Lindberg concerning the electrical properties of wire insulated with "Teflon" (R) TFE-fluorocarbon resin at elevated temperatures. The letter left an erroneous impression that the electrical properties of "Teflon" TFE resins were greatly reduced at temperatures above 730°F.

We have run very extensive heat aging tests on wire insulated with "Teflon" TFE resin and find that it is continuously serviceable at 260°C (500°F). It is also serviceable for finite times at temperatures above 500°F as shown by the attached graph.



The table shows other typical values of dielectric strength at elevated temperatures. The values of the hours of expected life for hook-up wire have been substantiated for magnet wire insulated with "Teflon" TFE resins by other laboratories. It is interesting to note that at a temperature of 735°F the weight loss of "Teflon" TFE resin is extremely small. Its value is 0.071% per hour.

As a practical test we have subjected various samples of wire to overload currents. A coil of AWG #22 wire insulated with "Teflon" TFE resin and fabricated to conform to MIL-W-7139B construction was subjected to a current of 25 amps. The exterior of the insulation reached a temperature in excess of 425°C in 35 seconds. The temperature of the conductor was not measured.

Although vapors were evident, the wire continued to carry the current without fault until the test was terminated after two minutes. Other high-temperature resins similarly tested melted and faulted between conductors or burst into flames in less than one minute.

From these data it is evident that wir insulated with "Teflon" TFE resin has finite service life well above the 730°F value of the reference letter.

Joseph C. Reed
Applications Technologist
"Teflon"
E. I. DuPont DeNemours & Co
Wilmington 98, Delaware

Reluctant Astronaut

To the Editor:

Rep. Leonard G. Wolf of Iowa report this verse is circulating at the Arm missile center at Huntsville, Ala.:

In the missile game we've won grea fame—
The world knows our Jupiter C
And what we've done with Explorer i
Medaris, von Braun and me.

O watch our smoke as we go fo broke
To solve the space mystery.
We have a thirst to be there first,
Medaris, von Braun and me.

Our skill we pride, we'll travel wid
Into space so wild and free;
To the moon, then to Mars, then t distant stars,
Medaris, von Braun and me.

When finally we've planned a spac ship that's manned,
And they call for brave men, tw or three,
To try first for the moon in tha metal balloon—
Call Medaris and von Braun—NO ME

—Ivan the Terrible

Sincerely,
Jay Holmes,
New York, N.Y.

Oversimplified?

To the Editor:

Your editorial, "Six Lines for th *V-2*," in the March 23, 1959, issue o M/R, tends to oversimplify an acute an complex problem. M/R's Managing Edito Don Perry, in the previous week's issu reported that "there is grave danger tha our military 'spec' writers may be en dangering the nation's defense by ove particularizing their orders to industry. This presents the side of the coin observe by industry.

The six lines defining the operation parameters for *V-2* were written in despe ation. The master plan conceived tha World War II would be won with existin electronics, thereby releasing precious sc entists and engineers for the exploitatio of other fields. Germany, through a cor certed drive at standardization, had re duced the military application of electro tubes to less than two dozen types. It ability to cope with the Allies' advance

lectronics brought Germany to its knees. he frantic introduction of jet aircraft nd the *V-2* came too late.

What is the role and destiny of elec-onics? Electronics is the key to the ıture. Militarily, electronics is the brain overning the muscular reflexes that parry nd thrust the spear and whoever fails to ıaintain the pace is doomed. To hasten ıe pace in obtaining tomorrow's weapons ve have resorted to the weapons system vhich, in respect to Government Fur-ished Equipment (GFE), provides indus-y a relatively unencumbered approach to ıe development and production of the veapon.

Today, our military electronics con-ains in excess of 3000 electron tube ypes. Further, transistors and other spe-ial devices are running amuck. R&D and roduction are in many cases indistin-uishable. While I am generally in agree-ıent with the precept that secondary con-iderations such as logistics support re-uirements shall not obstruct weapons de-elopment, I firmly believe that failure to dequately consider them will cost us early in operational availability, person-el and dollars.

Robert H. Byrne, LCDR, USN
208 Pacific Drive
Forrestal Village
North Chicago, Ill.

Compliment of a Sort

To the Editor:

May I congratulate you on your calm nd intelligent editorial of March 30th. M/R still has a long way to go on reliable eporting, but I now have the confidence hat it will make the grade.

Roy E. Marquardt,
President,
Marquardt Aircraft Co.

Let's Accelerate

To the Editor:

Maj. William C. Mannix's very interest-ng article in your April 27 issue reminds ne of the gag we used to throw around he lab a few years ago:

"Our hero rammed it to the firewall nd accelerated to 17 microluxes."

As you may gather, a microlux is pre-isely Maj. Mannix's "optik." We chose his size for the same reasons he did—t's about Mach 1 and very convenient ll the way round.

I think that it is better to use the speed f light as the basic unit rather than /1,000,000 since no new units are used. n electronics, microfarads have been sed for years with no trouble. They are sually referred to as "mikes," "micro-nikes," etc. Lux actually has another ignificance, so why not name the unit nicrolights, or perhaps, micromannixs?

In any event, don't name it after Einstein—he's wrong.

Robert E. Span,
Ligonier, Pa.



what's happening in Tucson?
GUIDED MISSILE DEVELOPMENT!

A HUGHES-TUCSON ENGINEER puts a new GAR 3 Falcon missile through its paces on the roller conveyor rails of an EGSP console.

With projects underway on new and highly advanced types of guided missiles, Hughes in Tucson offers assignments throughout the entire spectrum of missile research and development.

Hughes-Tucson offers permanent positions to people with the ability and enthusiasm to make major contributions in these areas: missile systems analysis, infrared and radar guidance systems, electromechanical and hydraulic control systems, missile test and handling equipment.

These opportunities for professional advancement are matched by the unique qualities of Tucson as a place to enjoy a fuller life. *(See the advertisement on opposite page.)*

Investigate Hughes...*and* Tucson... today. Send resume to Mr. James W. Kirchhoff at the address below.

Creating a new world with electronics

HUGHES

Tucson Engineering Laboratories
Hughes Aircraft Company
Emery Park Station, Tucson, Arizona

NEW PROGRAMS

have created

IMMEDIATE OPENINGS

for top quality engineers with experience in—

Preliminary Analysis
Aerodynamics
Flight Dynamics
Structural Dynamics
Aero-Thermodynamics
Flight Simulation
Space Communication
Space Instrumentation
Radar Systems & Techniques
Electronic Countermeasures
Guidance
Instrumentation
Electronics Test
Design
Computing
Reliability
Human Factors

Well paid jobs for qualified people.

Relocating expenses paid.

For information on these and other engineering positions, write:

B. J. Ralph, Dept. 451 M
Missile Division
North American Aviation, Inc.
12214 Lakewood Blvd.
Downey, California

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.

contract awards

NASA

$24,067,500—**Douglas Aircraft Co., Inc.**, for development of the *Thor-Delta* launching vehicle.

NAVY

$41,200,000—**Bendix Aviation Corp.**, for work on *Talos* guided missiles.

$1,700,000—**Babcock Radio Engineering, Inc.**, Costa Mesa, Calif., for remote guidance systems for shipboard control of missile target aircraft.

$1,225,000—**Summers Gyroscope Co.**, Santa Monica, Calif., for gyroscopic units for guided missiles, mainly for spring-wound gyros for use in *Bullpups* (subcontracts from The Martin Co.).

$729,662—**American Bosch Arma Corp., Chicago Div.**, for *Talos, Tartar* and *Asroc* missile switchboards and weapons direction equipment action cutout switchboard.

$658,965—**Lansdowne Steel & Iron Co.**, Morton, Pa., for *Zuni* rocket heads and other items.

$320,000—**Ralph T. Viola**, Oxnard, Calif., for construction of missile handling buildings at Naval Missile Center, Point Mugu.

$144,998—**United Aircraft Corp., Norden Div.**, for synchros.

$44,956—**Thompson Ramo Wooldridge, Inc.**, for interference generators.

$43,000—**Massachusetts Institute of Technology**, for alloy development program based on chromium for use at elevated temperatures.

$33,300—**University of California**, for investigation of feasibility of shaping ductile ceramics by methods involving plastic flow.

$32,015—**Bendix Aviation Corp., Montrose (Pa.) Div.**, for synchros.

$30,398—**Collins Radio Co.**, for research on high-speed wingless VTOL aircraft.

ARMY

$8,671,100—**Western Electric Co., Inc.**, for supplemental R&D on *Nike-Zeus* system.

$1,131,680—**Kaminer Construction Co.**, Chamblee, Ga., for construction of dessicant drier system for the Propulsion Wind Tunnel, Arnold Engineering Development Center, Tullahoma, Tenn.

$1,000,000—**Temco Aircraft Corp.**, for wings and elevons for the *Hawk* missile (a follow-on order from Raytheon manufacturing Co.).

$750,000—**Allied Chemical, General Chemical Div.**, for research on high-energy oxidizers for advanced solid rocket propellants.

$709,656—**McDonough Construction Co. of Florida**, Miami, for construction of buildings and utilities at Eglin Gulf Test Range.

$313,276—**Western Electric Co., Inc.**, for *Nike* spare parts and components (three contracts).

$250,000—**Standard Construction Co.**, El Paso, Tex., for construction of telephone cable plant at White Sands Missile Range.

$216,369—**Raytheon Manufacturing Co.**, for electron tubes (four contracts).

$174,818—**Minneapolis-Honeywell Regulator Co.**, for components for *Honest John* adaption kit.

$151,254—**Tung-Sol Electric Co.**, Newark, N.J., for electron tubes (two contracts).

$128,775—**Kuthe Laboratories, Inc.**, Newark, N.J., for electron tubes.

$100,930—**McGregor-Michigan Corp.**, Detroit, for a complete tunnel, arc chamber and related steel structures for the Propulsion Wind Tunnel, Arnold Engineering Development Center, Tullahoma, Tenn.

$99,068—**Motorola Inc.**, Phoenix, for nine months' continuation of studies of automatic plot of enemy signal origin point.

$85,240—**C. F. Mayer & Co.**, Bethel Park, for construction of warheading buildings for special AAA facilities for Cincinnati Defense Area.

$67,442—**W. R. Grace & Co., Dewey & Almy Chemical Div.**, Cambridge, Mass., for a meteorological balloon.

$61,000—**Belock Instrument Corp.**, College Point, N.Y., for fabrication of engineering test models of computer-driven reticles for articulated telescope T17I.

$58,443—**Union Carbide Corp., Union Carbide Chemicals Co.**, for ethylene oxide in government-furnished steel cylinders.

$52,780—**General Electric Co.**, for electron tubes.

$47,959—**Belock Instrument Corp.**, for design, engineering and fabrication of six integrating gyro assemblies.

$45,700—**Cohu Electronics Inc., Kin Tel Div.**, San Diego, for a closed circuit television system for the White Sands Missile Range.

$40,695—**The Eagle-Picher Co.**, Cincinnati, for thermal batteries.

$34,850—**Kearfott Co., Inc.**, for motor generators.

AIR FORCE

$33,175,558—**International Business Machines Corp.**, for transistorized support machine computers for SAGE air defense system.

$11,400,000—**ITT, Federal Div.**, Clifton, N.J., for duplex high-power radio amplifiers to be used in the SAGE network.

$6,859,000—**S. Patti Construction Co., Mac Donald Construction Co., C. H. Leaver Co., and Scott Co.**, Kansas City, Mo., (joint venture) for construction of launch and service buildings for missile launch complex in the vicinity of Spokane, Wash.

$3,000,000—**Chrysler Corp.**, for *Jupiter* ground support equipment.

$2,000,000—**Curtiss-Wright Corp., Metal Processing Div.**, for acquisition of machinery and equipment.

$1,637,887—**Litton Industries, Electron Tube Div.**, for electron tubes.

$636,713—**Pan American World Airways, Inc.** for increase in funds (for Patrick AFB).

$500,000—**Ryan Aeronautical Co.**, for technical support of the GC-130A Drone Launcher/Director aircraft development program.

$249,300—**Microwave Associates, Inc.**, Burlington, Mass., for electron tubes.

$197,365—**Radiation, Inc.**, Melbourne, Fla., for development of computing-tracking group.

$167,452—**General Electric Co., Defense Electronics Div.**, for telemetric data monitor.

$120,050—**Minneapolis-Honeywell Regulator Co., Heiland Div.**, Dayton, Ohio, for oscillographs, visicorders, subminiature galvanometers and manuals.

$111,153—**Hewlett-Packard Co.**, Palo Alto, Calif., for signal generators.

$91,784—**Haloid Xerox, Inc.**, Rochester, N.Y., for research on high-temperature complex component development.

$78,000—**Bendix Aviation Corp., Red Bank Div.**, for electron tubes.

$73,189—**Del Mar Engineering Laboratories**, Los Angeles, for infrared-emitting aerial tow target.

$65,500—**Sperry Rand Corp., Remington Rand Univac Div.**, for floating paint for Univac computer modification in support of Project WS-133A.

$60,125—**Avien, Inc.**, Woodside, N.Y., for product improvement on time-temperature integrators.

$59,357—**AVCO Manufacturing Corp., Research and Development Div.**, for multiple path photoelectric projectile detector and shadowgraph photograph system.

$58,317—**General Electric Co.**, for research toward study of radiation damage thresholds of the elements.

$54,695—**Boston College**, for research on collection, reduction and evaluation of geomagnetic field data and electric field phenomena, atmospheric and terrestrial.

$54,177—**Republic Aviation Corp.**, for determination of orbital motion of the Russian Satellite 1957 Beta.

$51,646—**General Electric Co., Research Laboratory**, for research on development, test and fabrication of sun-azimuth pointing platform.

$40,000—**Battelle Memorial Institute**, for continuation of research on effect of very high pressure and temperature on semiconducting and insulating materials.

$39,848—**Lightning & Transients Research Institute**, Minneapolis, for propagation studies using VLF impulses, to include ground wave and ionospheric studies.

$35,000—**University of Colorado**, for study of reflection and transmisison of materials for radiation in the far ultraviolet.



. . . What This Important News Means to You!

"Up to now, I've only dreamed of being able to use *pure* tungsten . . . now it's a reality." This is a typical reaction to the news of Fansteel's breakthrough in the fabrication of tungsten.

It opens endless possibilities for using tungsten in any number of products—whether it's a spectacular missile, or a down-to-earth consumer item. Now . . . tungsten—with its melting point of 6152° F., highest of all metals, with its terrific strength at high temperatures, with its outstanding density of .697 lbs./cu. in.—can be exploited to the fullest.

FANSTEEL

HIGH TEMPERATURE METALS

Because Fansteel can now fabricate *pure* tungsten into almost any conceivable shape by spinning, deep drawing, hot extrusion or forging, the design engineer can count on tungsten . . .

—for greater reliability and longer life
—for even greater miniaturization
—for highest strength at extreme operating temperatures

Want to explore the possibilities of adapting tungsten to *your* product? Fansteel engineers will be glad to work with you. Just send print, part sample or call in your Fansteel representative.

Only your imagination will determine what lies ahead in the uses of tungsten.

K593

FANSTEEL METALLURGICAL CORPORATION, NORTH CHICAGO, ILLINOIS, U. S. A.

Three officials of Aerojet-General Corp. have been tapped by the National Aeronautics and Space Administration for its Research Advisory Committees. **Dr. A. L. Antonio,** vice president-Chemical Division, will serve on the Committee on Chemical Energy Processes; **Gordon Banerian,** manager, Turbo-Machinery Division, on the Committee on Mechanical Power Plant Systems, and **Lawrence L. Gilbert,** head of the Materials Department, will head the Committee on Materials.

Three new Aerojet appointments:

Dr. Adolph Oberth, 30, son of pioneer rocket expert **Hermann Oberth,** has joined the solid-propellant research and development staff to work on high-energy propellants. Oberth, who has always wanted to follow in his father's footsteps, came to the U.S. in 1946 with a PhD in chemistry from the Institute of Technology at Munich and worked for DuPont in New Jersey.

Dr. Robert F. Brodsky, who once designed the configurations for America's atomic and hydrogen bombs, will be Systems Division Manager, Engineering Services Department. Before joining Aerojet, he was chief of aerodynamics at Convair, Pomona, Calif.

Rear Adm. L. C. Baldauf, USN (Ret.), former director of Quality Control for the Navy's Bureau of Ordnance, was named technical specialist on the corporate quality control staff.

Dr. Stanley Winkler has joined the Technical Planning Staff in Advanced Systems Research at the International Business Machines Corp.'s Military Products Division. Winkler was chief, Command Control Systems of the Office of Naval Research, where he directed a study of the influence of satellites and space technology on naval operations. He also led a group which evaluated missile guidance systems and conducted an investigation of inertial navigation systems.



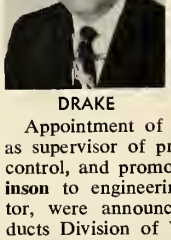
WINKLER

Robert H. Shatz has been named chief of technical military planning in United Aircraft Corp.'s Missiles and Space Systems division. Director for the past ten years of the Systems Research Division of Cornell Aeronautical Laboratory, he has served on Pentagon study groups involving the missile defense program.

At the same time United announced that its second George Mead Medal for Engineering Achievement went to **Thomas Richard Quermann,** chief gyro engineer of the Norden division's Ketay department. The medal and $2500 were awarded for Quermann's conception of a unique liquid-floated gyro with mechanical temperature control, and his preparation of the design for production in less than a year. A major step in development of gyros for missiles and space craft, it is now used in the *Atlas, Titan, Polaris* and *Snark* programs.

Dr. Burton H. Colvin heads the Mathematics Research Laboratory at Boeing. Colvin succeeds **Dr. Robert E. Gaskell,** who resigned to accept a post as mathematics professor at Oregon State College. Colvin joined Boeing as a mathematician in 1951 and was appointed supervisor of the mathematical analysis group in 1955.

John A. Drake, director of ASTRO, a division of Marquardt Aircraft Co., has been appointed to the Research Advisory Committee on Chemical Energy Processes of the National Aeronautics and Space Administration.



DRAKE

Appointment of **Howard E. Thompson** as supervisor of production planning and control, and promotion of **James R. Robinson** to engineering services administrator, were announced by Technical Products Division of Waste King Corp. For the past ten years Thompson was chief inspector, quality control manager and product engineer for National Seal Division, Federal-Mogul-Bower Bearings, Inc. Prior to joining Waste King, Robinson was assistant to the director of plant operations at Marquardt Aircraft Corp.

Alfred C. Harris has joined Commercial Shearing and Stamping Co., Youngstown, Ohio, as sales manager for Roto-form products, a new metal-forming service. Harris came to Commercial from the Metal Dynamics Division, Cincinnati Milling Machine Co.



HARRIS

Robert O. Briggs was recently named Chief Engineer of the Electronics Division, United ElectroDynamics, Inc. He was formerly with the missile system consulting firm, Robert Briggs Associates, Inc.

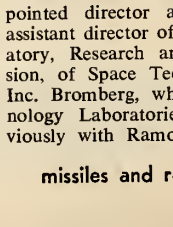
Richard S. Morse, Cambridge, Mass., newly-named Director of Army Research and Development, will succeed **Dr. William H. Martin,** effective June 1. Morse is founder and president of The National Research Corp., Cambridge. His new job carries authority equivalent to an Assistant Secretary of the Army.

Maj. Gen. T. C. Odom (USAF Ret.), IBM's new director of systems management for the Military Products Division, was until recently commander of the San Antonio Air Materiel Area.

Louis A. Payne has joined Lear, Inc., Astrionics Division, Santa Monica, Calif., as manager of its Engineering Division. For the past eight years he was senior dynamics group engineer with Convair Division of General Dynamics Corp., in charge of flight control system analysis, synthesis, lab development and flight test development.

Robert E. Rutherford and **Bernard R. Linden** have been named manager and assistant manager, respectively, of the Vacuum Tube Section of CBS Laboratories' Physics Department.

Eldon Overholtzer, corporate secretary of Tamar Electronics and Pres-To-Line Corp. of America, was appointed to the newly-created position of executive vice president for both organizations. Overholtzer was named general manager and secretary-treasurer in 1948, and assumed corporate responsibilities when Pres-To-Line acquired Tamar.



OVERHOLTZER

Dr. Robert Bromberg has been appointed director and **Arthur F. Grant** assistant director of the Propulsion Laboratory, Research and Development Division, of Space Technology Laboratories, Inc. Bromberg, who joined Space Technology Laboratories in 1958, was previously with Ramo-Wooldridge Corp.

I INSTRUMENTATION WIRING
C COMPLETE INSTALLATION
B BASE COMMUNICATION SYSTEM
M MISSILE GROUND SUPPORT SYSTEMS
BY AMERICA'S MOST COMPLETE ELECTRICAL SERVICE

ETS-HOKIN & GALVAN
551 Mission Street, San Francisco, California
218 N. Avalon Boulevard, Wilmington, Calif.
2295 East Belt Street, San Diego, California
233 N. San Joaquin Street, Stockton, Calif.
484 Washington Street, Monterey, California

ENGINEERS AND SCIENTISTS FOR COMPLETE SPACE AND WEAPONS SYSTEMS

Rarely does a corporation of United Aircraft's stature make available such key positions. Ordinarily these openings would be filled from within, but as the other divisions (Pratt & Whitney, Sikorsky, Hamilton Standard, Norden) cannot spare additional valuable staff men, these openings must be filled from the outside. You will work beyond ordinary boundaries on

MISSILE AND SPACE PROJECTS

Unusual, infrequently offered, high level positions for:

ELECTRONIC ENGINEERS
AERONAUTICAL ENGINEERS
MECHANICAL ENGINEERS
PHYSICISTS

Please reply to Mr. John North, Engineering Dept.

MISSILES & SPACE SYSTEMS
A Division of
UNITED AIRCRAFT CORP.
431 Main Street, East Hartford, Conn.



CREATIVE MINDS NEEDED to explore new fields in Space Age Electronics. Join one of the fastest growing engineering and scientific organizations in the new field of Space Electronics. Thus far, Hallamore has had a remarkable participation in nearly all of the space frontier programs... some of which are: 1. Development and manufacture of 4 tracking and telemetering stations for Explorer satellites. 2. Development and manufacture of 6 tracking and telemetering stations for United States Air Force lunar probe. 3. Development and manufacture of 4 tracking and telemetering stations for United States Army lunar probe. 4. Ultra-sensitive receivers for atomic cloud propagation studies. 5. Airborne reconnaissance TV system. 6. Underwater electromagnetic wave communications studies. 7. Automatic checkout equipment for space missiles. Such programs are on contract, and equipment is in field operation at the present time. If you have a highly creative mind, with an educational background of BS to PHD and an active interest in theory, circuit development, or project engineering, we invite you to join our outstanding team, to search into the future and to share in the rewards of Hallamore's dynamic growth. For further information, please write or call: Frank W. Lynch, V.P. Engineering, Hallamore Electronics Company, 8352 Brookhurst Avenue, Anaheim, California / Prospect 4-1010 : a division of The Siegler Corporation.



HALLAMORE

ropulsion engineering

Hydrazine formation from ammonia now can be more clearly derstood, thanks to University of Utah chemists who have defined e processes that occur in ammonia under high-frequency discharge. ney also report, in the journal *Industrial & Engineering Chemistry*, e controlling factors in producing hydrazine from ammonia, and relationship between the nature of the spark and the amount of is decomposed by it.

Maximum hydrazine yield is about 4-6 grams/kilowatt hour. actors which control the yield are gas flow rate, pressure, discharge rrent and electrode gap size. The work was done by W. Hoyt nderson, now with Aerojet-General; B. J. Zwolinski, currently at arnegie Tech; and R. B. Parlin, now with Operations Research, c. Understanding and possible control of the mechanism of hydra-ne's direct synthesis from ammonia could lead to wider availability id drastic price reduction.

Hydrazine makes news in Germany, also, as Farbenfabriken ayer reveals a new process for recovering the material from lean ater solutions. The patented technique pulls hydrazine from solu-ons containing as little as 1% hydrazine by weight. German chemists ix the water waste with cyclohexanone, precipitating dicyclohexyli-ene hydrazine. An acid then splits off the corresponding hydrazine lt from which hydrazine is released by action of a hydroxide. In ractice, the Germans say, the technique is simple and cheap—and l hydrazine can be recovered.

Transistors operate at 1800°F in an inert or reducing atmos-here, 1480°F in air, when they are made of boron phosphide. So eported Monsanto Chemical's Forrest V. Williams at the recent Amer-an Chemical Society national meeting. He also revealed a way to repare the high-purity boron phosphide by reacting boron trichlor-le, phosphorus, and hydrogen at a high temperature. Most present ansistors are germanium or silicon. Germanium works at tempera-ures up to 160°F, silicon up to 300°F. Boron phosphide is a very ard, refractory-like material which is not attacked by most corrosive gents.

Cheaper titanium will result from a new process developed by rmour Research Foundation. The key is a cold chlorination of wer-grade ilmenite ores and crude scrap. This produces the actual arting material—potassium chlorotitanate. From this, ARF can roduce not only the metal, but also two other major products: titan-um dioxide and titanium tetrachloride. Besides using low-grade ores nd scrap, and producing three needed items from one starting ma-rial, the process also may result in cutting other in-plant costs. This just a continuation of research that is gradually lowering the price f this corrosion-resistant metal. Titanium now sells for around 1.85/lb. A year ago it was $2.25, and five years ago it sold for 5.00.

Beryllium prices may head down, also, again thanks to a new search development. Sylvania-Corning Nuclear Corporation has de-eloped a continuous process for beryllium amalgam production. he process, still in the laboratory stage, is a simpler and more direct oute to the metal than techniques used at present. Sylvania's Be-malgam is produced continuously by electrolysis. In present industry ractice, beryllium fluoride is reduced by magnesium to tiny metal alls which must be ground and then fabricated by powder metallurgy chniques. With the new process, beryllium shapes can be made irectly from the amalgam.

A Personal Invitation to

ENGINEERS



from ROBERT McCULLOCH

President

"If you would like to be a member of a select corps of Engineers, working for an interesting, growing company . . in one of the country's most stimulating areas . . I invite you to write to Temco. Temco's growth is sound and planned, its products are diversified and challenging, our facilities are modern. Every benefit, for you professionally and in good living for you and your family, is here. Below are some of the areas in which jobs are open now."

ANTENNA DEVELOPMENT

Graduate Electronics Engineer or Physicist to perform analysis and design of antenna, microwave, and propagation systems for use in missile guidance and reconnaissance. Individual will be responsible for performing investigations in new types and concepts of transmitting and receiving antennas for both pulsed and CW signals, and the adaptations of these studies to current use in Electronic Development projects.

SENIOR FIELD SERVICE ENGINEER

Openings exist for a graduate Electronics Engineer with five years' experience in radar systems development, to be responsible for technical assistance and maintenance of Temco hardware in the field. Recent industry or military electronics experience with any of the following types of radar equipment is necessary. APS-20E, APS-45, FPS-20, FPS-8, FPS-6, MPS-11. The Field Engineer will coordinate the operation and application of the equipment to field uses with the Engineering Development sections.

Write BILL G. HICKEY

Supervisor Technical Employment

Room 305M, P. O. Box 6191

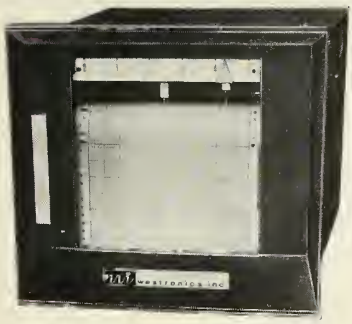
TEMCO

AIRCRAFT CORPORATION • DALLAS 22, TEXAS

Where space is important...

westronics

DUAL PEN 5" RECORDING POTENTIOMETER



BOTH PENS RECORDING FULL SCALE

FEATURING

SMALL SIZE

- Only 25% the size of old line instruments
- Two recorders will mount in standard relay panel

VERSATILITY

- Minimum span—1 MV
- Plug in ranges, MV or TC
- Chart drives, synchronous and/or selsyn, with large selection of chart speeds
- Marker pens, L and/or R
- Limit switches
- Transmitting slidewires

Also available: One and two pen 11" recorders

wi westronics® INCORPORATED

3605 McCART STREET • FORT WORTH, TEXAS

west coast industry

by Fred S. Hunter

The California Assembly has passed the bill which will make i possible for counties to tax machines or materials owned by th Federal Government but used by defense plants. The chances ar better than 50-50 that the Senate will concur and something like $35 million in property will go back on the tax rolls.

There are two sides to the question of exempting Federal propert in defense plants from local taxes. Take, for example, Convair-Astro nautics' plant at San Diego, for which the government supplied mos of the machinery and equipment. The City of San Diego can't ta this government property, but it was faced with finding the money t build new access roads to the plant to serve the employes.

On the other hand, any local taxes Convair-Astronautics migh have to pay on this government-owned property would be reflecte in increased costs of the *Atlas* missile. And the Air Force, conceiv ably, could tell Astronautics it would have to go someplace els where taxes are lower, to build the ICBM.

Most tax people seem to feel that once the legalities of the posse sory interest tax are spelled out in California other states will follo suit and a more-or-less uniform formula eventually will be applie throughout the country. But there is also the chance that some state may seize this as an opportunity to attract defense business to the borders.

One Assemblyman, seeking to amend the tax bill to soften th effect, argued that the tax would drive defense industry from th state. It won't be this bad, but there's no doubt that the dollar amou is big enough for consideration in evaluating a contract price or th location of a plant. At the going rate of the defense industry in Cal fornia, the law change means a tax boost of approximately $20 mi lion a year.

Radioplane's contract from McConnell Aircraft Corp. for desig development and test of a landing system and post-landing equi ment for the man-in-space capsule, Project *Mercury*, calls for 2 units. This division of the Northrop Corp. also will provide eig landing and recovery units for the National Aeronautics & Spa Administration for early space age tests. It is interesting to note th Radioplane's approach to the problem is simple and straightforwar It has been developing recovery systems for drones for years and i engineers know the lines to follow.

Douglas Aircraft Co. makes most of the ground equipment f the *Thor* IRBM—including the shelters which roll automatically wheels mounted on tracks—at Long Beach, where it has big hanga rather than at Santa Monica, where the missile itself is assemble The shelters, which cost $286,000 each, contribute a large share the Air Force's airlift of the *Thor* to the United Kingdom. They' shipped in prefab form and weigh 100,000 pounds each.

Willis M. Hawkins, assistant general manager of Lockheed's M sile and Space Division, is another who feels it wise to keep t public informed on missile and space projects. Only in this way, says, will voters learn to appreciate the need for these projects a understand the reasons behind their huge costs.

Use of North American Aviation's Rocketdyne facilities for bac ground in a Desilu Production film prompted local speculation fo new TV series titled "I Love Liquids."

Adam Makes Comeback in *Mercury*

by Paul Means

WASHINGTON—A governmental axm of long standing is that a project jected one year may be accepted the xt if submitted to a different governental agency in a slightly different ay.

This certainly is the case with the rmy's Project *Adam* man-in-space nture, (M/R, June, 1958, p. 40) hich was turned down cold by the epartment of Defense last year, but hich now forms the nucleus of the ational Aeronautics and Space Adinistration's Project *Mercury*.

Under Project *Adam*, the Army ould have sent an astronaut 100 miles in a ballistic missile trajectory with *Redstone*, and brought him back to rth with drogue parachutes.

Planning on *Adam* began in the all of 1957, but was turned down by OD last summer because the *X-15* cket plane would have been ready about the same time.

Now NASA's Project *Mercury* has corporated Project *Adam* as one of preliminary steps.

After the *Mercury* space capsule as been aerodynamically tested on top the four Thiokol *Sergeant* rocketustered *Little Joe* vehicles, it will tested on top of a modified *Redone* with animal passengers over the tlantic Missile Range.

The seven *Mercury* astronauts could ke their *Redstone*-powered rides down e Atlantic Missile Range as early as nuary, 1960.

• **Reliable** *Redstone*—*Redstone* was riginally picked for Project *Adam* nd subsequently selected for Project *Mercury* because of its proven reliility.

The modified *Redstone* (*Jupiter-C* nfiguration, minus the upper staging rrangement and Hydyne fuel) will ave approximately a 4500 to 5000 et/sec. velocity at power cutoff when e nose section separates.

The *Redstone* will carry its passngers to an altitude of 100 miles and 00 miles down range.

The capsule will come to a near andstill at the apex of its ballistic tractory, gaining a speed of about 5000 et/sec. when it re-enters the atmosere. Two or three automatic drag arachutes will slow the capsule down nd a parachute will be deployed at an titude of 7000 feet. The capsule's tro-rockets will be fired for test purses only.

Redstone will subject the astronaut at least six minutes of combined gative g's and complete weightlessss. Total flight time from launch to return to earth will be from 10 to 12 minutes.

• **Test plans**—First *Jupiter* firings of the capsule, which is the next step in Project *Mercury* development, could come by the end of 1959. These shots are to test the aerodynamic qualities of the capsule and the reliability of the retro-rockets at velocities approaching those to which the *Atlas* vehicle will subject the capsule.

Final testing before manned flight will be with the *Atlas* launcher itself. The capsule will be sent into orbit and recovered, alone and with animals, many times before man will be sent along as its passenger.

• **Actual flight**—The manned capsule will be launched at Cape Canaveral into an orbit with an inclination of about 30 degrees north of east. (See M/R, Nov. 10, 1958, p. 14.)

The escape system, consisting of forward thrust vernial rockets and support framework, will be ejected after separation of the *Atlas* nose cone instrumentation from the booster section. Orbit will be almost completely circular with an apogee of 120 nautical miles and a perigee of 110 nautical miles.

The astronaut will be traveling forward during the accelerating phase of the flight and backward during the reentry deceleration phase. A heavy metal shield at the passenger's back will absorb or radiate the aerodynamic heat of re-entry.

• **Controls**—Attitude (pitch and yaw) and roll jets will position the capsule for proper re-entry. They can also be operated manually by the astronaut after re-entry.

The retro-rockets will be fired at the beginning of the re-entry path, or during ascension if it is determined that the booster will not reach orbital speed.

When the capsule has decelerated to a velocity of Mach 1, a drogue parachute will be deployed to provide additional dynamic stability.

Two landing parachutes will be provided in case one should fail. The first will be deployed at an altitude high enough to allow time for the deployment of a second if necessary. Sinking speed will be 30 feet/sec. with a theoretical impact altitude of 5000 feet.

RUGGED and RELIABLE
New!
TRANSISTORIZED
The A. W. HAYDON COMPANY'S
TRANSISTORIZED SUB-MINIATURE
ELECTRONIC TIME DELAY RELAYS!



SAVE SPACE AND WEIGHT!

	Miniature Series	Sub-Miniature Series
Cross Section	17/16" x 121/32"	31/32" x 13/16"
Length	2 1/4" long	2" long
Weight	6 ounces	3 ounces
WRITE FOR:	Bulletin AWH TD-503	Bulletin AWH TD-504

TEST-PROVED PERFORMANCE!
High Temperature: 125°C (250°F)
Vibration: 2000 CPS at 15 g.
Contact arrangements up to 4 pole double throw.
Unique transistorized R.C. time constant network.
Time Delays from 50 MS to 120 seconds. Longer Delays available.
Hermetically sealed housings.

MEET REQUIREMENTS OF MIL-E-5272A.

The A.W. HAYDON Company
231 NORTH ELM STREET, WATERBURY 20, CONNECTICUT
® Design and Manufacture of Electro-Mechanical Timing Devices

Specifications Engineers

Lockheed Missiles and Space Division has important positions in specifications engineering at its facilities on the San Francisco Peninsula.

Technical degree or equivalent required, with experience in the preparation, coordination and negotiation of subsystem specifications, military documentation, specifications requirements, and technical writing.

Please send resume to: Research and Development Staff, 962 W. El Camino Real, Dept. E4-29, Sunnyvale, California. U. S. citizenship required.

Lockheed

MISSILES AND SPACE DIVISION

Sunnyvale, California

when and where

MAY

Institute of Radio Engineers, 11th National Aeronautical Electronics Conference, Dayton, Ohio, May 4-6.

Instrument Society of America, 5th National Instrumentation Flight Test Symposium, Olympic Hotel, Seattle, May 4-8.

International Scientific Radio Union, Spring Meeting, Willard Hotel, Washington, D.C., May 5-7.

1959 Electronic Components Conference, Benjamin Franklin Hotel, Philadelphia, May 6-8.

Institute of Radio Engineers, Seventh Regional Conference and Trade Show, University of New Mexico, Albuquerque, May 6-8.

Armed Forces Day, Observances scheduled throughout week of May 9-17.

Aviation Writers Association, 21st Annual Meeting and News Conference, Washington and Willard Hotels, Washington, D.C., May 10-16.

The Atomic Energy Commission, Technical Information Meeting on Test Reactors, National Reactor Testing Station, Idaho Falls, Idaho, May 13-15.

Society of Aircraft Materials and Processing Engineering-Eastern Div., Spring Meeting, Hotel Statler, New York City, May 15.

Space Medicine Electronics Symposium, Franklin Institute, Philadelphia, May 18.

Society of Aeronautical Weight Engineers, 18th Annual National Conference, Hotel Henry Grady, Atlanta, May 18-24.

American Institute of Electrical Engineers, Middle Eastern District, Satellite Tracking Session, Lord Baltimore Hotel, Baltimore, May 19-21.

The Society for Experimental Stress Analysis, 1959 National Spring Meeting, Sheraton Park Hotel, Washington, D.C., May 20-22.

Instrument Society of America, 1959 Ohio Valley Instrument and Automation Exhibit and Symposium, Cincinnati Section, Music Hall, Cincinnati, May 21-22.

Institution of Electrical Engineers, The Radio and Telecommunication Section, International Transistor Exhibition and Convention, Earl's Court, London, May 21-27.

American Rocket Society, Institute of the Aeronautical Sciences, American Institute of Electrical Engineers and the Instrument Society of America, "Investigation of Space" Conference, Brown Palace and Cosmopolitan Hotels, Denver, May 25-27.

National Missile Industry Conference, sponsored by The National Rocket Club in cooperation with Electronic Industries Association, Sheraton Park Hotel, Washington, D.C., May 25-27.

Advertisers' Index

Aerojet-General Corp., Sub.-General Tire & Rubber Co. 10
Agency—D'Arcy Adv. Co.

AiResearch Mfg. Co., Div.-The Garrett Corp. 28
Agency—J. Walter Thompson Co.

Avco Mfg. Corp. 51
Agency—Benton & Bowles, Inc.

Bendix Aviation Corp., Bendix Products Div. 8

Red Bank Div. 39
Agency—MacManus, John & Adams, Inc.

Clary Corp. 32
Agency—Erwin, Wasey, Ruthrauff & Ryan, Inc.

Cleveland Tool & Die Co. 27
Agency—Gerst, Sylvester & Walsh, Inc.

Crane Co. 3
Agency—The Buchen Co.

Ets-Hokin and Galvan 49

Fansteel Metallurgical Corp. 43
Agency—Symonds, MacKenzie & Co.

Hallamore Electronics Co., Div.-The Siegler Corp. 46
Agency—Cole, Fischer & Rogow, Inc.

A. W. Haydon Co., The 49
Agency—Cory Snow, Inc.

Hufford Corp., Div.-The Siegler Corp. 7
Agency—Cole, Fischer & Rogow, Inc.

Hughes Aircraft Co. 40, 41
Agency—Foote, Cone & Belding

Jet Propulsion Laboratory, Calif. Institute of Technology 37
Agency—Stebbins & Cochran

Ling Electronics, Inc. 52
Agency—John Ramsey Co. Adv.

Arthur D. Little, Inc. 12
Agency—Henry A. Loudon Adv., Inc.

Lockheed Aircraft Corp., California Div. 38

Missiles & Space Div. 24
Agency—Hal Stebbins, Inc.

Missiles & Space Systems Div., United Aircraft Corp. 45
Agency—Chambers Wiswell Shattuck Clifford & McMillan, Inc.

North American Aviation, Inc., Autonetics Div. 14

Missile Development Div. 42

Rocketdyne Div. 4
Agency—Batten, Barton, Durstine & Osborn, Inc.

Raytheon Mfg. Co. 34
Agency—Donahue & Coe, Inc.

Servomechanisms, Inc. 2
Agency—Hixson & Jorgensen, Inc.

Temco Aircraft Corp. 47
Agency—Rogers & Smith Adv. Agents

Westronics, Inc. 48
Agency—Glenn Adv., Inc.

EMPLOYMENT SECTION

Lockheed Aircraft Corp., Missile & Space Div. 50
Agency—Hal Stebbins, Inc.

CLASSIFIED

Missile Photos—For your office, den or collection. We produce B&W and color prints, slides, murals, and display photographs. For catalog and sample slide send 35¢ to Camber Company, Box 1051, Cocoa, Florida

AN FITTINGS & HARDWARE

Stainless, Aluminum, Brass, Steel. All sizes—immediate delivery from world's largest shelf stock. Buy direct from manufacturer. Lower prices—Quicker service. Send for free wall charts showing complete line of AN & MS fittings and hardware. We also machine parts to your own special print.

COLLINS ENGINEERING CORPORATION

9050 Washington Blvd., Culver City, California

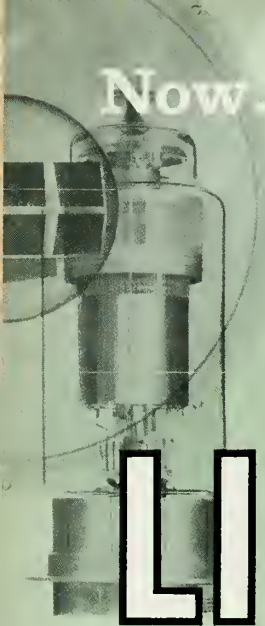


Avco and a Modern Minuteman—Recent work at Avco led to a solution of the missile reentry problem, and to production of the nose cone for the Air Force Titan ICBM. Now the Air Force announces a development program for Minuteman, a solid fuel missile that will be capable of instantaneous firing with no preparatory fueling delays. Its nose cone, too, will come from Avco's Research and Advanced Development and Lycoming Divisions . . . implementing this modern Minuteman's vigilant defense of our shores.

UNUSUAL CAREER OFFPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY.

Avco

AVCO MAKES THINGS BETTER FOR AMERICA / AVCO CORPORATION / 750 THIRD AVENUE, NEW YORK 17, N.Y.



Now... Partners in High-Power Electronics... Vibration and High-Intensity Sound Testing!

LING ALTEC

Ling acquires Altec Companies, Inc.!

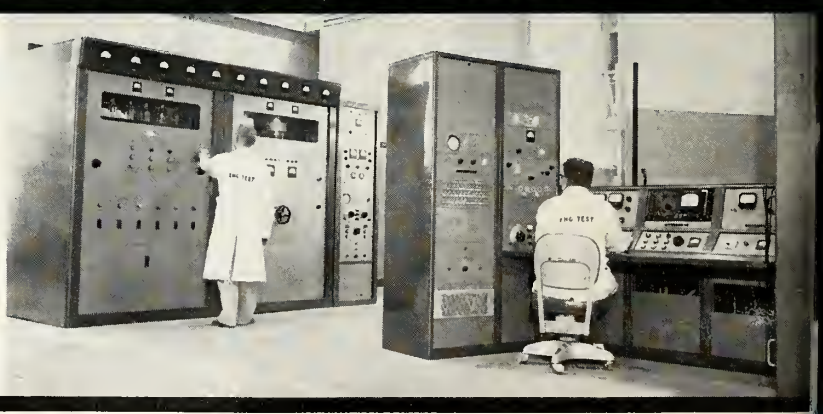
The acquisition of the Altec Companies by Ling Electronics provides the most experienced and successful combination of talent and facilities available today in high-power electronics.

LING, as one of the largest manufacturers of vibration testing systems (including power generators, control equipment and electrodynamic shakers) is also a major factor in the development and manufacture of high-power sonar systems and VLF communication equipment.

ALTEC, long a leader in loudspeakers, transducers and high-fidelity sound, has led the way in high-intensity acoustic systems.

Together, LING/ALTEC provide matched acoustic systems which extend the range and flexibility of vibration testing to meet the most challenging problems of our age.





ALTEC COMPANIES, INC.
...Leader in high-fidelity sound and high-intensity acoustic systems.

LING ELECTRONICS, INC.
...First in vibration systems and other applications of high-power electronics.

125 Field Engineers Throughout the Nation For Efficient Service!

Now...faster, better service for users of Ling and Altec equipment is assured by a new network of service offices. Altec Service Company field engineers in cities from coast-to-coast will assume servicing responsibilities for Ling and Altec products and systems.

LING ELECTRONICS, INC. 9937 West Jefferson Blvd. • Culver City, Calif. • TExas 0-7711

MAY 11, 1959



Missile Flight Simulator Spins "Ball-of-Yarn"

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

se-hardening May Cost Billions . . 13
'CON and *ARCAS* End-Burners . . 20
th of a *Titan* Nose Cone 32

AN AMERICAN AVIATION PUBLICATION

Convair
and the ages
we live in

JET AGE • MISSILE AGE
SPACE AGE • ATOMIC AGE

In this era that probes beyond all scientific horizons, the Convair division of General Dynamics Corporation has attained famous firsts in all four areas. **JET AGE:** B-58, first supersonic bomber. **MISSILE AGE:** Atlas, our first Intercontinental Ballistic Missile. **SPACE AGE:** The world's first ICBM to be placed in orbit. **ATOMIC AGE:** Convair was first to make tests on a nuclear reactor carried in flight.

Convair, as a member of the General Dynamics industrial family, is assisting to assure world peace and expanded scientific knowledge in the four ages we live in—an era unequalled in all of history!





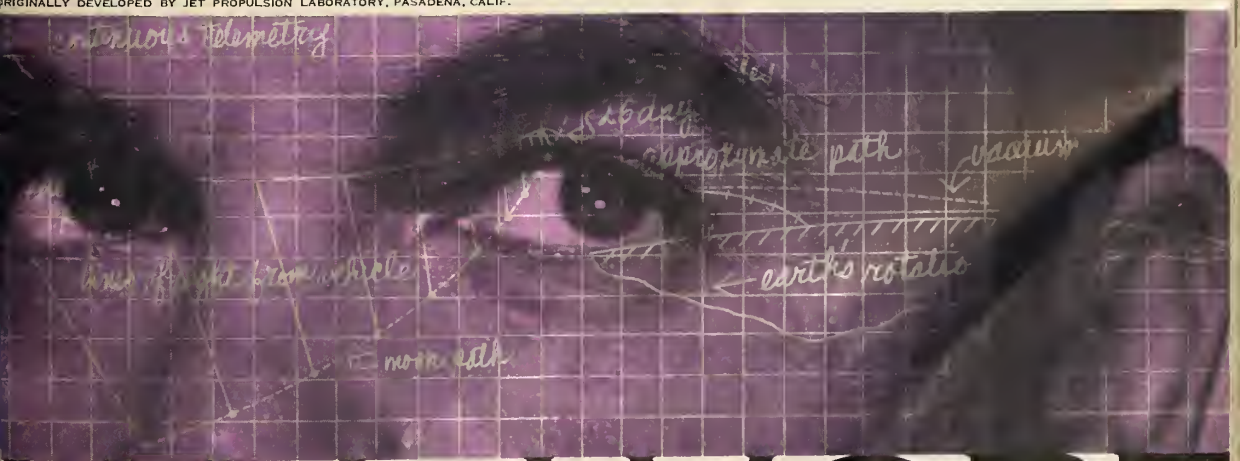
CONVAIR

A DIVISION OF **GENERAL DYNAMICS CORPORATION**



ITELLIGENCE—Hallamore Microlock* provides the all-important link of intelligible communication between space hicles and earth. Six Hallamore developed Microlock tracking stations monitor positions and receive intelligence from nguard and Explorer satellites...stand watch, with full capability, on U.S. Airforce and U.S. Army Lunar Probes. Micro-k "locks" on fractional signals from tiny transmitters to bring in messages free of noise distortion. Hallamore developments audio-visual telemetry, versatile automatic checkout systems, and guidance are speeding man's mastery of missilry and ace technology. For systems capability, plug-in building blocks and C.C.T.V., write Hallamore Electronics ompany, 8352 Brookhurst Avenue, Anaheim, California / TWX: AH 9079: a division of The Siegler Corporation.

RIGINALLY DEVELOPED BY JET PROPULSION LABORATORY, PASADENA, CALIF.



HALLAMORE

Proved! New, Better Way to Seal Drilled Holes with . . .



Less weight!

Less cost!

NEW **PIN-PLUGS**°

Seal simply, positively Prevent costly leaks!

Now — forget conventional, costly methods of sealing holes that serve as flow or pressure passages. The Lee "Pin Plug" is a cylindrical plug with a tapered reamed hole partway through its center and numerous small grooves on its outside surface. Simply place it into reamed hole and drive in the tapered pin until ends are flush. Controlled expansion causes grooves in plug to "bite" into casting and form independent seals and retaining rings. Extensive laboratory tests report no leaks under normal pressures, often show bone dry seals up to pressures of 40,000 psi.

Now successfully and widely used on aircraft and missiles — for pumps, servo valves, regulators, etc. Available steel and aluminum and in both long and short series.

° Pat #2,821,323

LEE Co.



(actual size)

SOME TERRITORIES STILL OPEN FOR QUALIFIED TECHNICAL SALES REPRESENTATIVES.

Write today for Standard Sizes and Engineering Data

THE LEE COMPANY WESTBROOK, CONN.

Executive Editor .....CLARKE NEWLON
Managing Editor ....DONALD E. PERRY

EDITORIAL STAFF
News Editor .....REED BUNDY
Military & Defense .....BETTY OSWALD
JAMES BAAR
Electronics/Support Equipment ..HAL GETTINGS
Electronics Engineering ....CHARLES D. LAFOND
Missile Manufacturing .....WILLIAM E. HOWARD
Missile Business .....ERICA M. KARP
NASA .....PAUL MEANS
Los Angeles .....FRED HUNTER
RICHARD VAN OSTEN
FRANK McGUIRE
London .....G. V. E. THOMPSON
Paris .....JEAN-MARIE RICHI
Geneva .....ANTHONY VANDYK
Art Director .....WILLIAM MARTIN
Ass't Art Director .....COLLIS CAMPBELL

CONTRIBUTORS
Propulsion Engineering .....MICHAEL LORENZO
Industry .....JAMES J. HAGGERTY, JR.
Soviet Affairs .....DR. ALBERT PARRY
Space Medicine .....DR HUBERTUS STRUGHOLD
Astrophysics .....DR. I. M. LEVITT
Research .....HEYWARD CANNEY, JR

ADVISORY BOARD
DR. WERNHER VON BRAUN ROBERT P. HAVILAND
DR. PETER CASTRUCCIO DR. ARTHUR KANTROWITZ
KRAFFT EHRICKE DR. EUGEN SAENGER
R. F. GOMPERTZ ALEXANDER SATIN

BUSINESS STAFF
Assistant Publisher .....E. D. MUHLFELD
Advertising Sales Manager .....W. E. BROWN
Circulation Director .....L. L. BRETTNER
Research Manager .....D. T. FOSSEY
Promotion Manager .....J. E. MULROY
Advtg. Service Manager ..MRS. GLADYS BUSSELL
Production Manager .....J. F. WALKER
Ass't Production Mgr. .....ELSIE GRAY
New York .....17 East 48 Street
Eastern Advtg. Mgr. .....P. B. KINNEY
P. N. ANDERSON
A. B. SCHEFFLER
Detroit .....201 Stephenson Bldg
K. J. WELLS
Chicago .....139 N. Clark St.
G. E. YONAN
Los Angeles .....8929 Wilshire Blvd.
J. A. CLAAR
C. R. MARTZ, JR.
Miami .....208 Almeria Avenue
R. D. HAGE
Toronto .....12 Richmond St. E.
ALLIN ASSOCIATES
London .....28 Bruton St.
NORALL & HARE
Paris .....11 Rue Condorcet
Geneva .....10 Rue Grenus

m/r Volume 5 Number 19

Published each Monday by American Aviation Publications, Inc., 1001 Vermont Ave., N.W. Washington 5, D.C.

WAYNE W. PARRISH .....*President & Publisher*
LEONARD A. EISERER ...*Executive Vice President & General Manager*
A. H. STACKPOLE .....*Vice President*
FRED HUNTER .....*Vice President*
ERIC BRAMLEY .....*Vice President*
ROBERT R. PARRISH .....*Vice President*

Printed at the Telegraph Press, Harrisburg, Pa. Second class postage paid at Washington, D.C. and at additional mailing offices. Copyright 1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, $8.00; 2 years, $12.00; 3 years, 14.00. Foreign—1 year, $10.00; 2 years, $18.00; 3 years, $26.00. Single copy rate—$.75 Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr., m/r, 1001 Vermont Ave., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

MAY 11 HEADLINES

Outlay for Hardened Bases
With Air Force already asking for $343 million in Fiscal Year 1960, expenditures could run to billions within a few years 13

Revived Interest in End-Burning Rockets
ARCON and *ARCAS* engines reportedly give high burning rates and flexibility of application and may be forerunners of low-cost birds 20

Host of Space Medicine Problems
Los Angeles conclave of Aerospace Medical Association discusses wide range of hazards facing first astronauts 22

Fluorine Rocket Engines Five Years from Now?
Given time and money, experts say it's feasible to produce power-plants that will boost capability by 70% 42

SPECIAL SECTION

Birth of a *Titan* Nose Cone
Picture story of process at Avco, a leader in space research 32

ASTRONAUTICS ENGINEERING

NAA'S Stainless Steel Honeycomb Panels
New wrinkles including a homemade heat-treating cycle produce large units and company forecast of a "new era" in vehicle construction 23

MISSILE ELECTRONICS

Communications Satellites Largely Neglected
Industry feels space relay stations are technically and economically feasible, but they are getting little attention except from the military 38

THE MISSILE WEEK

Washington Countdown 9
Industry Countdown .....11 & 18

DEPARTMENTS

Editorial 7
Reviews 25
People 44
Contract Awards 45
Propulsion Engineering ... 47
Missile Business 49
When and Where 50



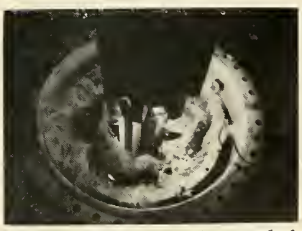
COVER: Gyrations of ballistic missile flight are re-created at Avco in a three axis flight simulator.



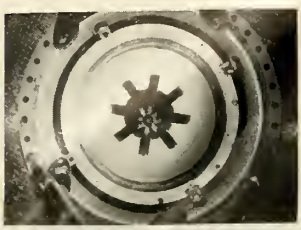
AMMONIUM perchlorate aluminized propellant was used in Astrodyne's Project "GO" unit which utilized XM-34 case.



SOME 45,000 pounds of thrust was produced in the 16' x 27" diameter case which had 40 times more propellant than any previous Astrodyne cast motors.



STAR-SHAPED steel mandrel, coated with Teflon to act as lubricant, is inserted in rocket case.



AP aluminized propellant made it possible to pour directly into 13-foot case without benefit of rubber liner.



Now! Cool through the thermal barrier with FLAMEMASTIC!

The high-heat insulating *material proved* in *actual production* for *4 years*

Now, you can provide positive protection and high-heat insulation for metal surfaces with FLAMEMASTIC. For four full years, FLAMEMASTIC has been used exclusively on one of the major production missiles. And it has been applied extensively in other experimental firings of rockets and missiles and on allied test and launching equipment.

FLAMEMASTIC protects against high-velocity combustion heats, ranging from 3000°F. upward. This insulation provides positive protection for vital electronic equipment.

FLAMEMASTIC is readily applied by conventional application methods.

For additional information on Flamemastic, write or wire:

DYNA-THERM Chemical Corp.

Culver City, California



Concurrency—Prime Need in Pentagon

Lt. Gen. Bernard Schriever took command of the USAF Air Research and Development Command on orders dated April 29 and the same week appeared before the Senate Space Committee and took a few healthy swings at the Defense Department's Advanced Research Projects Agency (ARPA).

Schriever, who is at least as knowledgeable on the subject of missiles and spacecraft as anyone else in the country, told Congress he had always been opposed to establishment of an operating agency on the Secretary of Defense level; that ARPA had not delayed the military space development program as of the present time, but that if ARPA continued to operate in its present fashion a delay would certainly come when the space systems were turned over to the military for operation.

He based his arguments and his logic on the established premise of "concurrency," which he explained thusly:

"A weapon system consists of much more than the hardware which is developed and tested. It also consists of the industrial base required for its production, the operational facilities for its operation and maintenance, the command communications system for its operational control, the supply and transportation system for its support, the training facilities and the instructors, and finally the people organized and trained to operate and maintain the weapon."

Military space systems require the establishment of a complete new operational environment. None of the above-mentioned weapon system elements, for instance, were in existence when work began on the *Atlas* and the *Titan* programs. Under the concept of concurrency, however, each element of the total weapon system was integrated into a single plan. Operational and training bases for both *Atlas* and *Titan* were under construction prior to the test launch of the first missile. So was the training program—and the logistic support program.

The ARPA method of operation pretty well precludes such concurrency. ARPA, conscious that its original mission was to stop the rivalry between the services, divided every military space project between the services. Army may have guidance, Navy tracking and the Air Force propulsion. Then, when the device is properly developed, it will be turned over to the service most needing, best suited, most vocal—or what not.

The trouble with that is that it will then take the service which gets the device two more years to develop the supporting elements required for its usage—the supporting elements which should have been developed concurrently.

General Schriever expressed some doubt that the ARPA system was best for the country. He is not alone in this feeling. The R&D civilian chiefs of all three services share it to a greater or lesser degree. All three of them, incidentally, have recently left or are leaving the Pentagon.

In 1958 A. Blagonravov, a member of the USSR Academy of Sciences, wrote: "It is easy to see that precisely the time element is the decisive factor which should be grasped in the competition with the capitalist countries in the field of technology."

The Rockefeller Report stated: "A nation can achieve a basic advantage if it is able either to develop or to produce weapons more rapidly than its opponents. One of the major weaknesses in our strategic posture has been our inordinately long lead-time."

And, the Von Neumann committee in recommending how to speed up the U.S. missile program said that the *pacing item* in the program would be not technology but organization, management and administrative procedures.

Somewhere in the last few years the Office of the Secretary of Defense has come to have a greater regard for procedures than for action, for form rather than result. There are too many directorates, too many committees, too many offices that exist—Heaven knows why.

Even the Joint Chiefs of Staff have fallen prey to a lethargy of indecision. More and more questions going there result in split decisions—and the matter is referred to a study group.

Maybe it is indecision, maybe it is politics. Whatever or why ever, the result is to drive a lot of good men out of the Pentagon in pure frustration and to impair speed of action when such speed is vital.

Clarke Newlon

Hughes in Southern California

announces the establishment of

a major new division . . .

the COMMUNICATIONS DIVISION

The growing importance of global and space communications, together with major contributions of the Hughes Communications Laboratory, such as the Long Arm (AN/URC-15) and Quicksilver (AN/URC-23) programs, has resulted in the creation of the COMMUNICATIONS DIVISION of the Hughes Aircraft Company. The new division is fully integrated and will be responsible for communications research, development, manufacturing and sales. Expansion plans are ambitious and aggressive, and the backlog of contracts already awarded promises an expansion consistent with the spectacular records established by the other major divisions of Hughes Aircraft Company.

The establishment of Hughes as a major factor in the communications industry has created many openings for experienced electronic engineers in the following areas:

Senior Staff Engineers

Transistor Circuit Design

RF Power Design

Digital Data Processing

Communication Systems Analysis

also

Communications Project Engineers

Propagation Specialists

For further information write Mr. John Melville at the address below.

HUGHES

© 1959, HUGHES AIRCRAFT COMPANY

HUGHES AIRCRAFT COMPANY, COMMUNICATIONS DIVISION
Dept. C, P. O. Box 90-902, Los Angeles 45, California.

washington countdown

IN THE PENTAGON

ARPA scientists hope to install a backstop device in *Discoverer III* to insure that its capsule bearing four black mice is ejected at the right time over the Pacific. A temporary failure of the timing device in *Discoverer II* prevented it from ejecting its mouse-less capsule at the right time last month.

• • •

Discoverer III—scheduled to be launched the end of May—will carry the four mice in the same kind of capsule used in *Discoverer II*. The Air Force also plans to use the same method to attempt recovery—C-119's equipped with trapeze nets.

• • •

This summer will see the greatest shift of Air Force general officers ever. Thirty-five will retire. The Pentagon development office (DSC/D) will be particularly affected by the changes and by the fact that the Directorate of Requirements was transferred from Development to Operations last week.

• • •

Maj. Gen. James Ferguson, who was Director of Requirements and moved with the office, will be transferred soon. Maj. Gen. Leland Stranathan, Director of Development Planning, will also be transferred. Maj. Gen. Donald J. Keirn, assistant C/S Development for Nuclear Systems, will retire. So will Brig. Gen. Don Zimmerman, assistant for Foreign Development. Maj. Gen. Ralph Swofford, assistant deputy C/S Development, is also scheduled for transfer this summer.

ON CAPITOL HILL

House Democrats appear to be adopting a strategy aimed at both eating and having the space program cake. Under the strategy, they'll just about give the Administration what it wants to spend on space—but no more. (This avoids the charge that they're spenders.) Then, if Russia makes a new sensational jump into space and a public howl goes up for action, the Democrats will be in a position to appropriate—and investigate.

• • •

The Senate Military Construction Subcommittee is certain to take up the invitation of Defense Secretary Neil McElroy to help resolve the rivalry between the Boeing *Bomarc* and Western Electric's *Nike-Hercules*. Moreover, the bets are heavy that the subcommittee headed by Sen. John Stennis (D-Miss.) will recommend that *Nike-Hercules* be curtailed in favor of *Bomarc*.

AT NASA

Space program planners are preparing for the not far distant future when the skies will be crowded with satellites. NASA has contracted to install an IBM 709 computer at the IBM-*Vanguard* Computing Center in Washington where a less advanced 704 has been computing the orbits of almost all U.S. satellites. NASA also has contracted for two even more advanced IBM 7090's—probably for use at the NASA Space Center planned for nearby Greenbelt, Md.

• • •

The NASA 704 can handle 42,000 operations a second. It could compute and predict orbits for 10 to 20 satellites simultaneously. The 709 operates three times as fast and could handle about 60 satellites. The 7090 is about five times as fast as the 709.

• • •

The current rumor that NASA Chief T. Keith Glennan will leave his post after his first year and that AF Assistant Secretary for R&D Richard E. Horner is being brought in to replace him apparently is not true. Glennan's friends say he intends to remain until the end of the Eisenhower Administration. Horner is being brought in as general manager, giving NASA the type of organization which Glennan favors and worked with when he was an AEC Commissioner.

• • •

Reason for the Venus probe cancellation was that STL tried to do too much too soon in integrating 13 major experiments into the "paddle wheel" payload of *Thor-Able III*. After *Thor-Able III* is eventually shot into its 30,000-150 mile orbit, the former Venus probes—*Thor-Able IV* and *Atlas-Able IV*—will be shot into deep space. With their improved solar cells, they will be tracked further than any previous payload (M/R April 27).

AROUND TOWN

The British are reported having trouble transporting their liquid *Blue Streak* IRBM to the Australian Woomera Missile Range for testing. Indian Prime Minister Nehru is understood to have refused to allow British planes carrying the missile to land in India on grounds it would affect Indian relations with Russia. Therefore, the British are extending the RAF field at Gan in the Maldive Islands south of India and will use it as the main staging area for missiles being flown to Australia.

...NEWS IS HAPPENING AT NORTHROP

Demonstrating the platform of LINS – new, Lightweight Inertial Navigation System – is Dr. William F. Ballhaus, Vice President and General Manager of Nortronics.



NORTRONICS REVEALS LINS... COMPLETE PRECISION INERTIAL NAVIGATION SYSTEM!

A recent demonstration at Nortronics' Guidance Symposium revealed the most advanced precision inertial guidance system ever assembled. LINS – Lightweight Inertial Navigation System – includes platform, platform electronics, environmental control and computer. Total system weight: slightly in excess of 100 pounds. Equipment volume: less than three cubic feet.

Actual working hardware, LINS is a complete, precision system for automatic navigation applications to advanced aircraft, drones, missiles, and space vehicles. It is ready now – the latest result of Nortronics' more than twelve years of creative research and production in the field of automatic guidance and navigation systems.

If you have the need to know more – contact Nortronics today, regarding LINS for your own system requirement. Nortronics' experience offers unique and proven capabilities in tailoring the design, development and production of complete and integrated guidance systems to your requirements.

NORTRONICS

HAWTHORNE, CALIFORNIA

A Division of Northrop Corporation

industry countdown

STRUCTURES

Douglas Aircraft Company has won an Air Force contract to "design" an ALBM as exclusively reported by M/R last week. No contract figures were released. Under the contract, Douglas is to come up with a design and cost study within six months. Douglas expects to let some subcontracts in the six-month period. The Air Force chose Douglas over nearly two dozen other firms, some of which had conducted experimental test launchings.

• • •

Beef-up of Tactical Air Command is in the works as the result of hush-hush TAC R&D survey showing 17 well-placed Soviet 1-megaton warheads could knock out all NATO missile emplacements in West Germany hardened to less than 5 psi. Contract for design in a hurry of underground sites for Martin's *Mace*, now 1000-mile plus near sonic surface-to-surface nuclear missile being deployed to Germany, is in the hands of Grad, Urbahn & Seelye, A&E firm. *Mace* base concept is expected to permit multiple launching from hillside caves, plus firing from enclosures where acoustics are a primary problem. Hardening of other TAC missile launchers including all presently deployed and expected-to-be-deployed missiles may follow shortly.

• • •

First free-flight of *X-15* is now set for early July. Captive test flights will wind up next month.

• • •

Polaris program is now driving toward two goals: 1.) production of the missile to provide emergency operational capability by 1960 when first subs are ready; 2.) development of the missile for 90% reliability over long pull. Lockheed will provide technical support for assembly at Navy's Charleston, S.C., facility. Next test series for *Polaris* expected this week will be to fire it from "shaker" simulating submarine.

• • •

France now is developing a tactical ballistic missile and a 2000-mile range IRBM. Mach 2 Mirage IV will be last piloted French bomber. Pre-production model expected to use Pratt & Whitney J-75 turbojets is scheduled to fly in 1961.

PROPULSION

Ammonium perchlorate aluminized solid propellant reported to be one of the most advanced in the industry has been successfully test-fired by Astrodyne from XM-34 rocket 16 feet long and 27 inches in diameter. I_{sp} is classified, but in-house developed unit produced 45,000 pounds of thrust and contained 40 times more propellant than any previous cast motor fired by the company.

ELECTRONICS

Look for an AF announcement soon that one of the largest (about $40 million) prime R&D contracts will go to Airborne Instruments Laboratory, a division of Cuttler-Hammer. Contract will be to develop airborne recon for B-52 and future aircraft with integration into a multi-weapon system. Subs are: Aerojet-General for IR; Filtron Co. for RF; Haller, Raymond and Brown Inc. for human engineering; Raytheon for semi-automatic receiver equipment; Sperry Gyroscope for tactical support and training; Sylvania for data processing; and Temco for weapons systems integration and flight test. Winning proposal, one of four presented on team basis, covered 1400 pages and cost $500,000 to prepare.

• • •

Pointing the way for practical ion propulsion of space vehicles is Republic Aviation's operating (for more than six months) magnetic pinch plasma engine producing a significant amount of measurable thrust which observers say reaches several thousand pounds for a micro-second. Prototype engine proves out Republic's "curved nozzle" theory.

• • •

Brand new field of semiconductor materials may be opened by high-temperature, high-pressure effects research at Army Signal Corp's R&D laboratory. Although process resembles making synthetic diamonds, emphasis is on changing electrical properties of materials rather than producing new ones. So far researchers have succeeded, in producing momentary super-pressure of several million psi, believed to be the highest pressure yet achieved.

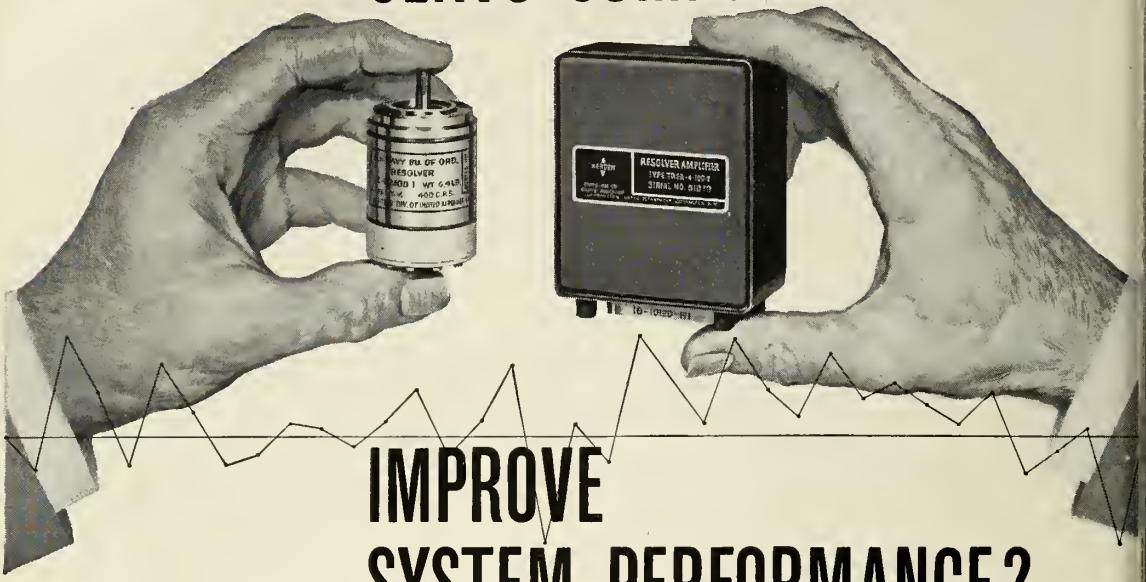
SPACE MEDICINE

In nuclear-propelled space flight, Douglas Aircraft bio-astronautic scientists propose shielding occupants from radiation with three to six feet of liquid hydrogen around control compartment. The H_2 is part of the payload, being ultimately used as a reactor after-coolant following propulsion termination.

• • •

No space suits? Dr. Hubertus Strughold believes if space ships land in the "lowlands" of Mars—3,000 to 5,000 feet below the general surface of the planet—man could survive for short periods using only a pressure-breathing oxygen mask.

CAN "MATCHED" SERVO COMPONENTS



IMPROVE SYSTEM PERFORMANCE?

They certainly can! And if performance in your servo system is important, you owe it to yourself to check out the advantages "matched" servo components by Ketay can give you.

For example, Ketay's 105D2V Resolver (designated by the Bureau of Ordnance as Mark 4 Mod 1) trimmed to the TREA 4-100-2 Amplifier gives you a bonus of high performance and interchangeability:

1. The system will be trimmed to $\pm.02\%$ transformation ratio, with a phase shift tolerance of $\pm 1'$.
2. The amplifier will hold linearity to $\pm.02\%$ from $-55°$ to $+100°C$.
3. The receiver will achieve .05% conformity to the sine wave, and $\pm 3'$ interaxis error.

Similar benefits in matched performance can be obtained with system combinations using Ketay synchro transmitters, transformers, receivers, differentials, transistorized servo amplifiers, and servo motors.

But performance is not all you gain. When all or most of your components are from Ketay, broadest technical assistance is assured, and service and spares problems are simplified.

Ketay engineers are working on many advanced environmental and accuracy problems in developing prototype systems. Why not call or write for help in solving your servo component problems?

Ketay matched components:
SYNCHROS
RESOLVERS
POTENTIOMETERS
SERVO MOTORS
TACHOMETERS
SERVO AMPLIFIERS
GYROSCOPES
Catalogues available

NORDEN Division of United Aircraft Corporation

KETAY DEPARTMENT, Commack, Long Island, N.Y.

MAY 11, 1959—VOL. 5, NO. 19

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Air Force wants $343 million in FY '60 alone to harden Atlas and Titan bases . . . advent of Minuteman will swell outlay which could add up to . . .

Billions for ICBM Launching Facilities

by William E. Howard

WASHINGTON—Challenging American industry today is a completely new dimension in defense installations—the ICBM launching base.

Only a few months old, the program to arm the United States with *Atlas* and *Titan* missile complexes from which to fire a knock-out retaliatory blow at Russia already is assuming vast proportions. The scope may be far greater when the solid-fueled *Minuteman*—with its projected 2600 launch silos—comes along in two or three years.

By the end of the current fiscal year on June 30, the Air Force says it will have committed $900 million for the construction of test, training and operational phases of the ballistic missile program. For the 1960 fiscal year, the Air Force is asking $343 million to go almost exclusively into the building of "hardened" *Atlas* and *Titan* launching sites.

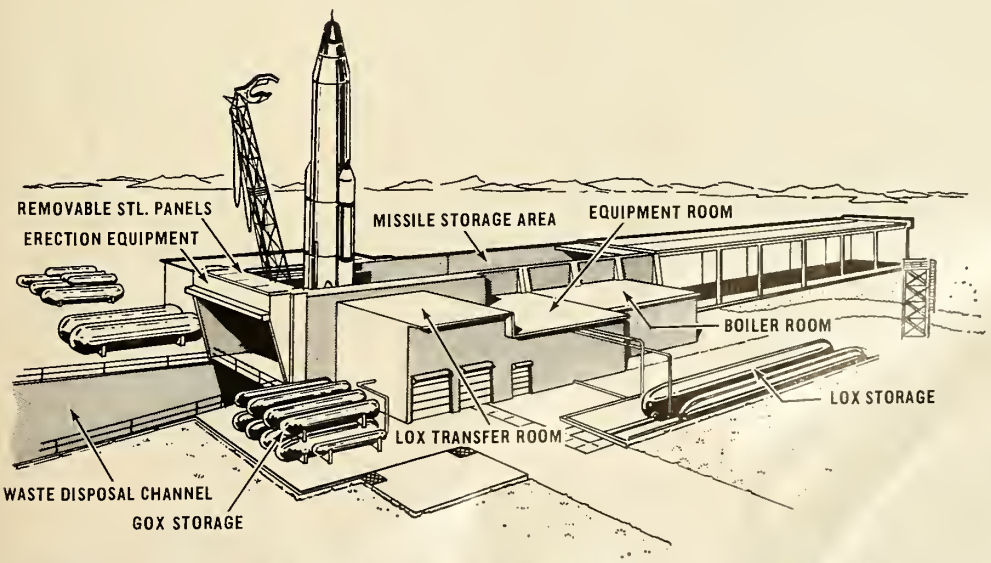
First of a Series on MISSILE SUPPORT

Future spending on facilities—which require 80% of the total investment of a missile system—is hard to project. Today's plans may be changed tomorrow by new strategic, technological or political developments. But Pentagon planners have made it plain that the ICBM is to be the backbone of the defense system and they could spend billions on facilities alone in the next few years.

As of the present, there is no apparent "master plan" for ICBM installations. As one military engineer puts it: "The program is going ahead all at once, and it's a real can of worms."

• **Comparative costs**—The overriding consideration is money, of course. With underground *Titan* bases costing about $40 million apiece, and *Atlas* about the same, defense officials are looking to *Minuteman* as a cheaper answer. Once in production the Boeing *Minuteman* is expected to cost much less than the liquid-propelled *Atlas* and *Titan*.

And, although it will have only a one-megaton warhead, *Minuteman* will



ANNEX "A" at Warren AFB, Wyo., will include six missile launch and service buildings like this one. This and three additional, similar sites in the Cheyenne area will cost a total of over $27 million.

not require a large launching complex and manpower. It is designed to be left alone in a reinforced concrete silo far from population centers and available for instant use. One of its problems, however, is development of a reliable ground environment system—which may turn out to be expensive.

There has been considerable talk among missile experts of wide dispersion of any future *Atlas* and *Titan* launching sites, which also would run up ground support costs. Another complicating factor is that Convair's *Atlas* will be operational this summer, according to former BMD commander Lt. Gen. Bernard A. Schriever. But many Air Force officials feel the Martin *Titan* will be a better missile when it is ready later next year.

Is there a possibility of adapting *Atlas* to *Titan* bases? The Air Force says it's possible, perhaps, but impractical now—though future missile modification might make it feasible.

• **Present and future**—Construction of ICBM complexes is under way now at 11 Air Force bases in the U.S. A total of 20 ICBM squadrons are programmed—11 *Titan* and 9 *Atlas*. These squadrons will have a combined capability of firing approximately 180 ICBM's in a one-shot salvo. Present construction plans do not call for reloading the launchers, which will be used only in event of nuclear war.

Conceivably, military strategists will see the need for many more to hit targets out of reach of the 1500-mile *Thor*, and *Jupiter* IRBM line in NATO countries and *Polaris*. Russia is known to be readying huge underground civil defense shelters and presumably is also digging in much of its industrial and military establishment. To knock out these targets would require bigger warheads, such as the 7-megaton wallop packed by *Titan* and 4-megaton by *Atlas*, than are carried by IRBM's.

Whatever number will be needed eventually, top officials of many of the nation's biggest companies are betting it will be large. And they are already moving or preparing to move in a big way into supplying the huge amounts of steel and concrete and the multitude of fabricated parts, electronic equipment, heavy machinery and other items which go into ICBM ground support.

Ahead of industry are some monumental engineering and development problems. Much of the present construction calls for completely underground installation—and a new breed of military personnel, "molemen," to operate it.

• **Design complications**—Each ICBM launching site must be tailored to fit the weapon it is designed for, and human occupancy as well. And complicating it all is a design requirement of the missile silo, control section, personnel quarters, power facilities, communications and computer-guidance equipment to withstand the overpressures, ground shock and radiation from a nuclear attack. For the bases are being built for up to 100 psi hardness under the concept that this country will be hit first before it strikes back.

A high Pentagon official told M/R that a key problem is "shock spectra criteria." Not enough is known about blast effects on a 90-foot missile like the *Titan*, which is put together with extremely close tolerances, or to extremely delicate electronic ground support components.

Suspension of nuclear tests, moreover, is preventing design engineers from obtaining the data. As a result, many experts feel that presently planned ICBM bases may be overdesigned. Nuclear tests last year, one official said, enabled them to cut back somewhat on the specifications for *Titan* bases. But they believe more could be done at a considerable saving in money.

Being built into bases now for personnel safety are free-floating floors and rubber mountings to absorb ground shock and complicated air filtration systems to protect "molemen" from radiation.

The Air Force Ballistic Missile Division, which is running the entire base construction program from its Los Angeles headquarters, has initiated environmental studies to obtain much-needed experience with people subjected to long periods of underground living.

The Air Force expects to utilize many off-the-shelf items developed by the Navy for submarines and ships to outfit the underground missile nests.

• **Lowry bases**—The first fully-operational *Titan* base is being constructed at Lowry AFB near Denver. Bids on a second Lowry facility will be opened May 27. Each will house one squadron of *Titans*—with nine launching silos.

Roughly comparable to putting a 10-story building underground, the first Lowry facility—composed of three complexes, each with three missile silos—will cost about $40.6 million without sensitive instrumentation equipment. The silos are dome-shaped, 163 feet deep and 40 feet in diameter.

Each complex will include a 73 x 27 foot storage silo for spare missiles; a spherically-shaped domed control center with a 39-foot ceiling and a 51-foot radius; spherical powerhouse measuring 46-feet high and having a 62-foot radius; propellant storage silo 47 x 37 feet; equipment storage silo 62 x 40 feet and two guidance antenna silos each 27 feet in diameter and 68 feet deep.

Connecting steel tunnels are provided. These include a nine-foot six-inch diameter personnel tunnel, a similar sized utility tunnel, a 12-foot diameter fuel and lox tunnel connected with six-foot six-inch diameter offset tunnels to each missile silo and nine-foot six-inch diameter exhaust tunnel structures as well as a five-foot diameter ventilation tunnel to blast locks.

The bird will be assembled on the silo elevator, motors first. At instrumentation sections there will be openings in the silos for test and checkout. To fire, *Titan* will be raised to the surface, and doors will close automatically over the silo opening. Simultaneously, the six antennas will also be elevated to the surface.

Design and fabrication of the silo elevator and missile handling equipment is by American Machine and Foundry under BMD contracts totalling $43 million. Western Electric, which has the guidance contract for *Titan*, and Aerojet-General, the powerplant, are overseeing the design of their own antenna and fuel installations.

The architectural design and engineering of *Titan* bases is divided between two firms—Daniel, Mann, Johnson & Mendenhall and Ralph M. Parsons Co. These firms are also doing the A&E for *Minuteman* bases.

• **Vandenberg specs**—A conception of the overall materiel requirements is contained in contract specifications issued by the Army Corps of Engineers for building three training silos at Vandenberg AFB. They call for excavation and subgrade preparation of 80,000 cubic yards of earth; 475 tons of steel ring beams and rods for bracing and shoring shaft excavations; 1691 feet of 10-foot steel tubing for tunnels; nearly 4000 feet of steel waterline for the fire water-control system; another 2000 feet of galvanized steel pipe for the domestic water supply; 2084 feet of sewer pipe; 3534 feet of perimeter fencing, and a number of valves, complete electrical control and distribution systems, blast locks and manholes.

Requirements for paving include 8530 square yards of various types of concrete and 797 tons of bituminous and asphalt topping and cement.

Cost of this work alone will run to nearly $7 million and it is expected to take 540 days to complete. Ground was broken in March.

Other *Titan* installations are being built at Ellsworth, S.D., and Mountain Home, Idaho.

The first operational *Atlas* will be deployed at Vandenberg AFB.

Construction is starting this spring on *Atlas* bases at Offutt AFB, Neb., which is SAC headquarters, and Fairchild AFB, Wash. Digging will begin this summer at Forbes AFB, Kan.

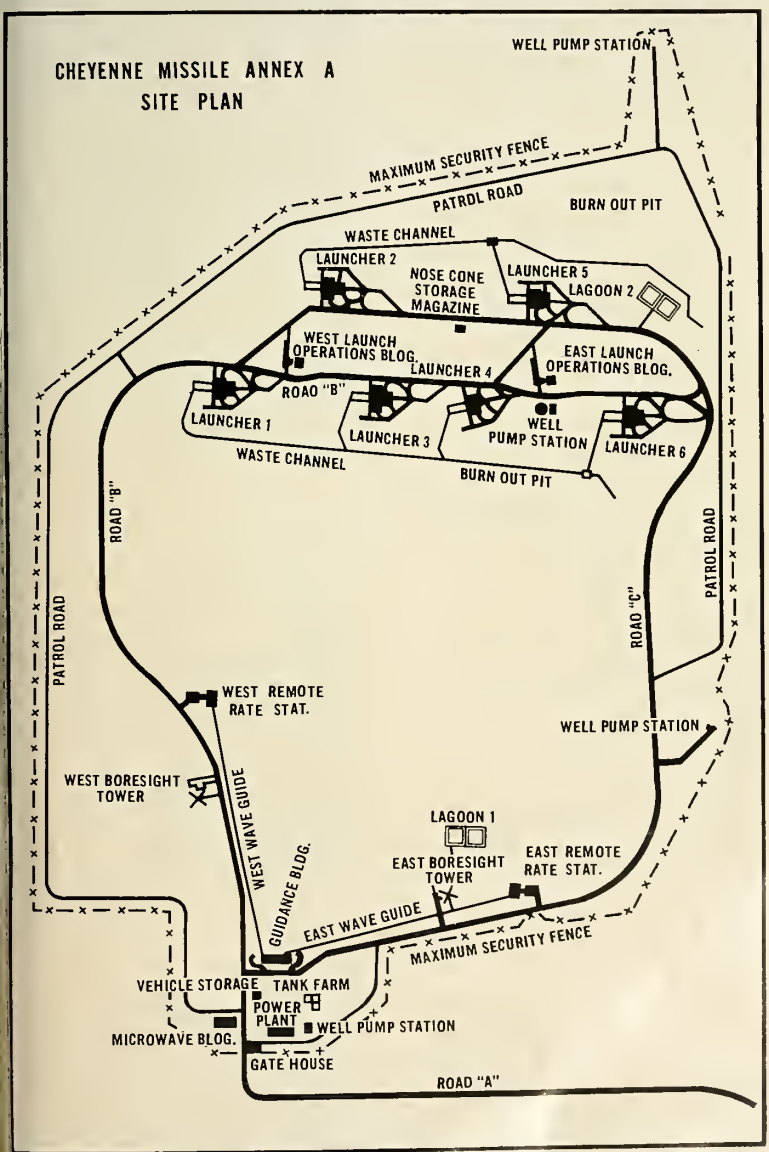
Other *Atlas* installations are planned at Schilling AFB, Kan., and Lincoln, Neb.

The two at Fairchild and Forbes will be "hard" bases.

• **A "soft" base**—Construction is nearly complete at the first "soft" *Atlas* site at Warren AFB, Wyo. Here there are four launching "annexes" located at an 18-mile radius from the four corners of Cheyenne. Annex "A"—to be ready this fall—has six launchers; the other three annexes will each have three launchers. Total cost: over $27 million.

Although above ground, the Warren facilities are being constructed of reinforced concrete and steel, enabling them to withstand considerable overpressure. The missile is housed and serviced in a horizontal "coffin" type structure, which has a mobile roof to allow the missile to be erected on a launch pad for firing.

Annex "A" is comprised of six missile launch and service buildings, each 103 x 133 feet, two blockhouse operations buildings measuring each 73 x 78 feet and a 75 x 212 foot guidance building. Pre-stressed concrete panels up to 36½ feet long go into the roof and part of the floor of the guidance building. Included in this facility are two boresight towers and two remote rate stations situated about 1300 feet east and north of the building. They are connected to the facility by waveguide enclosures.



FIRST "SOFT" *Atlas* site will actually be built with heavy amounts of reinforced concrete and steel. Some pre-stressed concrete panels will be 36½ feet long.

Design of the three other annexes is almost the same, with each site having half the amount of facilities of Annex "A".

The Corps of Engineers gives this rundown on materiel employed to build Annex "A": structural steel—1140 tons; reinforcing steel—1950 tons; mechanical steel items—8040 tons; electrical—1430 tons; concrete blocks and pre-stressed members—4350 tons; cement—6300 tons; concrete aggregate—37,460 tons; road aggregate—66,120 tons; asphalt—800 tons; miscellaneous wire, lumber, nails etc.—1260 tons. Total—128,850 tons.

Tanks to store oxygen, nitrogen and helium are located outside the building and above ground. In all there are 192 tanks in sizes up to 28,000 gallons. Fueling system has pressure capacity up to 15,000 psi and is of heavy stainless steel.

A&E for *Atlas* sites is under contract to Bechtel Corp., Stearns and Rogers, Holmes and Narver and Black and Beatch. Bechtel has the design for installations at Forbes, Fairchild and Lincoln. Stearns and Rogers has Schilling and Lincoln; Holmes and Narver —Warren and Black and Beatch—Offutt.

• **Jurisdiction**—All of the responsibility for design and construction of ICBM base facilities comes under the installations section of the BMD. This section establishes the technical criteria for the A&E firms and monitors their work.

The Corps of Engineers takes over as the constructing agency. At Warren AFB, for example, the work comes under the jurisdiction of the Omaha District Engineer and the Missouri River Division. Competitive bid prime construction contracts are let by the district engineer for major facilities, on authority issued by the Los Angeles District Corps of Engineers, which is working directly with BMD. Supervision of construction and coordination of the paperwork falls on the Cheyenne area engineer. BMD also maintains an on-site field office. On completion, the base is handed over to SAC.

Heading up the operational end is the 1st Missile Division. Last January the 706th Strategic Missile Wing (*Atlas*) and the 703rd Strategic Missile Wing were integrated with the 15th Air Force. The 706th SMW will have two squadrons at Warren, and the 703rd SMW is at Lowry.

Training of missilemen is underway at Vandenberg by the 704th SMW, and the 704th Instrumentation Squadron, the 394th Missile Training Squadron and the 576th Strategic Missile Squadron.

Also under construction is a missile targeting center at SAC's Offutt AFB.

This will be operated by SAC's directorate of intelligence. The Air Force says the center will supply all SAC missile bases with trajectory data. Systems to be used include paper tapes with pre-cut targets, enabling base crews to feed guidance information into the missile system "in a matter of minutes."

• **No lagging**—Historically, facilities have frequently lagged behind the development of weapon systems. The ICBM program has been a marked departure. Gen. Schriever, commenting recently on the lead-time requirement of 18 months to construct an ICBM base, said "we haven't the time to perfect the missile and then build. We have had to do it simultaneously."

So far the base-building program appears to meeting the missile development deadline. But the picture could change, quickly, with a sudden menacing move by Russia.

If top planners abruptly decide many more ICBM's are needed, construction will have to be shoved onto a "crash" basis. A high official in the Corps of Engineers told M/R that it might be possible to build bases within six months "going all-out." The present program is taking up only 3% of the construction industry's capability; thus there is a large untapped potential.

Congress is still up in the air as to how much more funds it wants to pump into the ICBM program, over and above the amount requested in President Eisenhower's budget. It is almost a sure bet, however, that lawmakers will increase the figure substantially.

• **More questions**—Aside from money uncertainties, there are other headaches confronting missile base builders. What is the ceiling on destructive capacity? Will the present and programmed nuclear capability of the U.S. be so great when exploded with Russia's in a war that the globe would become uninhabitable afterward? At what point does building more hydrogen weapons become academic?

Air Force officials, too, are conceding in private that public relations problems are looming in connection with ICBM locations. Every new site becomes another Soviet target—and with it the surrounding civilians.

This has inspired some studies on the feasibility of dispersing the launchers over much wider areas. And in the case of *Minuteman* thought is being given to making their launching equipment mobile. They could, for example, be moved from place to place on barges towed along rivers or be fired from railroad flat cars.

Next week: Requirements for Establishing an Equatorial Launch Site

RCA Demonstrates Solar Cell Using Gallium Arsenide

Company also shows new 'tunnel' diode and rectifier, calls development of vital importance

PRINCETON, N.J.—A new match-size solar cell which uses a high-temperature compound called gallium arsenide to transform light into heat has been developed by RCA scientists, who say it holds great promise for use in space vehicles.

A solar battery built around the novel cell, and a radio system using a new high-temperature diode of the same material, were demonstrated for the first time last week by the RCA Semiconductor and Materials Division at the National Aeronautical Electronics Conference in Dayton, Ohio.

The battery was shown powering a miniature radio transmitter of a model satellite which uses a gallium arsenide "tunnel" diode.

The RCA exhibit at the conference was assembled to show military personnel and engineers the progress made by the firm's investigation of new compound semiconductor materials which can operate at high temperatures up to 750°F, without appreciable loss in operating efficiency.

Beside the solar battery and radio system, the exhibit included new gallium arsenide rectifier diodes—the first high-temperature devices, according to RCA scientists, which compete electrically with diodes made from conventional semiconductors such as germanium or silicon.

The research leading to the new units was performed at RCA's David Sarnoff Research Center at Princeton. The gallium arsenide devices shipped to the Dayton conference were developed by Paul Rappaport, Joseph Loferski and Dietrich Jenny, members of the RCA Laboratories technical staff.

The solar battery was developed under sponsorship of the U.S. Army Signal Corps. The high-temperature diodes were developed at the laboratories under sponsorship of U.S. Air Force Electronic Components Laboratory, Wright Air Development Center, Dayton. The rectifier diodes are the result of a contract with the Air Force's Manufacturing Methods Division of the Air Materiel Command.

• **Potential**—According to RCA scientists the match-size solar cell, the basic element of the solar battery, promises to be extremely useful in powering electronic equipment in satellites, missiles, high-speed jet aircraft and other space vehicles. It is expected that gallium arsenide solar cells will give higher efficiency than the silicon solar cells now aloft in a number of America's satellites.

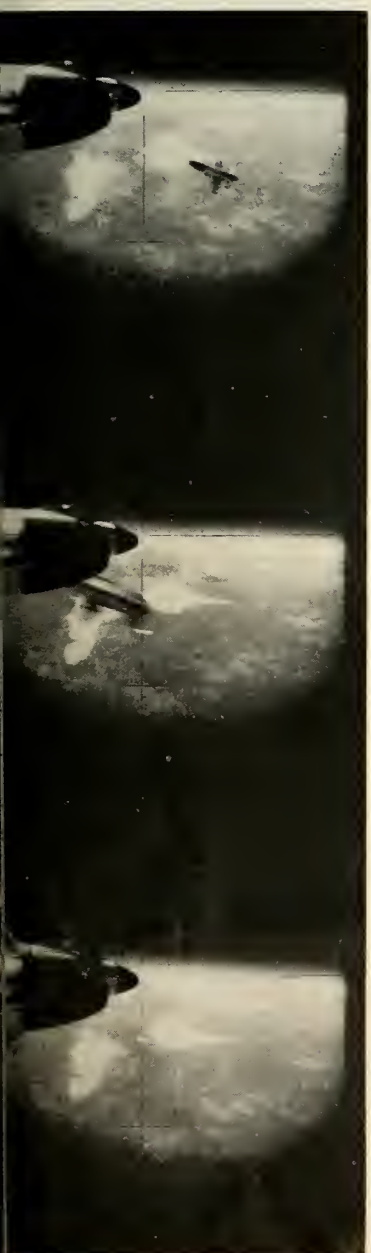
When light is focused on the surfaces of the solar cells, electricity is generated and fed to the transmitter. The transmitter consists of a coil, a capacitor and a new electron device, the "tunnel" diode, which is also made of gallium arsenide. Signals from the transmitter within the model satellite are picked up on a nearby radio receiver in the display.

The development of gallium arsenide devices is of vital importance to the electronics industry, according to Dr. Alan M. Glover, Vice President and General Manager, RCA Semiconductor and Materials Division.

"The new solar cell promises higher efficiency over a wider temperature range than present cells using other materials now available," he said. "The voltage output of the gallium arsenide cell matches the voltage requirements of the newly-developed 'tunnel' diode which operates the transmitter in the model satellite.

"The 'tunnel' diode is itself the industry's first gallium arsenide device to generate high-frequency radio signals. It promises great simplicity in circuit design, high reliability, high frequency operation and operation over a very wide temperature range. Furthermore, the diode's bi-stable characteristic makes it particularly suitable for use in electronic computers."

- *Progress on 24-channel time multiplex system*
- *No decision yet on a British spaceflight programme*
- *Blue Steel readied for test at Woomera*



DIRECT HIT is scored by a Bristol/-Ferranti *Bloodhound* launched in trial at Woomera Range. The surface-to-air bird is already in RAF service.

by G. V. E. Thompson

LONDON—The British Institute of Radio Engineers recently held a one-day symposium on radio telemetry. Most of the papers dealt with the 24-channel time multiplex system, in which up to 24 signals are selected in turn and transmitted over the radio link. This system has been chosen for missile work, in preference to frequency multiplexing or pulse systems, by the Royal Aircraft Establishment (responsible for guided weapons R&D of the U.K. Ministry of Supply).

The missile-borne telemetry equipment must withstand temperature ranges of −40°C to +85°C, pressures of the order of 35 mm mercury, vibration levels of 50g in the frequency spectrum 10 cps to 7 kc/sec and 50g shock loads. It must be immune to fungus and salt spray. To meet these requirements, various modifications had to be made to the prototype after environmental testing. A transmitter is now in production by E.M.I. Electronics Ltd.

A series of 24-channel receiving and recording systems have been commissioned from electronic firms by the RAE. The most recent—manufactured by McMichael Radio—is compact, incorporates improvements to facilitate operational use, and is completely mobile.

The Guided Weapons Engineering Department of the Bristol Aircraft Co. have developed a frequency multiplex f.m./a.m. system which transmits six channels of bandwidths such that frequencies in the range 10 cps to 10kc/-sec can be telemetered simultaneously. With commutated reference levels, the frequency coverage can be extended to include the band 0-10 cps. There have been only four failures in several years' firing of pilotless test vehicles, involving 600 units—a performance attributed to the fact that only a few components in the main transmitter are common to all channels.

In addition to recorders and test sets for the 24-channel time multiplex system, the firm J. Langham Thompson has produced a 20-channel, 600 mc/sec-pulse telemetry system. Using pulse position modulation, it is designed to handle information containing transients of the order of 1 msec from guidance equipment.

• **Still no programme**—No decision has yet been reached by the government on whether to establish a British spaceflight programme. Such a programme would be welcomed by the aircraft industry, which faces lean times as a result of changes in defense policy and the pattern of civil aviation.

It is estimated that two years from now the number of people engaged in the U.K. aviation and missiles industries will be 100,000 less (a reduction of 40%). A spaceflight programme would help to prevent this. However, economists and politicians are doubtful whether national resources are sufficient to support such a programme in addition to the other large technical projects in hand.

At a conference organized by the Institution of Production Engineers, Peter G. Masefield, Managing Director of Bristol Aircraft and President-Elect of the Royal Aeronautical Society, said: "Regrettably, perhaps, the financial ticket is the passport to success or failure. The millions which are being poured into aeronautics and astronautics by the United States and the U.S.S.R. cannot be matched except by adequate funds to compete in *selected* fields. How limited these fields should be is the biggest policy issue of all."

• *Blue Steel* **air-to-ground missile**—First full-scale firing of the Avro *Blue Steel* aerial torpedo is expected to take place soon on the Woomera rocket range in Australia. Details of the design of the missile are still secret but it is known that it is intended to be launched from bombers flying at around 60,000 ft at a distance of over 100 miles from the target.

Successful stage separation of *Titan* was reported by the AF in May 4 firing. Second stage was freed by ignition of two small solid-fueled rockets. Test was prelude to second stage ignition test of the 90-foot vehicle.

Slow contract negotiations, say West Coast missile makers, are making conduct of business with DOD tougher all the time. Example: in the past negotiations took 60 days for continuing development contracts; last year they ran to 11 weeks and this year they are starting later, probably in July, and are expected to last 15 weeks. This runs up overhead costs.

In Paris, France's rocket-making M.A.T.R.A. Co. is reported exporting 10% to 12% of its 511 air-to-air missiles to countries like India and Israel which use French-made fighter planes.

Missile-borne MASER amplifier is now under development at the Army Signal Corps R&D laboratory at Fort Monmouth. Feasibility has been proved, but future development may be limited by present state-of-the-art. Need is to eliminate pumps, among other problems. One MASER, greatly reduced in size, has operated continuously for days.

National Bureau of Standards analysis shows last summer's nighttime high-altitude nuclear bomb explosions ionized the upper atmosphere to near daytime intensity. The resulting electric current flows temporarily altered the earth's magnetic field. Significance of the observations is that man may some day control the ionsphere and radio communications—a vital factor in wartime.

AIA in its new edition of "Aviation Facts and Figures" reports the earnings of the 12 major aircraft and missile manufacturers decreased during 1958, despite record sales. Dollar volume for the 12 totalled $7.2 billion—up 5% from 1957. Aggregate earnings after a tax bite of $153 million were $142 million, or 2%. The 1957 earnings were 2.4%. AIA points out that the average earning rate for all other industries is about 6%.

Mergers & Expansions: Radiation Inc. of Melbourne, Fla., has merged with Levinthal Electronic Products Inc. of Palo Alto, Calif. Another cross-country combination is the Laboratory for Electronics at Boston and Servomechanisms Inc. of Los Angeles. Fansteel Metallurgical Corp. is building a 20,000-square foot plant at North Chicago with a daily capacity of 30,000 silicon rectifiers. A new 50,000-square foot facility is going up at Moorestown, N.J., for Philadelphia Insulated Wire Co. In the Boston area, Clevite Corp. of Cleveland is erecting a $3 million transistor and diode manufacturing plant. Space Electronics Corp. of Glendale has formed an exploratory development department—to develop advanced concepts for technical proposals and R&D in areas of applied physics.

Products: Latrobe Steel Co. has a new vacuum arc melting furnace to produce highly refined tool steels and superalloys. Improved version of its transonic jet-drone *Q-2C Firebee*, Ryan Aeronautical reports, recently hit a new altitude of 59,000 feet. Maximum speed was Mach .95.

Contract for *Pogo-Hi* II E3C Target Missile system has been received by Aeronca Mfg. Corp. for delivery by June 27 to the AOMC White Sands Missile Range. *Pogo-Hi* has Thiokol solid motor and is used to test *Nike-Hercules, Talos, Sidewinder* and *Falcon* at altitudes up to 80,000 feet.

Urgent need for miniaturized electronic equipment to obtain physiological data in early stages of *Mercury* man-in-space program will be underlined at a Franklin Institute, Philadelphia, symposium May 18. Discussions will center around transducer and television applications of bioastronautics.

Boeing Airplane Co., in an effort to expand dealings with small business, now has a policy instructing its buyers to indicate with each order the reason for placing it. If it is not a small firm, buyers must say why.

Anaconda Wire & Cable Co. has purchased Sequoia Wire and Cable from Mandrel Industries Inc. New subsidiary will make small wires for use in missiles, aircraft and electronic controls.

Britain's Royal Air Force is ordering an improved version of the ground-to-air *Bloodhound* produced by Bristol/-Ferranti. New system is reported to have "substantially" increased operating range and altitude over earlier models.

Financial notes: Texas Instruments President Patrick E. Haggerty expects company sales to hit between $185 million and $200 million in 1959 with earnings of about $13 million—more than double the 1958 figure. On the downside, Chance Vought Aircraft reports first quarter sales of $66 million and net of $1.5 million compared to the same quarter in 1958 when sales were $78 million and the net $2.3 million. C-V's backlog as of March 31 was $330 million. On the same date a year ago unfilled orders totaled $595 million. First quarter earnings of the Martin Co. of $3 million are up from the $1.6 million net of a year ago. Sales during the period were $122 million—an increase of 27% over the $96 million in sales of the like 1958 period.

A $6 million LOX, liquid nitrogen and liquid argon plant is being built by Air Products Inc. at Glassmere, Pa. First production is scheduled this fall.

First *Vega* contract for $33.5 million has been awarded by NASA to Convair. Test flights of the three-stage vehicle (*Atlas, Vanguard* booster and new JPL rocket) are scheduled late next year. NASA, which ultimately may spend $76 million on *Vega*, plans to use it to put a manned satellite into orbit and to make instrumented lunar and planetary probes.

Seven firms are in the competition for subcontracting elements of the Boeing *Minuteman* airborne telemetry test equipment. They include Consolidated Electrodynamics, Texas Instruments and Radiation Inc. Selection of the subcontractor will be made late in the summer.

SAC troops successfully fired a second *Snark* May 5 from Cape Canaveral 5000 miles down the Atlantic test range. Flight time was 8 hours and 45 minutes.

Pursuing its diversification program, Lockheed Aircraft discloses it is exploring a possible merger with Lear Inc.



AUNCH of Type 422 GAM missile.

Air-to-Air and Ground-to-Air Missiles

The M.A.T.R.A. Company, a French firm which specializes in the manufacture of rocket launchers and missiles, employs about 1200 in five plants. Two are in Paris (one is for airframes and another plant is for prototypes). Others are Boulogne-sur-Seine, a suburb of Paris (laboratories, tests, mechanics), Salbris (production line of rocket launchers) and Courbevoie, near Paris (laboratories, wind tunnel).

The main production of M.A.T.R.A. now consists of rocket launchers, but the type *422* ground-to-air and the *511* air-to-air missile (shown in these photographs) seem assured of a good future. They are being ordered in quantities to equip the next generation of French fighters. Ten to 12 percent of the M.A.T.R.A. production is now exported, particularly in such countries as India or Israel which use French-made fighters.



THE Vautour weapon system includes this massive array of rocketry.



YPE 422 missile on semi-trailer.



TYPE 511 slung under wing of Canberra.

ARCON and *ARCAS* Renew Interest In End-Burning Rockets

Descendants of earlier JATO's offer high-burning rates and flexibility and may provide cheap rockets for weathermen

by Michael Lorenzo*

WASHINGTON—The state of the art of solid propellant rocketry has been enhanced by recently-released novel design information on end-burning *ARCON* and *ARCAS* type rocket motors—a concept which could be likened to a burning cigarette.

These are technological derivatives of earlier vintage end-burning asphalt composite JATO's. They utilize conventional solid propellants in much the same way as do the familiar star and other hollow grain configurations.

Since all of the volume in the rocket case is used to house propellant and inhibitor, the resulting propellant mass fraction can be made high—taking advantage of the natural log function of the structural efficiency parameter of the ballistic missile range equation. Specific impulse and characteristic velocity figures obtained in development thus far are comparable to other members of the SPR family.

The comparatively smaller diameter of an equivalent mass end-burner design helps to facilitate aircraft installation in the case of JATO applications and lessens bulk in missiles. This smaller cross-sectional SPR design should create less drag in most applications—an airborne installation being more sensitive than a ballistic vehicle.

• **High burning rates**—An approximate value of 52.5 inches can be derived for the *ARCAS* rocket-motor length by differences in the accompanying table of design characteristics. The length of the grain can be estimated at 47 inches. Similarly, the *ARCON* rocket-motor and grain lengths are estimated to be 102.6 and 96 inches, respectively.

These end-burning grain lengths when considered with their burning times give corresponding values of 1.9 and 2.9 inches per second as burning rates. These values are considerably higher than those encountered in hollow grain solid propellants and, if correctly deduced, would obviously represent the basis for the current renewed interest in end-burning rockets.

• **Flexibility**—Paradoxically, published textbooks on rocket propulsion describe solid-charge end-burners as *restricted* burning types and hollow charges as *unrestricted* burning types. After taking note of the aforementioned burning rates of the *ARCAS* and *ARCON* motors, the nomenclature *restricted* probably should be changed to *adjustable* or *flexible*.

The end-burning design is innately flexible in that adjustments to achieve specific burning times, corresponding altitudes and/or ranges can be accomplished by simply cutting the length of a standard motor to a required size.

• **Development**—The *ARCAS* meteorological rocket is being developed for the Geophysics Branch of the Office of Naval Research by the Atlantic Research Corporation, Alexandria, Va. The Aerology Division of the Navy Bureau of Aeronautics and the Air Force Cambridge Research Center also are supporting this project which is headed up by Lt. Cmdr. "Sam" Houston of the Office of Naval Research.

On Jan. 27, the Army's Signal Missile Support Agency successfully fired this rocket to an altitude of 179,200 feet at White Sands, N.M. Col. John McGovern, commanding officer of the Agency, announced that this low-cost meteorological rocket system can be completely assembled and launched by a two-man crew within two hours. The closed-breech launcher consists of five major parts weighing a total of 39 pounds. It stands 11 feet 8 inches high and imparts a 100 fps exit velocity.

ARCAS (All-purpose Rocket for Collecting Atmospheric Soundings) eventually will be made of finely-spun glass fibers so that it may be fired by meteorological personnel over populated areas and exploded to fragment after it has gathered needed data.

ARCAS now joins a family of atmospheric data-collecting rockets including *Loki, Nike-Cajun,* and *Aerobee-Hawk*. It will be developed to carry payload weights of approximately 12 pounds (rocket total weight is 7 pounds) as high as 206,000 feet. The *Iris,* designed to carry 100 pounds 20 miles high, is in advanced development at Atlantic Research and completion is anticipated early next year.

Rocket vehicles used by meteorologists in the past have been expensive, heavy, bulky and complicated affairs converted from military missiles with high acceleration rates which damage the data-seeking instrumentation. Cost

DESIGN CHARACTERISTICS

	ARCAS	ARCON
Overall length	92.3 in.	133.8 in.
Diameter	4.45 in.	.....
Instrument section (nose cone) length	18.1 in.	31.2 in.
Parachute section length	13.4 in.	.....
Separation device length	2.7 in. (approx.)	.....
Payload	12.5 lbs.	.....
Gross weight	77 lbs.	.....
Burnout weight	36 lbs.	.....
Thrust	390 lbs.	.....
Burning time	25 sec.	.....
Propellant	ARCITE 373	.....

* *Contributing Editor to M/R and Advisor to Air Force on Propulsion*

rbade routine us of them for gather- weather data.

ARCAS, developed from the draw- board as a pure meteorological cket, seems to be an answer. It can fired almost as easily as a mortar ell, provided close supervision is car- d out by personnel experienced in cket trajectory calculations.

These *ARCASes* fired by SMSA ay be forerunners of inexpensive stic rockets that meteorologists will e daily to provide much needed curate weather forecasts.

The prima facie pros and cons of id-propellant end-burning grains ap- ar as follows:

• **Advantages**—1. The entire rocket se volume, with the exception of a ripheral volume occupied by insula- n and inhibitor, is utilized for pro- llant loading.

2. Problems of burning in a cavity, ., resonance and erosive burning, are eliminated.

3. Desirable aerodynamic shapes, i.e., high length-to-diameter ratios, may be achieved in long-duration applications. The length of an existing standard rocket can be readily adjusted to attain desired total burning time and resulting range and/or altitude.

4. In sounding-rocket applications, increased burning times permit conservation of fuel during low-altitude operation for more effective use in the thinner air above.

5. The simple geometrical shape of the grain reduces processing problems, relieves the demand for excellence of physical proprties which may conflict with the attainment of high performance, and gives rugged, shock-resistant grains.

• **Disadvantages**—1. Insulation is usually required to protect the motor case from the combustion gases as the burning surface recedes; however, insulation can be tapered toward the head end, and the relative volume occupied by insulation decreases with increasing motor diameter.

2. The center of gravity of the rocket shifts during burning; although the net shift is the same for end-burning and internal-burning grains, the mean location of the center of gravity of an end burner is forward of the mean center of gravity in a central-perforated system.

Some "imagineer" undoubtedly will see another seemingly innate advantage of end-burner designs by adopting an autophagia (from the Greek word "autophagos" meaning self-devouring) combustion principle. This certainly should enhance the state of the art of increasing the propellant mass fraction and resulting performance. After all, the chemist is well on the way to reaching the physical limit of releasing chemical molecular bond energy.



GHTNESS and ease of handling for *cas*, 72-pound research rocket is design uirement.



TAKE-OFF from Wallops Island, d-burning *Arcon* has high acceleration.

New Theory Advanced for Hydraulic Failures

WASHINGTON—The failure of missile hydraulic and liquid fuel systems may be caused by the same sort of stress which causes strokes in humans, according to a theory advanced at the American Physical Society meeting.

The theory was described in a paper presented by Harry Lobel, an electrical engineer who has done extensive private investigation into the application of electrical analogs to fluid flow and the human circulatory system.

Lobel has applied his studies to the design of hydraulic fittings patterned after arterial bifurcations which compensate for surges and stresses which may lead to failure.

Ideally, such junction fittings would be designed to change configuration automatically in response to varying stress conditions caused by turbulence, vibration, and cavitation. Lobel feels, however, that a non-variable fitting could be developed to compensate for a relatively wide range of variations.

Free-rotor Gyroscope Developed by Autonetics

LOS ANGELES—Inertial guidance platforms may be considerably simplified and made more stable by the use of a "free-rotor" gyroscope developed by North American's Autonetics Division.

Only two of these gyros are needed to stabilize an inertial reference platform whereas at least three conventional single-axis gyros are now used. In addition, a simple second-order type servo system will suffice, with inherently more stable characteristics and less complicated electronic circuitry.

The rotor is supported and turns in a spherical gas-lubricated bearing—with practically no friction and wear. The overall mechanical assembly is less complex and reportedly there is no need for gimbaling and liquid flotation of the rotor assembly.

The spherical bearing must be manufactured to extremely close tolerances. However, the minimum number of parts and the long life predicted for the gas bearing should lead to a considerable gain in reliability. A prototype bearing has been operating continuously at Autonetics for seven years.

Telemetering Conference

"Investigation of Space" will be the theme of this year's National Telemetering Conference at Denver, May 25-27. Papers and panels of telemetry experts from over the nation will discuss progress of telemetry and its important role in space exploration.

The conference, jointly sponsored by ARS, AIEE, IAS, and ISA, will be chaired by Max Lowy of Data Control Systems, Inc. Alan P. Gruer, of Sandia, is program chairman.

Some sessions scheduled and their respective chairmen, include:

Critique and Comparison of Various Telemetry Systems for Space Instrumentation, John Eckhart, Sandia Corp; Telemetry System Integrity, W. M. Koellish, Martin-Denver;

Miniaturization and Transistorization Progress, C. E. Ruckstuhl, Bendix;

Ground Stations - Techniques and New Components, K. A. Hall, STL;

Space Medicine Problems Probed by AMA

by Frank G. McGuire

LOS ANGELES—The 30th annual meeting of the Aerospace Medical Association here opened a Pandora's Box of radiation, weightlessness, psychological disturbances, physiological hazards and inter-agency bickering to be faced by the first astronauts.

Along with these, it brought out some interesting solutions to several problems, including hibernation to ease extremely long, boring space flights; severing of certain nerves in the inner ear to avoid motion sickness in space; and assuming a fetal position to present a smaller target for intense radiation. No simple solution for the inter-agency fights was forthcoming.

Some highlights of the conference:

• Dr. Hubertus Strughold, Air Force space medicine chief who is also an M/R contributing editor, said man may be able to operate in the Martian lowlands with no more elaborate equipment than an oxygen mask, and that man may be unable to survive the 100°C heat on Venus.

• The possibility that man may be able to venture into deep space for only three years out of every eleven was voiced by Dr. Hermann J. Schaefer of the Navy's School of Aviation Medicine at Pensacola.

• The technique of spinning a satellite to provide an artificial gravity for the occupants may give rise to a motion sickness so severe that the astronauts might be much happier in a weightless state, according to Dr. Ashton Graybiel, also of the Navy's School of Aviation Medicine.

• A lone man on a protracted mission into space might soon find himself completely detached from his own personality and convinced that he can't possibly be that silly fool sitting in a space ship and going nowhere. Lt. Col. Jerrold L. Wheaton, USAF neuropsychiatrist, added, however, that a properly selected individual might be trained enough to circumvent this situation.

• The problem of weightlessness compounds, according to Dr. Harald von Beckh of Holloman AFB, when the subject suddenly awakens and finds himself in this state, contrasted to the ease with which he adapts to it when fully expecting it.

• **Space-suit-less?**—Dr. Strughold told a press conference at the meeting that Mars has certain lowlands with an atmospheric pressure equivalent to 45,000 feet in the earth's atmosphere. This would allow, he said, the wearing of heavy clothing and an oxygen mask. The climate there is about like that of the Pamir Plateau in the USSR. Other areas of the Red Planet, with higher elevations, have pressures equivalent to about 55,000 feet, and will probably require a pressure suit.

On Venus, Strughold said, there is a great amount of CO_2 in the atmosphere, resulting in a high heat-absorption that makes a "greenhouse effect." The surface temperature of the planet may thus be as high as 100°C, preventing manned exploration.

• **Radiation**—The data obtained from *Pioneer III* was not borne out by *Pioneer IV*, said Dr. Hermann J. Schaefer, and it now appears that the radiation intensities near earth are as much as ten times that predicted by van Allen. The inner belt particles have much higher penetrating power, he said, and the shielding problem here may be hopeless.

There is a possibility, however, that the situation as shown by *Pioneer IV* is only a temporary one resulting from a solar flare that occurred a few days before the launching. In this case, it is likely that a manned space ship caught in a burst of radiation from a solar flare would be doomed. The radiation intensity could easily increase one-thousand-fold in fifteen minutes with no warning.

The use of polar exits from the earth's vicinity could solve the problem, he said, but there is reluctance to use this method because of the greatly complicated navigation problem. If the worst indications of *Pioneer IV* data are confirmed by future findings, it may be possible for man to leave the earth's vicinity beyond 1000 km for only the three inactive years of the eleven-year solar cycle.

• **Motion sickness**—The astronaut riding in a rotating satellite in orbit may be content to let weightlessness take its course rather than suffer the miseries of motion sickness under artificial gravity. This opinion from Dr. Ashton Graybiel came after experiments had shown that persons who do not keep their heads perfectly fixed while rotating become violently sick.

Head movement during rotation causes angular acceleration in the semicircular canal of the inner ear in a different plane than that being maintained by the rotating satellite. While it is possible to use drugs to offset this condition, it is more desirable to cut the nerves leading to the semicircular canal. Severence of these nerves is not difficult, he said, and it does not impair the hearing.

• **Extreme boredom**—Behavior and emotional problems in space ar not easy to predict accurately, becaus of the difficulty in reproducing cond tions there. Any subject undergoin psychological tests in an isolatio chamber, etc., is fully aware that a though he may be isolated, he is sti on the ground and safe.

However, extreme boredom tak over and an astronaut may find hin self daydreaming and dozing off. Whe awakening to find himself still in cramped and lonely space ship, he wi become irritable and restless. After while, his thoughts turn to fantasy ar he becomes detached from himself.

"After a length of time dependi on the type of person he is, he will n know who he is, but he'll be sure he not that silly fool sitting all alone in space ship going nowhere," report Col. Wheaton. But a carefully selecte and mature individual might g through a lengthy trip with no mo than mild irritation, he said.

• **Hibernation**—Defining hibern tion as "a periodic physiologic state which the body temperature falls to low level approximating that of t ambient temperature, and heart ra metabolic rate, and all other functio fall to correspondingly minimal levels Raymond J. Hock, USAF Arctic Aer medical Laboratory, said the theo has great advantages for space fligh but is not immediately feasible.

Periodic arousal from hibernati is highly desirable, to allow certain a tivity essential to the mission. To pe mit man to hibernate, scientists mu first solve at least four problems: lo ering the body temperature to 10 or below, without the occurrence ventricular fibrillation; ability to mai tain these low temperatures for lo periods, rather than the present lim in animals of a few hours; understan ing of the energy turnover that w allow this condition to be maintain and ability to arouse man to a norm condition periodically.

• **Weightlessness**—Unless cont consoles are properly designed, ported Dr. Harald von Beckh, an o erator under conditions of weightle ness may reach for a button witho looking for it, and find he has t wrong one. This was pointed out citing the importance of vision in o entation. Even this, however, is not great a problem as the disorientati experienced by an astronaut who aw ens suddenly to find himself weightle where there was no weightlessness fore.

NAA's Novel Approach to Stainless Steel Honeycomb Panels

Company sees "new era" in vehicle construction; process includes original heat-treating cycle

by Frank G. McGuire

Los Angeles—North American Aviation, Inc. has developed a new process for producing stainless steel honeycomb sandwich panels for aircraft and potential missile construction. NAA devised its own heat-treating cycle, changed the method of building retorts for fabricating panel sections, and developed a new "roller-skate" device for heliarc welding the edges of the retort.

The new panel is designed to operate in a temperature range of 460°F to 640°F (see Fig. 1), and is constructed with a view toward its use in fabrication of integral fuel tanks. Simultaneous heat-treating and brazing is done in a unique gas-fired porous-brick furnace with eight separate heat-control zones.

• **Special cycle**—The stainless steel alloy used is PH 15-7 Mo CRESS (precipitation-hardening, 15-7 Mo corrosion-resistant stainless steel) with a heat-treating cycle (see Fig. 2) determined by NAA engineers, in preference to that recommended by the supplier. The cycle involves fast uniform heating rates to brazing temperature of 1625°F, where it is maintained for about 18 minutes. Fast uniform cooling is then applied until the temperature reaches 1000°F in about 45 minutes, after which the panel is subjected to −110°F for three hours, then to 900°F for eight hours to the end of the cycle.

According to NAA, the "most critical phase" of the cycle is the rapid cooling from 1625°F to 1000°F in a 45-minute period. "If this rate of tem-

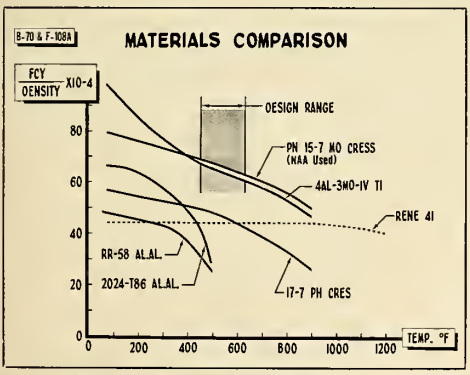


FIG. 1—Superior performance of PH 15-7 Mo CRESS.

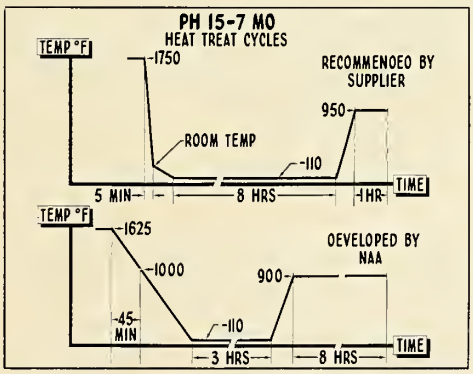


FIG. 2—NAA devised its own heat-treating cycle.

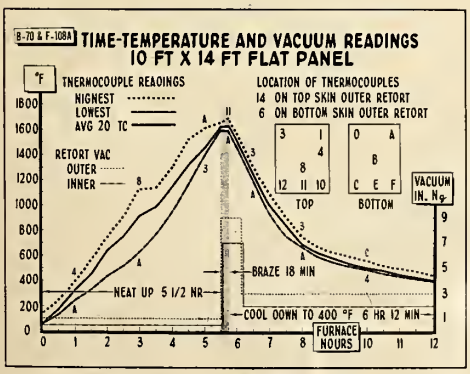


FIG. 3—Big panel exceeded strength requirements.

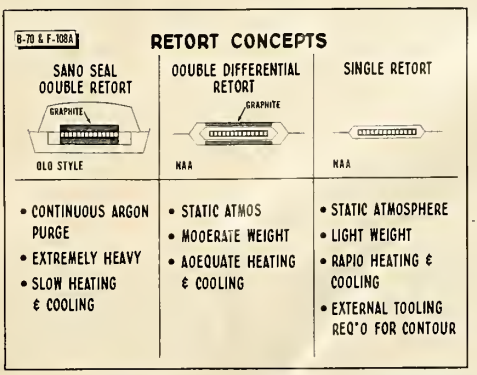


FIG. 4—Graphite removal precluded contamination.

perature descent is not exactly controlled, the panel probably won't be worth much," a company official said. The cooling is accomplished through the use of cold air pumped through the furnace after heat-treating and brazing.

The general operation of this furnace is as follows: a mixture of gas and air is pumped into a plenum chamber between the steel shell of the furnace and the brick internal surface. The gaseous mixture flows through the porous brick and is ignited upon reaching the internal surface. The flow is such that it cools the brick, and although the inside surface temperature of the brick is above 1600°F, this temperature has dropped to 300°F two inches from the inside surface.

To promote cooling at the end of the cycle, the operator cuts off the flow of gas, which terminates ignition, and allows the cool air to continue flowing into the furnace, substantially reducing the temperature. The eight control zones which allow the operator to govern the elevated temperature over any portion of the panel also allow closely controlled cooling during the critical phase.

• **Brazing alloy**—Brazing is accomplished through use of a sterling silver (92½%), copper (7⅜₁₀%) and lithium (⅜₁₀%) alloy which is compatible with the base metal, stainless steel. The copper acts as a temperature gradient equalizer, assuring equal temperature throughout the surface of the panel. The copper used must be phosphorized, or oxygen-free, to prevent blistering of the finished panel.

Before NAA discovered the use of copper in December, 1958, the largest panel which could be made was about six feet square. After oxygen content in copper ruined a $28,000 ten-by-fourteen-foot panel, the company switched to the oxygen-free type. Copper is also used in the inner retort when attached members must be welded to the facing plate of the panel in the retort.

In constructing its largest panel, 10 x 14 feet (see Fig. 3), NAA was required to achieve a minimum yield strength of 200,000 psi (it achieved 227,000 psi), a minimum tensile strength of 225,000 psi (it achieved 242,000 psi), and a minimum elongation of 4% (it achieved 4 to 6½%). X-ray examination of this large panel disclosed 99% brazed bonding between the core material and the facing plates of the panel.

Thermal conductance of the bonding alloy was lowered in order to reduce heat transfer to fuel supplies when structural designs call for using the panel in integral fuel tanks, as in the B-70 bomber and the F-108A interceptor. The brazing temperature was lowered from 1750°F to 1625°F in order to make it more compatible with the brazing alloy's optimum brazing temperature.

• **Graphite is eliminated**—North American also devised a method of eliminating graphite from the tooling needed within the retort, and thereby removed the possibility of contamination (see Fig. 4). In the single-retort method used, the weight of the panel being fabricated is greater than the weight of the retort. This method also provides rapid heating and cooling, a static argon atmosphere (compared with continuous argon flow formerly needed) and simplicity of design.

Edges of the retort are automatically fusion-welded by use of a "roller-skate" device which replaces the hand-operated method. The roller skate mounts a heliarc welding torch and traverses the edge of the retort, fusion-welding it in a short time. This method allows use of the retort a number of times, since it is unnecessary to grind away a great portion of the flange in order to open the retort. The roller skate was conceived and designed by NAA engineers.

• **Ultrasonic inspection**—Inspection of finished panels is done by use of ultrasonics (see Fig. 5). The method was adopted when the company was seeking to reduce the amount of time and money required by X-ray inspection. It previously took one hour for X-ray inspection of one square foot of panel and the cost of inspecting this square foot was $16. The present method handles 14 square feet per hour and costs $1 per square foot (one side only). NAA plans to use multiple inspecting heads on its ultrasonic equipment to greatly increase the inspection rate.

The ultrasonic scanner operates at 18 inches per second, on a width of 1/32". A strip chart recorder reproduces the interior image of the panel on a 1:1 ratio. Defects found are analyzed by a fluoroscope installation, because the ultrasonic scanner can find defects, but not the cause for them. The fluoroscope presents a 3D image enabling the company to determine if salvage or repair of the panel is possible, and if so, how.

Present average size of the panels in production is 6 x 12 feet, but sizes up to 10 x 14 feet have been fabricated. The B-70 bomber will utilize about 20,000 square feet of the panel and the F-108A interceptor will use about 350 square feet. The B-58 Hustler reportedly uses about 1200 square feet of honeycomb sandwich panel.

North American feels that the three most significant advances in state-of-the-art methods inherent in their new system are: removal of graphite from within the retort; use of a static argon atmosphere instead of a continuous flow; and use of copper in the brazing alloy, thus allowing fabrication of large-size panels.

North American foresees the use of the panel in many future high-speed aero/space vehicles. The process, according to company officials, ushers in a "new era" in vehicle construction.

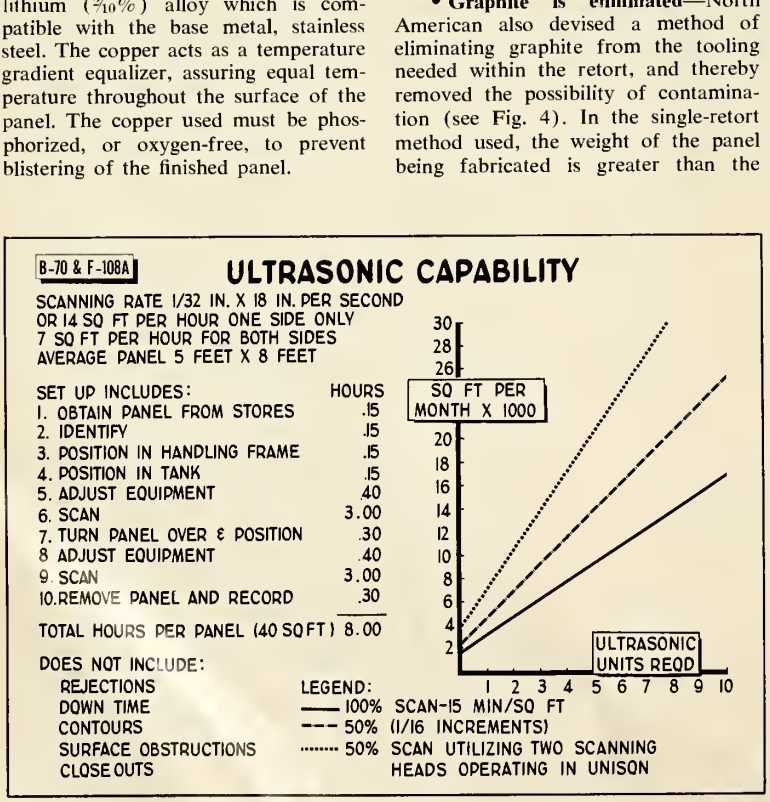


FIG. 5—Panel inspection by ultrasonics instead of X-ray saves in time and money.

MATERIALS FOR ROCKETS AND MISSILES. Robert G. Frank and William F. Zimmerman, 124 pp., $4.50, The Macmillan Company, New York, N.Y.

The new lightweight, high-temperature materials now available for use in missiles and rockets have appeared with such rapidity on the market during the last year that attempts to index and catalogue them have run far behind. This book concisely fills the need of many engineers in the industry to know what present engineering data is on existing metal and ceramic materials, and what materials can be expected to become available during the next few years.

Because of the technical advances in the missile material field and the difficulty that engineers not directly concerned with the development of these materials have in understanding these advances, the book also gives brief descriptions of new ceramic and high-temperature metallurgy techniques.

The book attempts to give a broad cross-section of all the materials available for specific applications, and then recommend the best materials for each use. Conclusion: A handy handbook on materials and metals and a valuable addition to the missile industry library.

METALS FOR SUPERSONIC AIRCRAFT AND MISSILES. D. W. Grobecker (Ed.), 23 pp., American Society for Metals, Cleveland, O.

A compilation of technical papers presented at the Conference "Heat Tolerant Metals for Aerodynamic Applications," at Albuquerque, N.M., in January, 1957, under the joint sponsorship of the Albuquerque and Los Alamos Chapters of the American Society for Metals, and the University of New Mexico.

Eleven papers are included on the various techniques and problems concerned with the metals and ceramics applications to missile development.

Chapter 12 is a summary and evaluation of the papers by J. R. Townsend, previously of the Sandia Corp., and presently a Special Assistant to the Assistant Secretary of Defense for Research and Engineering.

THE UPPER ATMOSPHERE. H. S. W. Massey and R. L. F. Boyd. 326 pp., $17.50, New York Philosophical Library, New York, N.Y.

An account of the experiments conducted and knowledge gained about the upper atmosphere during the International Geophysical Year for students, scientists in other fields, and those technically interested in space travel.

This book has one very unique asset and one distinct liability.

Its authors have been able to explain more of the technical details about both the experiments and the results of the IGY upper atmosphere tests in lay language than any publication to date. They treat mathematical exposition as if it were taboo, and explain in language

(continued on page 29)

HADLEY

missile valves & controls



If you want to keep that project on schedule . . .

You need motivation to get performance. Hadley has that motivation with sound engineering, environmental testing, precision manufacturing and rigid quality control.

In addition, Hadley offers performance . . . the ability to design, develop and deliver the quality product on schedule.

For more information write, J. T. Reilly, Director of Marketing.



Pioneers in Cryogenic Valves

• **ENGINEERS: Inquire about attractive project & design career opportunities.**

B. H. HADLEY INC.*

POMONA, CALIFORNIA

*Wholly owned subsidiary of Central Hadley Corporation — listed American Stock Exchange.



A missile streaking through the sky . . . a ship plowing through the ocean . . . a submarine gliding through the depths . . . all guided with unerring ac by Autonetics' inertial navigation systems.

Twelve years ago development was under way on the first Autonetics' i autonavigator—a system to guide a supersonic missile to a distant target.

Since then, refined versions of this system have shown remarkable cap for guidance over, on and under the terrestrial surface in any craft, at any under any conditions . . . a significant advance in the state-of-the-art.

It was an Autonetics' autonavigator that guided an aircraft on the first suc daylight cross-country flight by stellar-inertial autonavigation. Another

Inertial navigatio



ily passed the Navy's exhaustive sea tests aboard the USS mpass Island in 1957. And in 1958, Autonetics' systems ded the USS Nautilus and Skate on their historic voyages ler the polar ice.

Today Autonetics is producing in quantity the systems to de the Air Force's GAM-77 missile. Its engineers are de- ning systems for America's Polaris-carrying subs and the uteman intercontinental ballistic missile. Even more anced systems will provide the accurate stellar-navigation a needed to guide man on his travels through Outer Space.

But the imaginative engineering that brought inertial navigation so far, so fast, is only half the Autonetics' story. New ideas had to be implemented by new manufacturing techniques. Many components of inertial autonavigators—gyroscopes, accelerometers and computer elements—called for precision that was once impossible. Now Autonetics has put it on the production line.

These are the achievements that have given here-and-now reality to inertial navigation . . . and have made Autonetics first in the field.

by Autonetics

A DIVISION OF NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA • REGIONAL OFFICES: WASHINGTON, D. C. AND DAYTON, OHIO

INERTIAL NAVIGATION / ARMAMENT CONTROL / FLIGHT CONTROL / COMPUTERS AND DATA PROCESSING

Explore new areas at IBM in



Solid state studies are now yielding important discoveries at IBM. Ranging from basic research to product development, solid state projects include a study of the behavior of molecules adhering to a surface in an ordered array. Another project involves the correlation of transistor parameters with circuit transient performance. In magnetics, engineers and scientists are developing a ferrite core which will function normally at 500°C., and a one-million bit memory drum weighing only five pounds. Advanced work such as this requires creative engineers and scientists with inquiring minds and an enthusiasm for investigating the unknown.

At IBM you will enjoy unusual professional freedom and the support of a wealth of systems know-how. Comprehensive education programs are available, as well as the assistance of specialists of many disciplines. Working independently or as a member of a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

CAREERS AVAILABLE IN THESE AND RELATED AREAS . . .

Circuit design	Logic	Nuclear physics	Radar circuits
Component engineering	Magnetics	Optics	Reliability
Computer design	Mathematics	Phosphors	Semiconductors
Cryogenics	Metallurgy	Physical chemistry	Systems engineering
Inertial guidance	Microwaves	Physics	Transistors

Qualifications: B.S., M.S., or Ph.D. in Electrical or Mechanical Engineering, Physics, Mathematics, or Physical Chemistry — and proven ability to assume a high degree of technical responsibility in your sphere of interest.

ASSIGNMENTS NOW OPEN INCLUDE . . .

MAGNETICS ENGINEER to design and analyze magnetic core circuitry for use in advanced digital computers. Must understand application of these circuits to logical connectives and systems, and be familiar with basic fundamentals of nonlinear magnetics. Qualifications: B.S., M.S., or Ph.D. in E.E. or Engineering Physics plus 2 to 5 years' experience with magnetic circuits and a strong interest in logical circuit application of magnetics.

CIRCUIT ENGINEER to develop advanced circuit designs based on transistor-diode logic for digital systems; to review new circuits for application in digital control systems and define basic techniques for improving performance characteristics; to participate in advanced analytical studies associated with the application of transistor circuitry to pulse and digital systems. Qualifications: B.S., M.S., or Ph.D. in Electrical Engineering. Minimum of two years' experience with pulse circuitry, transistor circuit design or digital techniques. A knowledge of magnetic devices or solid state physics is highly desirable.

CHEMIST AND PHYSICAL CHEMIST to initiate fundamental studies of the phenomena of surface boundary layers relating to absorption friction, wear, and surface energy states. Qualifications: B.S., M.S., or Ph.D. degree in Chemistry, Chemical Engineering, or Physical Chemistry and suitable experience.

SOLID STATE ENGINEER to carry out applied research studies on precision linear circuitry employing solid state devices. Qualifications: B.S., M.S., or Ph.D. degree plus experience in feedback amplifier and servo design.

METALLURGICAL OR PHYSICAL ENGINEER to handle research and advanced development relating to electrical connections, vacuum melted metals, and thin film techniques. Qualifications: B.S. in Physics or Metallurgy plus extensive knowledge of materials and means of joining metals. Thoroughly experienced with metallograph, photomicrography, and experimental techniques.

PHYSICIST to supervise efforts in integrated circuit development and fabrication using variety of thin film components. Qualifications: Advanced degree in Physics and well-qualified experimental experience.

TRANSISTOR ENGINEER to direct projects dealing with device and process development of transistors and advanced types of multi-element semiconductor devices. Qualifications: M.S., or Ph.D. in Physics or E.E. with 2 years' experience in semiconductor field.

For details, write, outlining background and interests, to:

Mr. R. E. Rodgers, Dept. 604E2
IBM Corporation
590 Madison Avenue
New York 22, N. Y.

IBM®
INTERNATIONAL BUSINESS MACHINES CORPORATION

reviews

not requiring advanced knowledge the instruments and vehicles used and the information obtained.

The book has the liability of having been printed at a time when our knowledge about the upper atmosphere was ever-increasing. It was printed before Van Allen discovered the two belts of charged particles, which is the most significant piece of information produced about the earth's atmosphere in centuries. The authors did point out, however, that one urgent problem to be solved was the amount of "concentration of meteoric and micrometeoritic particles in space and in the upper atmosphere."

The book describes the techniques and vehicles used in the investigation of space, such as balloons, spectroscopic devices, sound and radio waves, searchlights, rockets and artificial satellites. Methods used in finding the positions and speeds of rockets and satellites, and of interpreting their coded signals, are explained. Detailed attention is also given to the phenomena of radio fadeout, radio absorption, night airglow, aurorae, meteors, cosmic rays, and currents responsible for magnetic variations.

POWER UNLIMITED! and TOMORROW THE MOON, both by Abraham and Rebecca B. Marcus, both $3.50, both approximately 150 pp., Prentice-Hall Inc., Englewood, N.Y.

Space primers by a husband and wife team which give adequate coverage of the fields in easy to read terms and diagrams. *Power Unlimited!* covers the field of propulsion from jets to ion rockets. *Tomorrow The Moon* starts with the ancient Greeks and projects us out into space by way of Peenemunde, White Sands, and Cape Canaveral.

These are not books for missile and rocket technicians and engineers. They are good books to recommend for friends who would like to know more about the industry and space technology, and for the children and wives of people in the missile and rocket industry who would like to know more about what daddy and husband are doing.

* * *

The National Bureau of Standards *Journal of Research* will be published in four separate sections beginning July 1:

Section A—Physics and Chemistry
Section B—Mathematics and Mathematical Physics
Section C—Engineering and Instrumentation
Section D—Radio Propagation

According to the Bureau, the change is being made to permit better distribution and to better meet the specialized needs of the scientists, engineers, and mathematicians who subscribe. The change will also allow the editorial scope of the *Journal* to be broadened to better cover the Bureau's technical program.

Printing schedules and subscription costs vary among the various sections. Subscriptions may be ordered from the Government Printing Office.

Special Problems of the Monkey-in-Space

by Dr. Earl T. Carter
Ohio State University

COLUMBUS, Ohio—Space medicine scientists are hard at work on the problems involved in placing experimental animals in orbit and returning them safely to earth.

They have found that monkeys—in some respects—present greater difficulties than men.

• **Science of balance**—Maintaining the health and normal functions of an animal under sealed environmental conditions involves the science of Ecology, dealing with the process of keeping an energy balance between an animal and its environment.

To achieve such a state of balance it is necessary to know the exact metabolic requirements of an animal—the exact amount of oxygen, water, and food he consumes, as well as the amount of heat he adds to the environment and how this amount compares with the heat input from all possible external sources.

For many years, data has been accumulated concerning metabolic functions of animals such as the monkey. But there is a scarcity of data applicable to the special conditions of space flight. Accordingly, researchers have had to create laboratory capsules in which space flight conditions can be simulated as closely as possible.

Studies of this type are being conducted in laboratories of the Department of Physiology-Biophysics at the USAF School of Aviation Medicine. Here Drs. Hans Clamann and Richard Bancroft are making careful studies of the behavior and metabolic requirements of the spider monkey in experimental sealed capsules. Many unexpected problems have arisen.

• **Drinking problem**—First, there was the key problem of providing liquid to an animal in the weightless state, since drinking in this condition is impossible without special mechanical means. This was solved by development of a special gelatin mixture which is 80% water and is packed with nutritious materials such as peanuts, oatmeal and vitamins. This semi-solid gelatin is contained in small trench-like recesses along the inner walls of the capsule. The monkey can handle and chew it even in the weightless state.

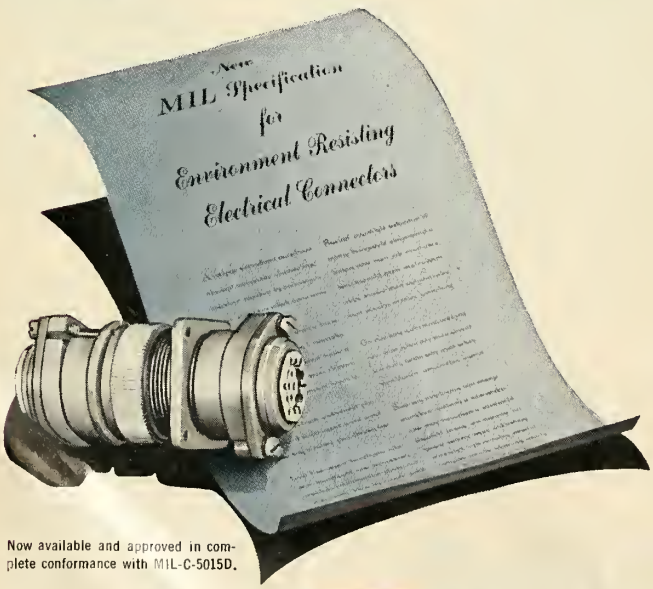
• **Dark confusion**—Another problem unique to such a system is prolonged darkness. A monkey, like a human, is used to sleeping in the dark and eating in the daylight. Prolonged darkness tends to alter many of his habits and even his basic physiological functions. Whether such effects might have deleterious results will be determined by further testing.

• **Overindulgence**—The monkey himself has provided several problems because of his peculiar personality. In early experiments it was found that he tended to eat his entire food supply in one sitting. To overcome this gluttony, a special food dispensing device was designed with a timing mechanism to insure that only a single day's supply of food was delivered at the beginning of each day.

• **Little menaces**—Furthermore, it was found that monkeys are like human children—destructive. In preliminary experiments, they were bored in the sealed capsule and amused themselves by taking everything apart. Ventilation systems were unscrewed and dismounted, power supply cables were chewed through, and measuring devices were otherwise put out of order.

To handle this problem, a sealed system was designed in which no loose object, sensing device, motor, or other control mechanisms could be reached by the busy-fingered simians.

NEW BENDIX MS-R ENVIRONMENT RESISTING ELECTRICAL CONNECTOR



Now available and approved in complete conformance with MIL-C-5015D.

This new connector answers the demand from the aircraft industry for a shorter, lighter and more reliable environment resisting connector. This connector will inactivate practically all other MS types and the Military has assigned a new class letter R to insure incorporation of this better connector in all new designs.

An important reliability feature of the new MS-R connector is an "O" ring at the main coupling joint which provides for the best possible sealing and more positive inter-facial compression and assures complete performance compatibility among all approved MS-R connectors. Establishment of the MS-R connector as the "universal" military connector is testimony to the record of previous MS environmental resistant connectors using resilient inserts as pioneered by this Division. In the Bendix* connector, wire sealing is accomplished by an exclusive slippery rubber grommet which permits convenient wire threading and grommet travel over wire bundles.

Write for more complete information on this latest addition to the ever-growing family of Bendix electrical connectors.

*TRADEMARK

Bendix SCINTILLA DIVISION
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec

FACTORY BRANCH OFFICES: Burbank, Calif.; Orlando, Florida; Chicago, Ill.; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

THE U.S. TREASURY SALUTES THE AIRCRAFT INDUSTRY



—and its thousands of employees who help strengthen America's Peace Power by buying U.S. Savings Bonds

Men and women who make up the great group who design, fabricate, assemble and test our newest aircraft are also making another substantial contribution to our national security. Many thousands of them are buying U.S. Savings Bonds, regularly, through the Payroll Savings Plan.

Regular purchases of Shares in America help these patriotic and thrift-minded people set up substantial reserves for the education of their children, the buying of new homes and the building of their retirement funds. Through the Payroll Savings Plan the practice of thrift is made easy and automatic.

If your company has not yet put in a Payroll Savings Plan, start now. Your State Savings Bond Director is anxious to help and to show you how easy it is to put the Plan to work. Telephone him now. Or write to Savings Bonds Division, U.S. Treasury Department, Washington, D. C.



L. A. MARTIN, skilled aircraft mechanic, is typical of the thousands of valued employees in this field who are buying U.S. Savings Bonds regularly. Mr. Martin, through his company Payroll Savings Plan, is making a personal contribution to the Peace Power of his country.



THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE.

COVER STORY



$23 MILLION research center ready.

BIRTH OF A *TITAN* NOSE CONE

The story in pictures
of previously secret data on nose cone technology
conducted by Avco which is opening new R&D center

WILMINGTON, MASS.—One of the most complete and advanced Space Age research centers in the world will be dedicated here on May 14. Completion of the $23-million center—Headquarters of Avco's Research and Advanced Development (RAD) Division—marks the end of one phase of a phenomenal success story. Less than five years ago the company's research effort on the critical ICBM re-entry problem was begun with only a handful of scientists. Today it has grown to a staff of more than 2500 scientists, engineers, and supporting personnel.

The center will be devoted to basic and applied research and development. One of its most important functions will be continuing work on the ICBM program—primarily, atmospheric re-entry. Avco holds contracts for nose cone work on both the *Titan* and *Minuteman* long-range missiles. The division is also doing significant work in related fields of high-temperature gas dynamics, magnetohydrodynamics, metallurgy, materials research, and environmental test methods. Division scientists began research during the last year on the anti-ICBM problem.

The decision to put Avco into Space Age work was made by Victor Emanuel, chairman of the board, in 1955. Since that time the Research Division has become the company's "greatest instrument of growth." While its primary work is concerned with missile programs, it also provides a pool of talent and facilities for other Avco divisions. It aims for the kind of scientific breakthroughs upon which totally new products, and sometimes new industries, are built.

Corporate funds support research in many fields. Work is under way in propulsion, radar, guidance, gas dynamics, nuclear energy, navigation, communication, fire control, and electronic computers.

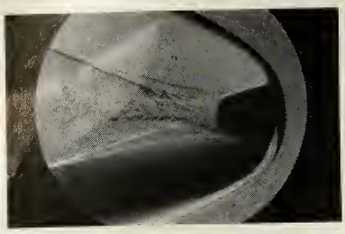
The president of RAD is James Kerr. He helped form the new group when the decision was made to bring the company into the space business. At that time he was head of Avco's Office of Defense Planning.

A vice-president of Avco and director of the Research Laboratory since its founding, Dr. Arthur Kantrowitz, has had the responsibility of gaining experimental data on Mach 25 flight—a prerequisite to solving the problem of atmospheric re-entry.

Project director of the *Titan* nose cone program is Dr. Jack A. Kyger. He was once the top scientist in the Navy group that rushed the nuclear-powered Nautilus to successful completion.

The following pages show some of the division's work on the re-entry nose cone—how it is made and tested and some of the vital components that go into the final system. Many of the just-released photographs show details never before published.



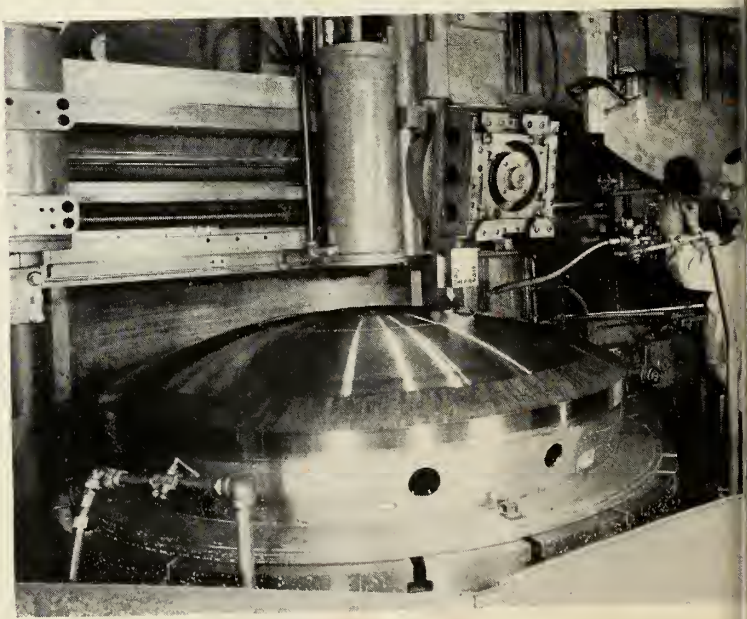


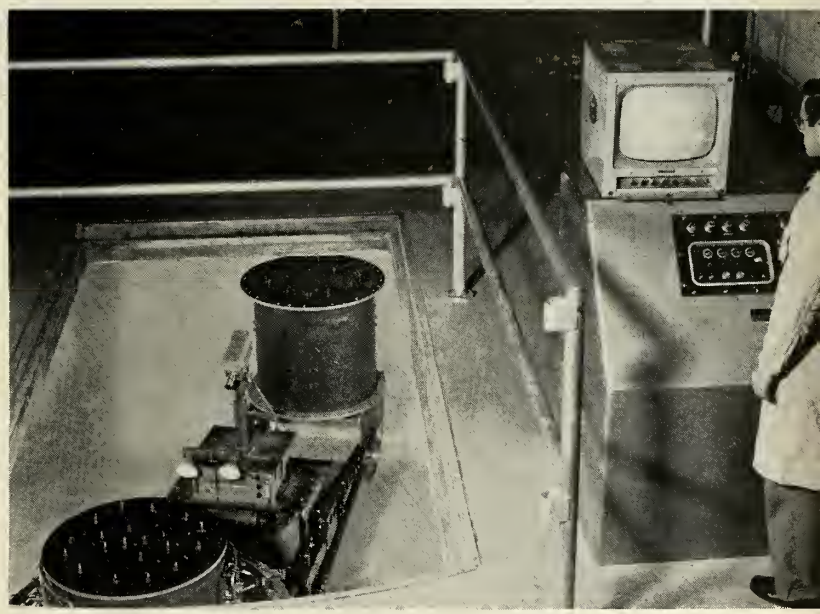
PRELIMINARY WORK on the *Titan* nose cone begins with schlieren studies of stock wave and wake turbulence of actual cone shape test model.



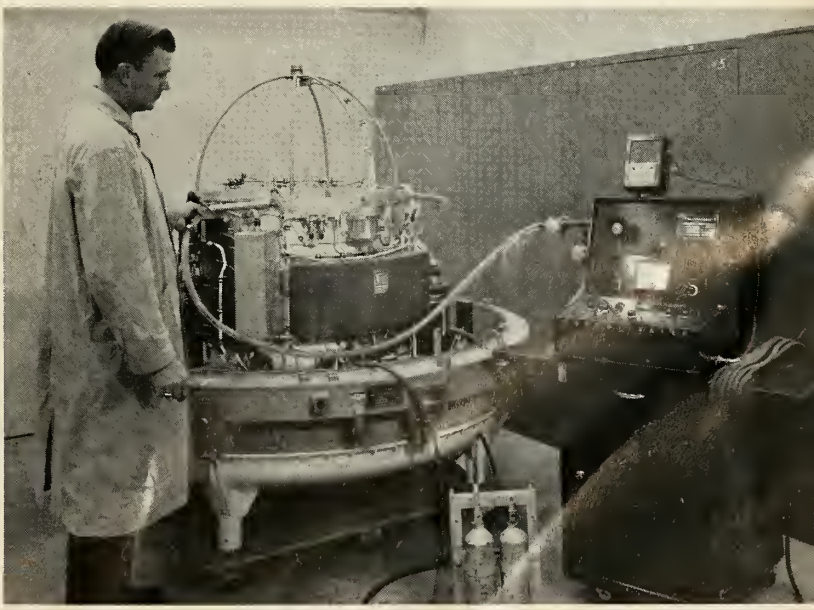
THE FACE of the heat-sink nose cone is milled to the extreme tolerances required for successful re-entry.

. . . and nickel-plated and finished to mirror smoothness to minimize atmospheric friction.

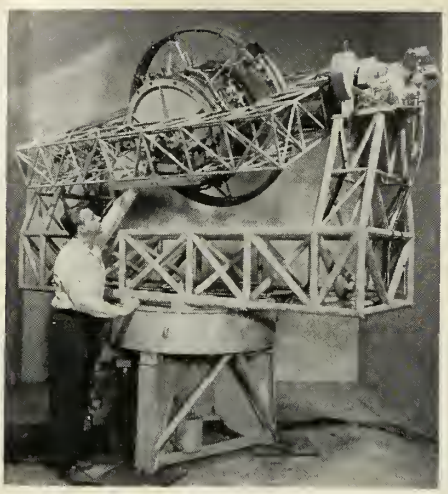




COMPONENTS ARE SUBJECTED to 100g acceleration tests and watched by closed-circuit television for signs of failure.

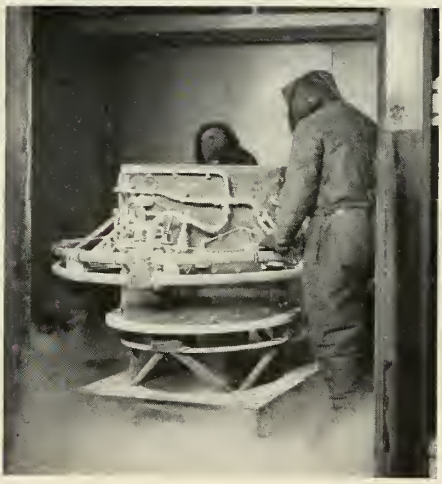


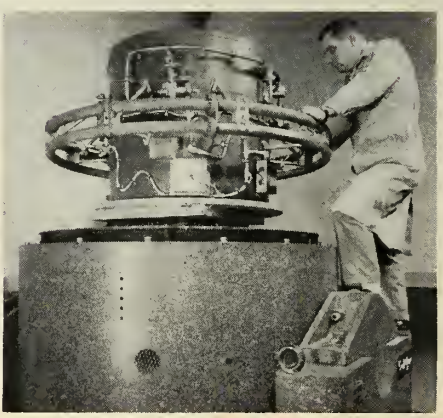
THE INTERNAL SYSTEMS receive final pressure check before final assembly.



THE AVCO DARAC—which aligns the nose cone to the proper attitude to re-enter the atmosphere—is tested on the three-axis flight simulator

. . . and on the shake table which simulates rocket-engine vibration





. . . and subjected to the extreme cold of outer space.

The men who guide Avco research . . .



James R. KERR
Vice-president, Avco Corp.
President, Lycoming Div.
President, Res. & Adv. Dev. Div.



Dr. Arthur R. KANTROWITZ
Vice-president, Avco Corp.
Dir., Avco Res. Lab.



Dr. Jack A. KYGER
Vice-president & Tech. Dir., RAI
Proj. Dir., *Titan* nose cone



AT THE END OF THE LINE the completed vehicle receives a final vibration check before shipment to a *Titan* test site to make its contribution to space technology . . .

Communications Satellites:

A Largely Neglected Force for Peace

Long-proposed space relay system, now technically and economically feasible, still gets little non-military attention

by Hal Gettings

WASHINGTON—Satellite communication relay stations—the first practical application of space research to non-military pursuits—could be close to reality. Several significant problems still stand in the way—notably, satellite life and reliability. But according to D. M. Culler of ITT Laboratories, the system could be implemented in the very near future.

Actually, such a system was proposed 14 years ago by English scientist A. C. Clarke, who has stated that "the TV satellite is mightier than the ICBM. It may well determine whether Russian or English is the main language of the future." Dr. Louis G. Dunn, president of Space Technology Laboratories, has predicted that communications satellites "will have more direct effect on the man in the street than any other development in space technology."

The first step in such a project has been made with the *Atlas* SCORE, which successfully received and retransmitted voice messages back to earth. But what is being done to further the program?

Nothing, actually, so far as a non-military system is concerned. Althou the first sentence of the Space A declares ". . . it is the policy of t United States that activities in spa should be devoted to peaceful pu poses for the benefit of all mankin only a military system is being work on at present.

The military program (which d not include TV is going forward joint effort of ARPA and NASA. low-altitude *Courier* is scheduled 1960 and a higher-altitude satellite 1962. These are delayed-repeater s tems, however, and will handle only channels of teletypewriter code inf mation. Within 5-6 years they hope have a 24-hour system in orbit. T system will have an increased co munication capacity of up to 144 vo channels.

No budget figures are available approximately $50-60 million per y is being scheduled for "communi tions." Although the problems are qu different and the military system complex than the "commercial" v sion, knowledge gained by the milit should contribute to success of a pea ful project.

• **System concept**—The system p posed by Culler consists of three re stations mounted in satellites each a 24-hour orbit so as to remain fi over a specific spot on earth. Prop maintained in these locations, the tions would allow line-of-sight c munications with 98% of the ear surface. Culler says the cost of suc system would be competitive with j sent transoceanic cable systems, wh incidentally, are not adequate to har the wide bandwidth required by t vision.

The satellites, with active repeat would orbit in the equatorial plan

TABLE I: MAJOR SYSTEM DESIGN PROBLEMS

PARAMETER	LIMITATIONS	SYSTEM REQUIREMENTS
1. LIFE	Component State-of-the-Art Control Propellant Supply	1-2 Years Minimum
2. RELIABILITY	No Satellite Maintenance	No Satellite Failure Redundancy
3. COMMUNICATION SUBSYSTEM		
a. Coverage	Line-of-Sight 3 Satellites—98%	Depend Upon Application
b. Frequency	Ionosphere Effects Atmosphere Effects	1000—10,000 mc
c. Capacity	Weight Bandwidth Power Modulation	Voice, Teletype, TV
d. Satellite Transmitter Power	Weight Electrical Power Supply	Directional Antenna High Power Efficiency
e. Ground Receiver Sensitivity	Noise S/N Ratio Modulation Technique	High Antenna Gain Parametric Amplifiers
4. VEHICLE SUBSYSTEM		
a. Payload	Rocketry State-of-Art	V = 10,070 ft/sec h = 22,300 mi
b. Ascent Guidance and Control	Multiple Orbits Planar Transfer Guidance Blackout	$\Delta V = \pm 5$ ft/sec $\Delta a = \pm 0.1°$
c. Orbit Guidance and Control	Moon-Sun Gravitation Light Pressure Dumbbell Effect Internal Moments Antenna Beamwidth	$\pm 0.1°$ Latitude and Longitude $\pm 4°$ Attitude Control
5. ELECTRICAL POWER SUBSYSTEM	Weight Surface Area Solar Collector State-of-Art	Maximum Energy Conversion Efficiency

n altitude of 22,300 miles, as shown
the illustration. By stationing one
f the three satellites every 120 de-
ees about the orbit, it is possible to
rovide almost complete global cover-
ge with line-of-sight communications
rough the addition of the three indi-
ated ground relay stations in the line-
f-sight overlap areas. All but 2% of
e earth's surface is covered by such
system. Only limited areas about the
rth and south poles are below the
nes-of-sight horizon with respect to
e satellites in the equatorial plane.

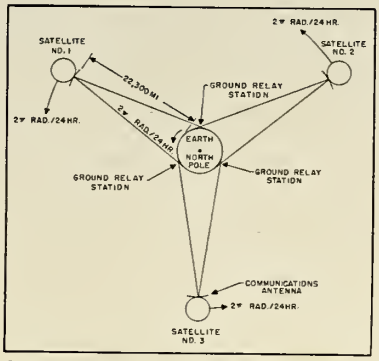
The angle subtended by the two
ngents to the earth's circumference
om the satellite is approximately 17
egrees; thus, the coverage indicated
ill require a satellite antenna beam-
idth of at least 17 degrees.

With only two satellites, one over
e Atlantic and the other over the
acific, most of the free world can be
overed by microwave broad band
ommunication capable of handling
any channels of telephone, teletype,
nd television transmission. With three
tellites located as indicated, and the
ree ground stations at, for example,
thens, Tokyo, and Houston, complete
orld-wide coverage is obtained except
r minor polar regions. With appro-
iate ground networks it would be
ssible to establish a world-wide dial
lephone system as one application of
e satellite repeaters.

• **Problems**—Two of the biggest
oblem areas are life and reliability.
order for this communications sys-
m to be economically feasible the
tellite must operate continuously for
minimum of one to two years, plac-
g a tremendous burden upon com-
nent life. Actually, the functional life
the satellite is primarily dependent
on two factors: 1) life capability
alizable within the component state
the art, primarily electronic com-
nents; and 2) the supply of control
opellants that can be carried to main-
in the satellite on station and in
oper attitude.

In reliability, the major limitation
that there is no opportunity for main-
nance of equipment—it must exhibit
overall failure during its life. This
viously places a strong requirement
component reliability and the need
r redundancy.

Three development problems re-
ire particular consideration. But none



ORBIT location of 24-hour satellites.

of these necessitates any major breakthrough; they need only extension and refinement of existing equipment and techniques.

1) Reliable satellite-borne equipment with sufficient power supply to operate high-power transmitting and receiving equipment.

2) Guidance and control systems to place and maintain the satellite in proper orbit and attitude.

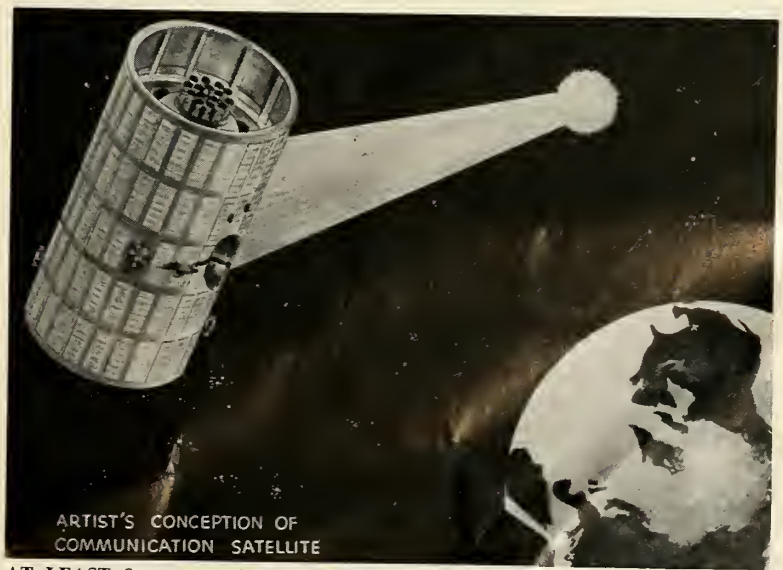
3) Increased satellite payload capacity.

• **Communication subsystem**—In the design of the communications subsystems two parameters are most influential: ground receiver sensitivity and satellite transmitter power output. Current rocketry imposes a low limit on the payload that can be put into a 24-hour orbit. Therefore, it is desirable to maximize the capability of reception on the ground in order to minimize the satellite transmitter power output.

With parametric amplifiers, receiver noise figures of 0.5 to 1.5 db are possible. Also, recent improvements in modulation techniques allow efficient utilization of these noise figures at high channel signal-to-noise ratios to make possible both high sensitivity and signal quality in the ground receiver within the present state of the art.

The satellite transmitter power output requirement is a function of the path loss and the ground station sensitivity. Since the satellite transmitter power is limited by payload weight and electrical power supply, the maximum communications capacity of the system is a function of the minimum power level detectable by the ground station (maximum sensitivity) and the maximum power output of the satellite transmitter.

The other link of the communication path from the ground to the satellite is not a limiting factor, since the ground transmitter power has consider-



AT LEAST five communication satellites—two within polar orbits—are needed for world-wide communications.

able latitude under present capability.

• **Satellite position and attitude**—Once the satellite is in its appropriate orbit, it must be maintained on station and in proper attitude. Here a limitation is the satellite antenna, which must be directional and of minimum beamwidth to cover the necessary area. The vehicle must be referenced to the earth's vertical as closely as possible.

The vehicle is constantly subject to such perturbating forces and torques as the moon-sun gravitational field, light pressure, dumb-bell effect, and internal moments. Considering the moon-sun gravitation, light pressure, and residual drift rate, the position of a satellite can be controlled within approximately one-tenth degree latitude and longitude. Considering best estimates of torques due to light pressure, residual magnetism, induced currents, and the dumb-bell effect, attitude can be held to within ±4 degrees of nominal about all three axes.

At present, very little data is available to accurately define the forces and torques that will cause these perturbations. It therefore cannot be overemphasized that the guidance and control during both ascent and orbit phases is a very significant problem.

• **Power system**—The electrical power system is limited in capability by the weight and surface area available in the satellite payload and the efficiency of the solar collectors. In the immediate future the primary source of energy for the satellite will be solar energy with batteries used for energy when the satellite is in the earth's shadow. In the long term, nuclear and other energy sources will be used in space vehicles for electrical power.

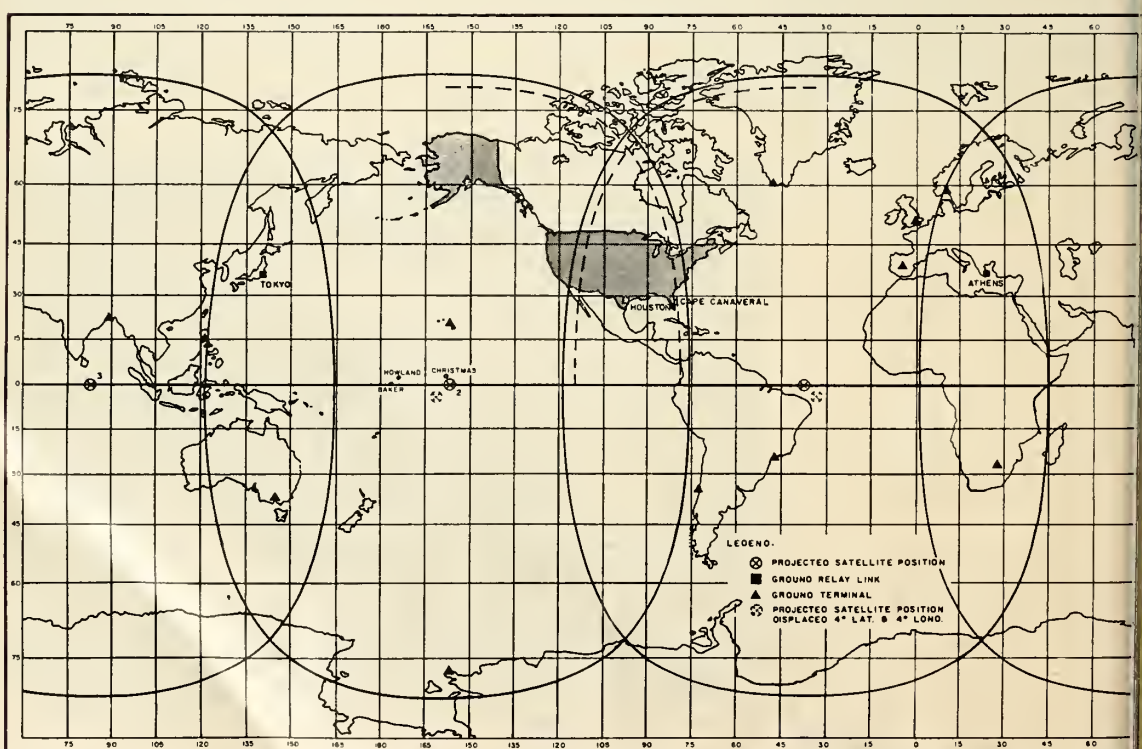
The recent development of the "plasma thermocouple," for example, offers significant promise for a space power source. Furthermore considerable improvement of the solar collectors can be expected in the future.

• **Economic considerations**—From an economic point of view, it is interesting to note that the communication satellite system is rapidly becoming quite competitive with the cost of transoceanic cable systems. For example, current transatlantic cable costs are approximately $200 per voice channel mile. A 96-voice channel satellite repeater system feasible within the immediate future for Atlantic Ocean coverage only would cost approximately $300 per voice channel mile even compensating for a 2-year life for the satellite as compared to a 20-year life for the cable.

Furthermore, present cable systems are incapable of handling conventional television transmission due to the 4.5 mc bandwidth requirement.

Estimates indicate that a complete global 24-hour active satellite communication system would cost, under present state of the art, approximately $100-300 million. Thus, the system ap pears economically feasible for the in mediate future. On the longer term, is quite probable that it will be th most economical means of long-rang broadband transmission. Anticipate improvement in payload and reliabili of rocket systems leads to a very opt mistic viewpoint on future system cost For example, while only two years ag it cost approximately $1-million fo every pound of payload in low-altitud orbit, it is expected that by 1960 th will have been reduced to $1000 an by 1964 to $100 per pound. Althoug these figures refer to low-altitude orb conditions, they do reflect the rate improvement in rocketry costs to b expected in the future.

• **Conclusions**—Cruller's argumen provide strong support for the 24-hou satellite as a major breakthrough long-range broad bandwidth commun cation capability as a time when com munication channels are rapidly reac ing capacity. Through increased worl wide communication—particularly tel vision—made possible by such a syste the interests and social customs of th various countries of the world will closer bound together and the univers brotherhood of man brought near Thus it is very possible that the com munication satellite will be the fr world's best instrument for peace. T day's technology can bring it about the very near future.



IR Analyzers Monitor Giant Wind Tunnel

TULLAHOMA, TENN.—To monitor and control explosive gases and fumes in the U.S. Air Force's giant transonic and propulsion wind tunnel at Arnold Engineering Development Center here, a system of 16 infrared analyzers is used.

Built by the Perkin-Elmer Corp., the analyzers are located at critical points around the tunnel with a sample-collecting line running from each unit into these areas. Recorders and indicating dials for each unit are centrally located on one panel in a test control building.

In operation, the analyzers continuously monitor conditions in their area. When an explosive concentration reaches 25% of the lower explosive limit, an alarm is set off. If the concentration reaches 50% of the lower explosive limit, the instrument automatically initiates shut-down of fuel and reduction of power input to the tunnel compressor. It also activates equipment that fills the tunnel with nitrogen.

Unlike the more common open-end wind tunnels, the AEDC tunnel is a completely closed system. Fuel can collect in several ways during testing of jet and rocket engines, and this build-up, if it went unchecked, could become a serious danger to personnel and to the expensive structure itself.

• **Critical areas**—Fuel is pumped into engines under test at rates up to 25 gallons per minute. At this rate, even a small leak can result in a sizeable build-up of fumes. There is usually a small amount of fuel spillage from engines, and, since they are tested up to stall, some fuel is not burned.

To handle the great quantity of fuel needed in tests, a special test-fuel building serves as a storage area. Here a certain fraction of leakage is to be expected. Fumes also collect in the below-ground foundation of the main test area.

A serious leak or fume collection in any one of several of these areas could lead to a damaging explosion. The infrared analyzers guard against such a situation.

• **Operation**—The analyzer instruments are sensitized to analyze a number of different fuel elements: JP fuels 1, 2, 3 and 4; kerosene; alcohol; methane; aviation gasolines and rocket fuels. The analyzers can detect the lower explosive limit for the most explosive member with an accuracy of ±5%. The instruments indicate the tunnel contents with a response time of six seconds.

The instruments are designed to operate with a high degree of accuracy and with as fast a response time as possible under the unusual conditions found in the wind tunnel. The instruments analyze vapors which can exist under widely different environmental conditions: temperatures ranging from −10° to 230°F, velocities varying from 0 to 200 feet per second, and altitude pressures ranging from sea level to more than 100,000 feet.

To achieve reliable operation under such conditions required unique design, especially in the sample handling, according to Perkin-Elmer. The fast response time called for an unusually large sampling capacity. Despite the wide range of pressures, the pressure in the instrument's sample cell is held constant within 5%.

• **The development center**—The Arnold Engineering Development Center was established for the development and evaluation of aircraft, propulsion systems and guided missiles.

The wind tunnels and test cells of AEDC, by simulating the conditions of actual flight, provide a precise, safe and economical means for determining effects of speed, temperature, pressure and altitude on engines, aircraft and missiles. The facilities of the AEDC can test the largest engines under development or on the drawing boards, as well as scale model and full-size aircraft and missiles.

Ionosphere Reported Bigger Than Supposed

COLUMBUS, O.—According to T. Gordon Hame, scientist at the Antenna Laboratory of Ohio State University, the ionosphere extends thousands of miles further out into space than was previously supposed. Previously it was thought that the ionosphere, which begins about 50 miles above sea-level, extended upward to about 300 miles.

Hame said the electrons in the ionosphere reach their greatest density at a point about 300 miles above the earth, and from there outward the electron density tapers off gradually.

He said that at an altitude of some 200 miles, the density is about 10^{12} electrons per cubic meter. At 1000 miles out in space, the density has dropped only to 2×10^{11} electrons per cubic meter.

He said this probably means that kinetic temperatures in the exosphere (which is considered to encircle the earth above an altitude of some 625 miles) are much higher than previously was thought. It also means that the ionosphere extends outward into what has been called the exosphere.

These conclusions were based in part on data obtained by Hame while working on a research project sponsored by the Wave Propagation Branch of the Wright Air Development Center's Aerial Reconnaissance Laboratory at Wright-Patterson Air Force Base, Dayton, Ohio.

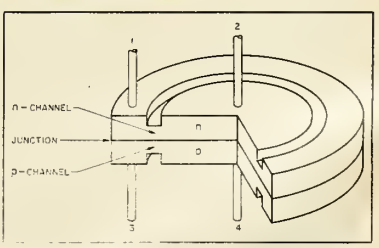
The Ohio State engineer said that beyond an altitude of 200 miles, real kinetic temperatures would increase five times within 700 miles on an outward space journey.

Hame, who is assisted by three graduate students, has described some of his findings in a report to be published in the Institute of Radio Engineers Proceedings. The research team has been listening to *Sputnik III* since last July on a radio frequency of 20.005 mc. (This Russian satellite was chosen because its orbit is farthest from the equator.) Since January, he also has been listening to the Soviet satellite's second harmonic on 40.01 mc. This, he said, cut down the margin of error in measuring the electron density to about 2%.

Hame said when the satellite's radio signals pass through the ionosphere, the effect of the earth's magnetic field and the electrons polarize the signal. By measuring the time difference between the polarized peaks on recording graphs, he and his associates are able to work out mathematically the electron density in space.

The researchers tune in on the satellite's beeps some five hours each day, and collect more than 25 feet of recorded data daily.

—Bell Tetrode—



A FOUR-TERMINAL semiconductor device—a field-effect tetrode—has been invented by Bell scientists. The device is unlike tubes or previous transistors and will act as either a transformer or a gyrator—functions normally available only with extensive circuitry. The cutaway shows construction of the unit, an etched disk of semiconductor with a diffused junction.

Fluorine Engines May Arrive Within Five Years

Dramatic increase in rocket capability will come when compatible materials are developed. Fuel supply considered more than adequate

by Paul Means

WASHINGTON—Time and money are the only two factors needed to produce a rocket engine using elemental liquid fluorine as its oxidizer—the ultimate chemical propulsion system for space vehicles.

Chemists need time to find materials, compatible with fluorine under operational conditions, to be used for such a rocket's gaskets, joints, seals and lines.

And many of the nation's chemists and rocket makers think that more of the second factor—money—would cut down on the time it takes to find the compatible materials.

The technology needed to produce a fluorine engine is here. This was demonstrated as long ago as 1949 when the NACA Lewis Research Center at Cleveland operated a small engine with it. It was dramatically demonstrated recently when the Bell Aircraft Corp. field-tested a large fluorine engine.

Fluorine engine research is presently being carried on at Bell, Lewis, JPL, and the Rocketdyne Division of the North American Aviation Corp. Lewis has a new $2.5-million facility designed to handle fluorine rocket engines up to 26,000 pounds thrust, and received more money in the Fiscal '60 budget to carry on fluorine engine development.

Bell recently received a $1,070,000 contract from NASA to carry on its fluorine engine development program originally funded by the Air Force in 1956. NASA has asked Bell to determine "feasibility of a high-energy fluorine-liquid hydrogen rocket engine."

If the problems of handling fluorine and finding materials compatible with it are solved, a high-energy upper-stage fluorine engine could be produced within very few years.

• **Pioneer**—And the company most likely to solve many of these problems is not in the rocket engine business at all. The General Chemical Division of the Allied Chemical Corp. is a pioneer in production and handling of fluorine, the major producer of fluorine, and the only producer selling elemental fluorine to the missile and rocket industry.

It was not practical to produce great quantities of elemental fluorine, or to consider it as a likely oxidizer for a rocket engine, until General Chemical found a way to economically transport large quantities in 1957. (M/R, Sept., 1957.)

Prior to that time, ICC regulations restricted shipment of the gas to six pounds of fluorine in a 200-pound cylinder under 400 pounds of pressure.

Now, General Chemical's tanks can transport 5000 lbs. of elemental liquid fluorine at a time.

In order to eliminate the problem of fluorine burn, the seamless tanks are first cleaned to remove all impurities, and then filled with gaseous fluorine. The oxidation of the fluorine with the metal forms a coating of iron fluoride. Then the liquid fluorine i very slowly bled into the tank until i displaces the gaseous fluorine.

With the shipping tank and carefu handling, General Chemical has ha good success in transporting larg amounts of fluorine from its Metropolis Ill., and Baton Rouge, La., plants wit a negligible number of accidents.

• **The big problem**—The grea problem in handling fluorine, in pro duction, transportation, or rocket de velopment, is that it is the most powe ful oxidizing agent known, reactin with practically all organic and in organic substances. The few exceptior are the inert gases, metal fluorides, an a few pure completely fluorinate organic compounds.

And the problem becomes formi able when the rocket experiments a taken out of the static conditions of th laboratory into the field.

Bell's engine uses no gaskets ar as few joints as possible. Joints cann be welded with such smooth consis



FEASIBILITY of transport of large quantities of highly-toxic liquid fluorine has be demonstrated by Allied Chemical.

ency that nodules do not form, leaving imperfections that cannot be protected so easily by a fluoride.

Gasketing in fluorine rocket engines with present materials is risky. General Chemical, when it must use gaskets in production and transportation of fluorine, uses pure soft aluminum, which has the necessary give.

Fluorocarbons, though satisfactory with gaseous fluorine, break down when used with liquid fluorine under operation friction or pressure. The eventual gasket materials for fluorine engines, however, will probably be improved fluorocarbons and/or silicons.

Another problem which must be overcome is the finding of lubricants compatible with fluorine.

General Chemical says it has had success in handling fluorine at room temperature with nickel, monel, steel, stainless steel, brass, copper, aluminum and magnesium. At elevated temperatures, the use of nickel and its alloys and stainless steel is preferable. For all-around applications at low and high temperatures, General Chemical likes monel.

General Chemical has also used tetrafluoroethylene polymer for valve packing.

• **Potentials**—When chemists solve the last major problem impeding the progress of fluorine engines—that of finding compatible materials—rocket manufacturers can look forward to developing engines that can lift payloads 70% heavier than any space vehicle now on the drawing board.

A fluorine-hydrogen engine will give a specific impulse of 463, and yield 5,800 B.T.U.'s per pound.

Such a rocket, according to John L. Sloop, Chief of the Rocket Engine Branch at Lewis, could lift into space a 20,000 lb. manned satellite with half the booster weight and half the thrust of current propellants. On a trip to the moon and return, according to Sloop, the fluorine-hydrogen rocket could increase the ratio of payload weight to take-off weight eightfold over what can be done with today's propellants.

• **Ample fuel sources**—Because of the facilities of General Chemical and other manufacturers producing fluorine, and General Chemical's ability to transport the oxidizer, the advent of fluorine engines in large-scale production will find the fuel waiting for them.

General Chemical began producing large quantities of elemental fluorine for conversion into uranium hexafluoride, which the AEC buys for nuclear work. The U.S., Canada and Mexico have ample reserves of fluorspar which could more than take care of any expanding need for fluorine.

• **Cost justified**—In comparison with present fuels, the cost of fluorine is high. Present prices start as $3.75 a pound and range down to $2.65 a pound f.o.b. in lots of 100 tons per year. General Chemical believes that use of liquid fluorine in operational missiles in the future would bring the price down to $1.00 a pound in large quantities. Liquid oxygen, by comparison, costs only 10 cents a pound.

But the reduction of cost effected by the increased thrust and lower weight of a fluorine rocket would more than make up for the more expensive oxidizer, making the entire rocket less expensive to build.

• **Fluorine bases**—As the fluorine engine approaches operational status, missile and rocket men will have to solve the final problem: How do you fire a fluorine rocket safely?

Missile experts say a fluorine engine cannot be fired from any of the present missile bases or any now on the drawing board.

In case of a misfire or a topple in which fluorine spills out of the rocket, the resulting reactions could endanger not only the crew but surrounding installations.

It is felt that the safety precautions and materials developed in the construction of a fluorine engine would solve many of the problems connected with firing the rocket. Launching pads would probably have to be widely dispersed and automatic controls refined in order to handle the powerful oxidizer.

Judging by the rapid improvement in the techniques of handling present-day liquid engines, the problem of handling a fluorine engine does not seem to be insurmountable. *Thors, Redstones* and *Jupiters* are now handled operationally by troops in the field only a few years after the first experimental firings of large-thrust liquid rockets.

Such high-energy engines would probably be used for scientific exploration of space rather than for military missiles, reducing the need for mass firing techniques.

• **How soon?**—How far away is a fluorine rocket? The best guess is five years. But more research on materials compatible with fluorine could cut the time considerably.

And development of such a rocket would provide the nation with a rocket powerful enough to meet all needs until nuclear and even more exotic forms of propulsion are developed.

Austenite Lowers Steel Fatigue Strength

WASHINGTON—Austenite in amounts up to 10% lowers the fatigue strength of high tensile steel, research by the National Bureau of Standards has demonstrated.

Experiments also showed that retained austenite in the matrix is transformed by fatigue stressing into untempered martensite. NBS said this "probably accounts for the deleterious effect," which may find use in the processing of steel for missile casings.

Four different low-alloy steels, SAE 4340, Tool Steel No. 1, Tool Steel No. 2 and SAE 52100, with carbon content ranging from 0.44% to 1.06%, were investigated.

For each steel, the NBS said, adjusted fatigue strengths decreased as the amount of retained austenite increased. However, for the three higher-carbon steels there appeared to be a "limiting value of approximately 10% beyond which no further decrease in strength occurred."

Specimens refrigerated before tempering had greater fatigue strengths, indicating that refrigeration tends to cut the amount of retained austenite.



FIRST LARGE-SCALE test of rocket using liquid fluorine has been accomplished by Bell Aircraft Corp.


PUCKETT

Two scientists from the senior staff of Hughes Aircraft Co.'s research and development laboratories in Culver City, Calif., have been named to sit on National Aeronautics and Space Administration advisory committees. **Dr. Allen E. Puckett,** Hughes vice president and director of the company's systems development laboratories, has been appointed to NASA's committee on control, guidance and navigation. Dr. Puckett, an authority on aerodynamics and guided missiles, was chief of the wind tunnel section of the Jet Propulsion Laboratories at CalTech. **Dr. Leo Stoolman,** manager of Hughes' aerodynamics department, will join the NASA committee on structural loads. He is a former senior staff engineer of the Jet Propulsion Lab and author of technical papers on aerodynamics.

Two top executives and a director were elected at a board of directors meeting of Kearfott Company, Inc., subsidiary of General Precision Equipment Corp. **Donald W. Smith** is the new chairman of the board. **Fred D. Herbert, Jr.,** is president and **Robert N. Brown** was elected director. Smith, who has been Kearfott's president since 1955, was recently elected president of General Precision Equipment. Herbert, son of the late founder and first president of Kearfott, has been associated with the company since 1932, when he helped develop the first successful automatic radio direction finder. He is also a vice president and director of General Precision Equipment. Brown, who joined Kearfott in 1946, is vice president and assistant general manager, and manager of the company's newly-established Avionics Operations group.


BARTLEY

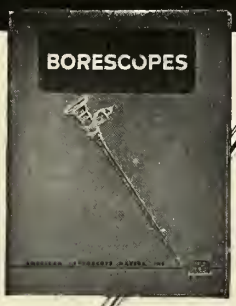
The Gabriel Co. has announced plans for immediate construction of a solid fuel manufacturing plant at Mesa, Ariz., and appointment of **Charles E. Bartley,** former founder and president of Grand Central Rocket Co., to head Rocket Power, Inc., a wholly-owned subsidiary organized to operate the new plant. In 1954 Bartley founded Grand Rocket Co., which was sold to Tennessee Gas Transmission Co. in 1958 in a reported $6,000,000 transaction. Earlier, he was chief engineer of the solid rocket division of CalTech's Jet Propulsion Laboratory.


USTIN

George Ustin fills the newly-created post of vice president in charge of engineering at Buchanan Electrical Products Corp., subsidiary of the Elastic Stop Nut Corp. of America. New products currently in the planning or development stage have brought the company into the space and aviation fields. Ustin was formerly with Continental Copper and Steel Industries and holds a number of patents on electrical components and devices.

The Daven Co. announces appointment of **Emil Kohler** as project engineer in charge of development on transistorized power supplies and equipment. Kohler formerly worked for the Bogue Electric Manufacturing Co., where he was responsible for electro-mechanical, ultrasonic, and semiconductor development. He also was installation and service supervisor for the RCA Service Co. and supervisor of the prototype section of the ESC Corporation.

INSPECTION PROBLEMS?
This booklet is for you!



This comprehensive, elaborately illustrated booklet provides practical information on the use of the famous A. C. M. I. Borescope in various industries, for the inspection of interior areas or surfaces not otherwise visible—together with full data on the types of Borescope available, and on their care and maintenance. Have you received your copy?

Free on request *Fill in and mail today*

To *American Cystoscope Makers, Inc.*
8 PELHAM PARKWAY PELHAM MANOR, NEW YORK

Gentlemen: Please send me without obligation a copy of your booklet on Borescopes.

Name_____
Firm_____
Address_____
City_____ State_____



TOPFLIGHT RESULTS

. . . when you place your classified advertising in MISSILES AND ROCKETS Magazine. Every week you can reach about 30,000 top men in the booming missile and rocket industry. If you want to buy . . . sell . . . seek employment . . . send your classified message today to

MISSILES & ROCKETS
1001 Vermont Avenue, N. W.,
Washington 5, D. C.

contract awards

WASHINGTON—The Convair Division of General Dynamics Corp. has been given the $33.5 million NASA prime contract for *Vega*, a two or three stage rocket with *Atlas* as its booster due for test flights by mid-1960.

The 295,000 pound *Vega*, capable of putting 5000 pounds into an earth orbit, will consist of an *Atlas* first stage, a modified *Vanguard* booster as the second stage, and a 6000-pound-thrust encapsulated nitrogen tetroxide and hydrazine engine as its third stage. The General Electric Company has the second stage contract, and JPL is responsible for the third stage, technical supervision, and payload planning.

Convair will have the responsibility for design, construction, tests and launching of the vehicle. The contract does not include the cost of the *Atlas* boosters.

NASA

$1,992,848—Doyle and Russell, Norfolk, Va. for two launching pads.

MISCELLANEOUS

$4,340,000—Sylvania Electric Products, Inc., New York for production on new communications system; fourth "significant" recent multi-million-dollar award—details not available because of security classifications.

$1,500,000—Aeronutronic Systems, Inc., Allied Research Associates, University of Chicago, Convair Div. General Dynamics Corp., General Electric Co., General Mills, Inc., Hughes Aircraft Co., Industrial Research Associates, Ramo Wooldridge Corp., RCA, Republic Aviation Corp., Technical Operations, Inc., for research and study of *Project Defender*.

NAVY

$761,751—Aerojet General Corp. for *Jato* rocket motors and 17 spare igniters.

$239,785—AL-CO Co., Inc. for construction of communication transmission feeders at Naval Missile Facility, Point Arguello.

$3,718—Walker Electrical Co., Inc., Atlanta for switchboards.

$50,400—Standard Electric Contracting, Inc., for construction of a KDA facility at Naval Auxiliary Air Station, Brown Field, Chula Vista.

$29,250—National Lead Co., Research Laboratories, Brooklyn, N.Y. for dihydroxy benzoate.

ARMY

Leronca Manufacturing Corp., Middletown, Ohio, for production of the *Pogo-Hi II* E3C target missile system for the White Sands Missile Range, N.M. Amount not disclosed.

$10,668,034—Morrison-Knudsen Co., Inc., F. E. Young Co., Johnson, Drake & Piper, Inc., Olson Construction Co. for construction of WS-107A-2 technical facilities, Lowry Air Force Base, Denver.

$20,384,003—Western Electric Co., New York for *Nike-Hercules* repair parts. (two contracts).

$13,266,720—California Institute of Technology, Pasadena, for research and development. (four contracts).

$11,900,165—Thiokol Chemical Corp. for production of rocket motors and plant maintenance at Longhorn Ordnance Works, Marshall, Texas.

$8,000,000—Westinghouse Electric Corp. for advanced shipboard radar systems.

$7,623,416—Chrysler Corp., Detroit, for repair parts and tools for the *Redstone* missile program.

$2,153,375—Sylvania Electronics Corp., Needham, Mass., for electronic equipment.

$1,851,000—Davidson Construction Co., Inc., Manchester, N.H. for construction of tracking and data acquisition station at New Boston.

$1,190,767—Douglas Aircraft Co., Inc. for missile launching items.

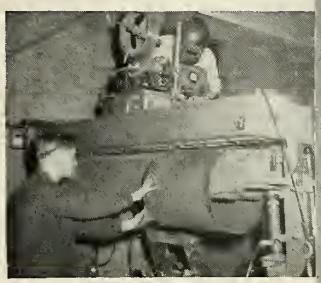
$889,000—Charles Ramsey & Co. for *Nike-Zeus* LAR receiving building, White Sands, N.M.

$581,654—Northrop Corp. for target missile research and development.

MISSILE HARDWARE by NEWBROOK

Specializing in

- MOTOR CASES
  Solid and Liquid Propellants
- JATO CASES
- NOZZLES
- PLENUM CHAMBERS
- BLAST TUBES
- FUEL INJECTORS



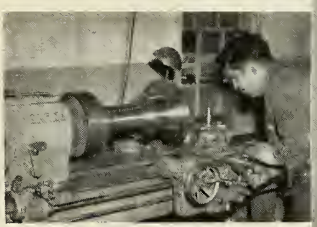
Finest Welding Facilities
Certified Welders

We have the "KNOW-HOW"

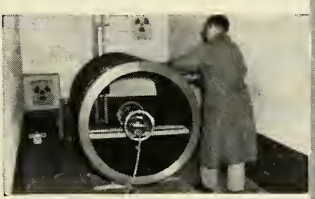
We have developed new techniques, new methods, new processes that effect production economy so necessary to a successful missile program.

Here at Newbrook you will find men with experience gained from doing... a modern plant with up-to-date equipment... precision inspection to meet your most exacting quality control requirements.

And most important, Newbrook specialization results in strict reliability! Let us help you with your Missile Hardware problems.

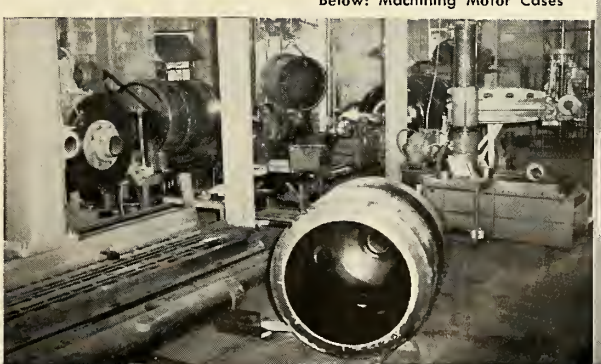


Machining Nozzles



X-Ray Inspection

Below: Machining Motor Cases





Newbrook
MACHINE CORPORATION

45 MECHANIC ST. PHONE 45 SILVER CREEK, N. Y.

R/M PYROTEX® REINFORCED PLASTICS ... DEVELOPED TO ENDURE THE FIERY REALM OF THE ROCKET

Light, strong, heat resistant . . . for low-cost, precision fabricated rocket parts— both structural and aerodynamic



Good insulating properties make R/M Pyrotex an excellent material for rocket throats, aft insulators, and groin seat rings. Pyrotex can be molded or laminated into a wide variety of shapes.

Looking for a material that will withstand the elevated temperatures generated by missiles and rockets—internally from burning propellants, externally from aerodynamic heating? Must this material have good insulation and thermal properties, chemical and water resistance, and take a smooth finish? If so, one of R/M's family of Pyrotex reinforced plastics may be the solution to your problem.

The many outstanding thermal and structural features of R/M Pyrotex have led to its use on almost every U.S. missile. It has been fabricated into parts such as nose cones, fins, igniter tubes, rocket throats and sliver traps. Its exceptionally good dimensional stability makes possible mass production to precision standards. And it is low in cost. Write for additional information.

R/M

RAYBESTOS-MANHATTAN, INC.

REINFORCED PLASTICS DEPARTMENT, Manheim, Pa.

FACTORIES: Manheim, Pa.; Bridgeport, Conn.; Paramount, Calif.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Asbestos Textiles • Laundry Pads and Covers • Engineered Plastics • Mechanical Packings • Sintered Metal Products • Industrial Rubber • Rubber Covered Equipment • Brake Linings Brake Blocks • Abrasive and Diamond Wheels • Clutch Facings • Industrial Adhesives • Bowling Balls

. . . contract awards

$514,845—**Western Electric Co., N.Y.** for *Nike* spare parts and components. (seven contracts)

$406,000—**Poorvu Construction Co., Inc.,** Wellesley Hills, Mass. for construction of Boston CONAD facilities, Fort Heath and Fort Banks.

$400,000—**Telemeter Magnetics, Inc.,** Los Angeles for development of high speed computer drums.

$310,204—**Rheem Manufacturing Co.,** Downey, Calif. for classified material.

$247,743—**J. I. Lark Construction Co.** for construction of drone target facilities at Tyndall Air Force Base, Fla.

$234,403—**Electronic Engineering Co.** of California, Santa Ana for ballistic camera synchronization system.

$200,415—**Rheem Manufacturing Co.,** Downey, Calif. for warhead fuzing system.

$206,578—**Western Electric Co., Inc.** for *Nike* spare parts and components. (four contracts)

$187,483—**North American Aviation, Inc.,** Autonetics Div. for computers.

$169,512—**Telecomputing Corp.,** Data Instrument Div. for research and development of a fixed camera reader.

$104,610—**Gilfillan Brothers, Inc.,** Los Angeles for *Corporal* missile repair parts.

$100,000—**California Institute of Technology,** Pasadena, for research and development work at the Jet Propulsion Laboratory, Pasadena.

$78,000—**North American Aviation** for design and development.

$70,000—**Maurice H. Connell & Associates, Inc.** for architect-engineer services with criteria for IRBM launch complex at Island "J."

$63,413—**Douglas Aircraft Co., Inc.** for *Blue Streak* and emergency spare parts. (three contracts)

$57,750—**North American Aviation, Inc.** Canoga Park. Classified.

$52,699—**Norris-Thermador Corporation,** Vernon, Calif. for rocket parts.

$46,651—**Hufford Corporation,** El Segundo for research and development.

$46,651—**Librascope, Inc.,** Glendale, Calif. for a tape cartridge memory system.

$45,957—**Telemetering Corp.** of America for telemetry system.

$45,000—**The Firestone Tire & Rubber Co.,** Los Angeles for modification of guided missiles.

$43,492—**A. P. Wyman, Inc.** for construction of water supply for missile facility, Bangor, Me.

$31,200—**Firestone Tire & Rubber Co.** for repair of guided missiles.

$30,000—**University of Utah,** Salt Lake City Utah for research and development.

AIR FORCE

$18,715,141—**Philco Corp.,** for extension modifications of AF AIRCOM technical control intersite and multiplex point to point facilities, including spares, special test equipment and data.

$17,000,000—**General Electric Co.** for production of high-power search radar.

$11,408,009—**I.T.T. Federal Division,** Clifton N.J. for transmitting sets, electric guidance signals.

$1,155,480—**Union Carbide Corp.,** Linde Co Div., N.Y. for liquid oxygen and semi trailers.

$923,200—**Lewyt Manufacturing Corp.,** Lon Island, N.Y. for coordinate data.

$598,360—**Cook Electric Co.,** Chicago for design, construction and test of a positiv ion accelerator.

$250,000—**National Co., Inc.,** Malden, Mass Frequency standard, missile borne wit synthesizer to be employed for missil application used in service test program

$130,000—**AVCO Manufacturing Corp.,** Cros ley Div., Cincinnati for radio receivin sets and modulators for missiles.

$112,686—**Melpar, Inc.,** Falls Church, Va. fo design, development and construction o a voice data processing system.

$100,960—**Eitel-McCullough Inc.,** San Carlo for tubes.

propulsion engineering

Propulsion by upper atmosphere chemicals is impractical for most purposes, and impossible for all but low-speed craft, a UCLA engineering professor contends. A. F. Charwat, who is also consultant to Aeronutronic Systems, says the performance of an engine operating on recombination of atomic oxygen in the so-called chemosphere (about 50 miles up) would be a function of the flight Mach number. Some people have suggested that when our knowledge of the chemosphere increases this condition may be changed, but Charwat says the speculations are not justified.

Chemospheric propulsion depends on the established kinetics of the oxygen recombination reaction. Looking at the reaction, as Charwat does in the American Rocket Society Journal, shows that an oxygen recombination engine would be operable over only a very limited range—in the "low supersonic flight Mach numbers; flight at near orbital speeds is proved not to be possible." Even in this limited range, Charwat says, the engine's performance will be marginal. He says nobody has completely disproved such an engine's usefulness or feasibility, but he doubts that a successful one can be built.

New catalysts will have to be found if an upper atmosphere engine is to be built even for marginal operation, Charwat says. The oxygen recombination reaction, although capable of releasing large amounts of energy, does not proceed satisfactorily under natural conditions. Although catalysts cannot shift the reaction equilibrium, they can accelerate reaction time. However, thermodynamically, even at a near-ideal reaction rate, there is no net thrust except in the low supersonic range. This means operation below Mach 4, with an optimum operating speed of about Mach 2.

Only very large and extremely light oxygen recombination ramjets can sustain flight at all, and then the payload is practically nothing, further Charwat calculations show. The practical problems of launching the engine and then boosting it to operational speed—besides the job of "unfolding" the engine at 50 miles—will be tough to solve. Charwat says popular statements that such an engine will be ready to fly in about two years "appear to be somewhat premature."

Linde's new super insulation (Propulsion Engineering, April 6) makes possible unvented liquid hydrogen storage tanks with a loss rate of only 9% per year, not 0.9% as mentioned. There apparently is some mix-up in the nomenclature for the insulations and super insulations. Linde reports the "super insulation" which will make lowloss liquid hydrogen storage possible is SI-4, not an offshoot resulting from the work done in developing that insulation. The April 1 article referred to the new insulation as a "powder," but the company will not confirm whether it is or is not a powder.

Hard-boiled eggs show why accelerated aging of propellants at elevated temperatures is not a true test of how a propellant responds to nonrefrigerated storage for long periods. Carl Boyars, head of the chemical physics division, Naval Propellant Plant, Indian Head, Md., says BuOrd uses accelerated cycling aging—even though there are many valid criticisms—because some short-term testing procedure has to be available to supplement long-term testing. Look at the egg, he says, and you'll see why the results of rapid aging by elevated temperatures are not necessarily valid. A chicken egg aged for just a few minutes at a little above 200°F becomes hard-boiled. However, that same egg, aged naturally at a more moderate temperature, might have produced a baby chick!

Accelerated aging, however, is a necessity in order to forecast—even with narrow limitations—the probable future behavior of a rocket. The test has its value: Certain phenomena have been spotted prior to increases in malfunction frequency. The accelerated aging program, Boyars says, also can bring to light, more rapidly than can be done by normal storage, unforeseen chemical changes.

A Message to Executives Seeking a New Plant Site

Check these 3 Important Plant Location Advantages in

PENNSYLVANIA

100% financing for your new plant

Complete financing on lease-purchase plan—low interest rate—deferred amortization. Plant "shells" now being readied for completion. Inspection welcomed.

Improved "tax climate"

No capital stock and franchise taxes—no machinery and equipment taxes—no stock transfer tax—no state personal income tax—reduced manufacturer's sales tax.

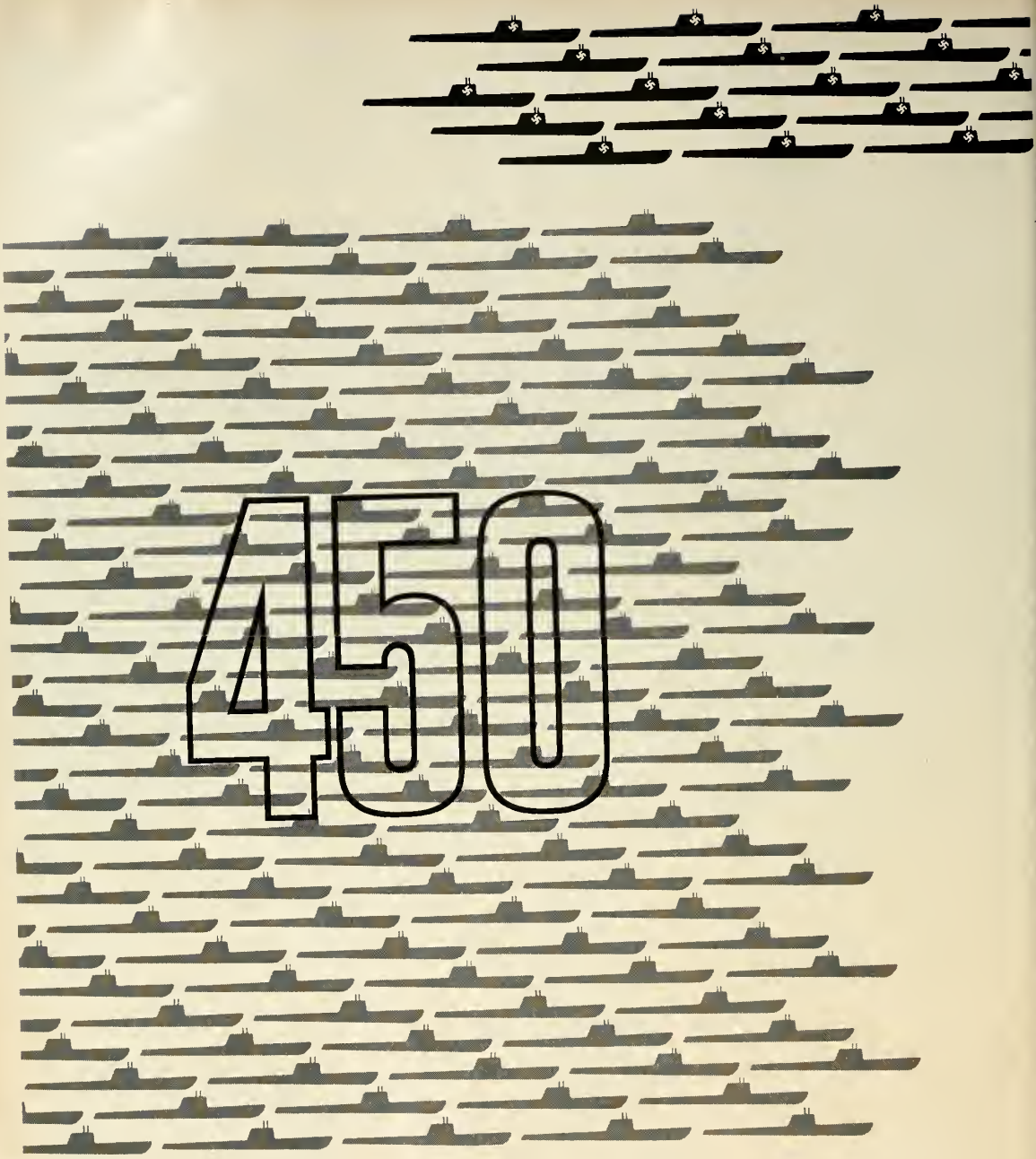
Plant location services

Staff specialists available to serve industry, engineering firms, management consultants, industrial realtors and others with fully detailed plant location data.



For free copy of pamphlets on these Pennsylvania Plant Location Advantages, write or call:

PENNSYLVANIA DEPARTMENT OF COMMERCE
Main Capitol Building
413 State Street, Harrisburg, Pa.
Phone: CEdar 4-2912



EIGHT TIMES GREATER THAN THE U-BOAT THREAT

Fifty-seven submarines came close to strangling world commerce and knocking the Allies out of World War II. This was Hitler's U-boat strength at the start of the war. Today it's the sobering fact behind estimates of what 450 subs might do. For this is the threat the U. S. now faces. Today's sub is far more powerful than before . . . a more deadly menace to American overseas commerce, 99.85% of which still come and goes by ship. And today there's the additional menace o sub-launched nuclear missiles, which open our inland citie to possible devastation. If the Free World is to survive, th submarine threat must be solved. Primary fighters in thi urgent contest are the men and ships of the Navy.

ADVANCED WEAPONS | ASTRONAUTICS | ASW | ELECTRONICS | MISSILES AIRCRAFT | G | RANGE SYSTEMS

CHANCE VOUGHT DALLAS, TEXAS



VOUGHT KNOWS THIS ENEMY!

Ten years' close association with submariners, submarines and sub-launched missiles gives Chance Vought comprehensive and unique knowledge in the fight against enemy submarines.

Chance Vought has pooled this experience in a special engineer-scientist task force. Today, these men are working with the Navy and its Fleet units in critical antisubmarine areas.

For the Office of Naval Research, Vought's task force is studying advanced devices in the general field of submarine detection. For the Navy Bureau of Aeronautics, the company is exploring new means of protecting forces at sea from attack by submarines.

Vought's antisub specialists are analyzing the whole problem. Solutions will require improved devices and methods for detecting and classifying undersea craft. Development of new aircraft, missiles, and control methods is under intensive study.

In whatever direction these studies lead, Vought's antisubmarine warfare task force has the specialists and experience to analyze, design, and produce.



Antisubmarine warfare is just one in the broad spectrum of Chance Vought fields of activity. Other areas include: design and production of high performance aircraft, astronautics, electronics, advanced weapons, range systems management, commercial process control systems.

CHANCE VOUGHT
DALLAS, TEXAS

missile business

by William E. Howard

Dollarwise, what's the future of the space market? In 1965 will the United States be spending closer to $10 million or $10 billion on space missions? How important is a manned expedition to the moon? Will the day come when a probe to Mars is scratched in favor of an irrigation project in the Sahara?

An evaluation of the broad problems ahead of industry and the nation has been made by E. B. Doll, vice president of Space Technology Laboratories. His conclusion, in brief: right now we are long on technical know-how, but too short on basic wisdom.

"The technical developments in this field have come so rapidly, and pose such complex questions," say Doll, "that there has not been time for the general public, our national leadership, or even our scientific community to evolve a sufficiently deep and broad-based set of values, principles and objectives concerning space projects to permit these projects to be viewed in proper perspective."

Moreover, Doll contends, "as a nation, we are not yet prepared philosophically to judge the importance of space technology as compared with other segments of science and engineering. There is no reservoir of common understanding of the military or economic or scientific values of accomplishing space missions. There is no general agreement on which particular projects will contribute the most to our military strength and national security, to scientific progress, or to the preservation of individual liberty and health and happiness."

Foresight being a hard-to-come-by commodity anytime, Doll proposes that in view of the nation's "limited" economic and intellectual resources, much concentration should be given to distinguishing between what is possible—and what is needed; what can be done—and what should be done.

What is the immediate space market outlook? Doll, whose firm is a chief consultant to the Air Force BMD, sees space missions bound closely "for many years to come" to military requirements and, chiefly, ICBM development. "It is unlikely that the development of manned stations on the moon or like projects will be pursued in the foreseeable future under the forced draft of military necessity," he says. Emphasis will be on improving ICBM's, advanced aircraft systems or other advanced, but earth-tied, military projects.

Does this mean that space missions are out? Not necessarily. But, here is where the question comes in of determining what should be done. Doll notes that there are commercial as well as military applications for communications satellites, intercontinental rocket flight, and possibly, control of the earth's weather from a satellite system. With global television, he concedes there may be problems. "Nevertheless, I suspect that an international public which has learned to withstand the pressures of TV commercials would be less likely to succumb to misleading political propaganda."

Money spent now on instrumented and manned space probes, Doll feels, must be weighed against earthly requirements, such as the conquest of cancer. But he thinks that perhaps in 50 years the economy may expand to where paying $1 billion for a "synthetic planet-type" space vehicle holding several thousand people would be a "trivial" expenditure.

However, Doll says "major new scientific discoveries" are needed first before manned flights to Mars and Venus and creation of a manned lunar station become possible. This requires extensive research. Therefore, he says, "advanced research and development activity is a most important future space market."

Another important requirement: there must be widespread public understanding of basic technical and non-technical facts associated with both missiles and space programs. The reason, says Doll, so U.S. citizens may "properly arrive at some of the difficult national decisions which lie ahead of us."

CAN YOU USE a STEEL FABRICATING PLANT in LOS ANGELES AREA ?

Unique opportunity to acquire all or part of this old established company. Facilities for all code work. Experienced employees. Owner can lease, sell, or accept stock. Brokers invited.

Write or Wire BEN SAMPSON
450 East Colorado St.,
Pasadena, California

CLASSIFIED

HI-FIDELITY components, tape recorders, and tapes at wholesale prices. Send for FREE catalogue. CARSTON 215-RM, East 88, N.Y.C. 28.

Miniature, All-Purpose CALCULATOR

A precision instrument that will do *all* the calculations of larger expensive desk models. Weighs only 8 oz. Fits Hand. Fast, accurate, sturdy . . . completely portable. Ideal for all on-the-spot calculating. Fully guaranteed. Write for *Free* literature, prices, name of nearest dealer. **THE CURTA COMPANY** Dept. 1B 2735 W. North Shore, Chicago 45, Ill.



Missile Photos—For your office, den or collection. We produce B&W and color prints, slides, murals, and display photographs. For catalog and sample slide send 35¢ to—Camber Company, Box 1051, Cocoa, Florida

SERVO COMPONENTS REPRESENTATIVES

Sterling Precision Corporation desires immediate representation for its Servo components (gear heads, clutches, reducers, precision gears, etc.) In the following territories: Arkansas, Illinois, Indiana, Kentucky, Louisiana, Minnesota, Mississippi, North Carolina, North Dakota, South Dakota, West Virginia: **Call PO 7-7200 or write H. J. Hannon, 17 Matinecock Avenue, Port Washington, New York.**

when and where

MAY

The Atomic Energy Commission, Technical Information Meeting on Test Reactors, National Reactor Testing Station, Idaho Falls, Idaho, May 13-15.

Society of Aircraft Materials and Processing Engineering-Eastern Div., Spring Meeting, Hotel Statler, New York City, May 15.

American Institute of Chemical Engineers, Symposium, Hotel Muehlebach, Kansas City, Mo., May 17-20.

Space Medicine Electronics Symposium, Franklin Institute, Philadelphia, May 18.

Society of Aeronautical Weight Engineers, 18th Annual National Conference, Hotel Henry Grady, Atlanta, May 18-24.

American Institute of Electrical Engineers, Middle Eastern District, Satellite Tracking Session, Lord Baltimore Hotel, Baltimore, May 19-21.

The Society for Experimental Stress Analysis, 1959 National Spring Meeting, Sheraton Park Hotel, Washington, D.C., May 20-22.

Instrument Society of America, 1959 Ohio Valley Instrument and Automation Exhibit and Symposium, Cincinnati Section, Music Hall, Cincinnati, May 21-22.

Institution of Electrical Engineers, The Radio and Telecommunication Section, International Transistor Exhibition and Convention, Earl's Court, London, May 21-27.

Federation Aeronautique Internationale, Annual Meeting, Moscow, May 24-June 5.

National Missile Industry Conference, sponsored by The National Rocket Club in cooperation with the Electronic Industries Association, Sheraton Park Hotel, Washington, D.C., May 25-27.

American Rocket Society, Institute of the Aeronautical Sciences, American Institute of Electrical Engineers and the Instrument Society of America, "Investigation of Space" Conference, Brown Palace and Cosmopolitan Hotel, Denver, May 25-27.

American Society for Quality Control, All-Industry Production and Quality Control Exposition and Convention, Cleveland Public Hall and Hotel Sheraton, Cleveland, May 25-27.

American Society of Mechanical Engineers, Design Engineering Show and Conference, Convention Hall, Philadelphia, May 25-28.

The Institute of the Aeronautical Sciences, San Diego Section, Regional Meeting on Supersonic Transports, San Diego, May 26-28.

JUNE

Institute of Radio Engineers' Professional Group on Microwave Theory & Techniques, National Symposium, Harvard University, Cambridge, Mass., June 1-3.

Institute of Radio Engineers' Professional Group on Production Techniques, Third National Conference, Villa Hotel, San Mateo, Calif., June 4-5.

The Pennsylvania State University's Missiles Systems Engineering Seminar, University Park, June 7-13.

Aero Club of Michigan, Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, June 8-9.

American Rocket Society, Semiannual Meeting, El Cortez Hotel, San Diego, June 8-11.

United Nations Educational, Scientific and Cultural Organization, Paris, June 15-20.

Cornell University Industry Engineering Seminars, Cornell University, Ithaca, N.Y., June 16-19.

Institute of the Aeronautical Sciences, National Summer Meeting, Ambassador Hotel, Los Angeles, June 16-19.

Institute for Practical Research on Operations, Chief of Research and Development, U.S. Army, the University of Connecticut, Storrs, June 21-July 3.

American Institute of Electrical Engineers, Air Transportation Conference, Olympic Hotel, Seattle, June 24-26.

JULY

Tenth Annual Basic Statistical Quality Institute, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 12-24.

Advertisers' Index

American Cystoscope Makers, Inc. 44
Agency—Noyes & Sproul, Inc.

American Pipe & Steel Corp. 50
Agency—Thomas M. Cavanagh, Inc.

Avco Mfg. Corp., Crosley Div. 51
Agency—Benton & Bowles, Inc.

Bendix Aviation Corp., Scintilla Div. 30
Agency—MacManus, John & Adams, Inc.

Chance Vought Aircraft, Inc. 4B, 49
Agency—Tracy-Locke Co., Inc.

Commonwealth of Pennsylvania, Dept. of Commerce 47
Agency—Bachman, Kelly & Trautman, Inc.

CONVAIR, a Div-General Dynamics Corp. 2
Agency—Lennen & Newell, Inc.

Dyna-Therm Chemical Corp. 6
Agency—Taggart & Young, Inc.

B. H. Hadley, Inc. 25
Agency—Jackson & Morse Adv.

Hallamore Electronics Co., Div.-The Siegler Corp. 3
Agency—Cole, Fischer & Rogow, Inc.

Hughes Aircraft Co. 8
Agency—Foote, Cone & Belding

International Business Machines Corp. 2B, 29
Agency—Benton & Bowles, Inc.

Lee Co., The 4
Agency—Larry Hoggan Adv.

Newbrook Machine Corp. 45
Agency—Melvin F. Hall Adv. Agency

North American Aviation, Inc., Autonetics Div. 26, 27
Agency—Batten, Barton, Durstine & Osborn, Inc.

Northrop Corp. 10
Agency—Erwin, Wasey, Ruthrauff & Ryan, Inc.

Raybestos-Manhattan, Inc. 46
Agency—Gray & Rogers

Thiokol Chemical Corp., Rocket Div. ... 52
Agency—Brown & Butcher, Inc.

United Aircraft Corp., Norden Div. ... 12
Agency—Lennen & Newell, Inc.



Unusual career opportunities for qualified scientists and engineers . . . write Avco/Crosley today.

Avco / Crosley

From Crosley . . .

Command Receivers for Drones and Missiles

Designed and manufactured by Avco's Crosley Division, Command Receivers are standard equipment aboard most of the nation's missiles. Their job: To receive and act upon instructions from the ground to destroy the missile when its flight path indicates the missile has gone awry.

In a missile configuration, the Command Receiver weighs only 12 pounds, has three channels and incorporates a decoder and power supply in a simple pressurized package.

A second version of the Command Receiver, employing 12 channels for radio communication, is used in high-performance drones and decoys. In such applications, the Command Receiver actuates control surfaces, directs engine operation and opens the recovery parachute—all by radio-conveyed instructions from the ground.

A Product of Crosley Engineering, the Command Receiver has proven itself for the future by the job it is doing in the missiles and drones of today.

For more information, write to: Vice-President, Marketing-Defense Products, Dept. M-59, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.



Weighing only 12 pounds, Crosley Command Receivers direct destruction of off-course missiles, control drone recovery.







THIS IS THIOKOL...





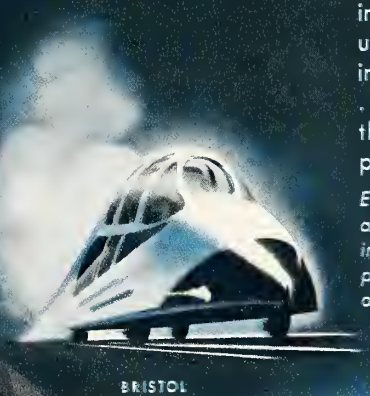
serving industry and the national defense

In modern plants strategically situated throughout the country, Thiokol is making many significant contributions to the art and science of rocketry.

By developing new and better propellants (both solid and liquid)—by designing and building improved power plants to utilize these fuels—by furnishing essential support equipment . . . Thiokol helps to strengthen the nation's defenses, helps push back our spatial frontiers.

Engineers, Scientists: perhaps there's a place for you in Thiokol's expanding organization. Our new projects present challenging problems and a chance for greater responsibility.



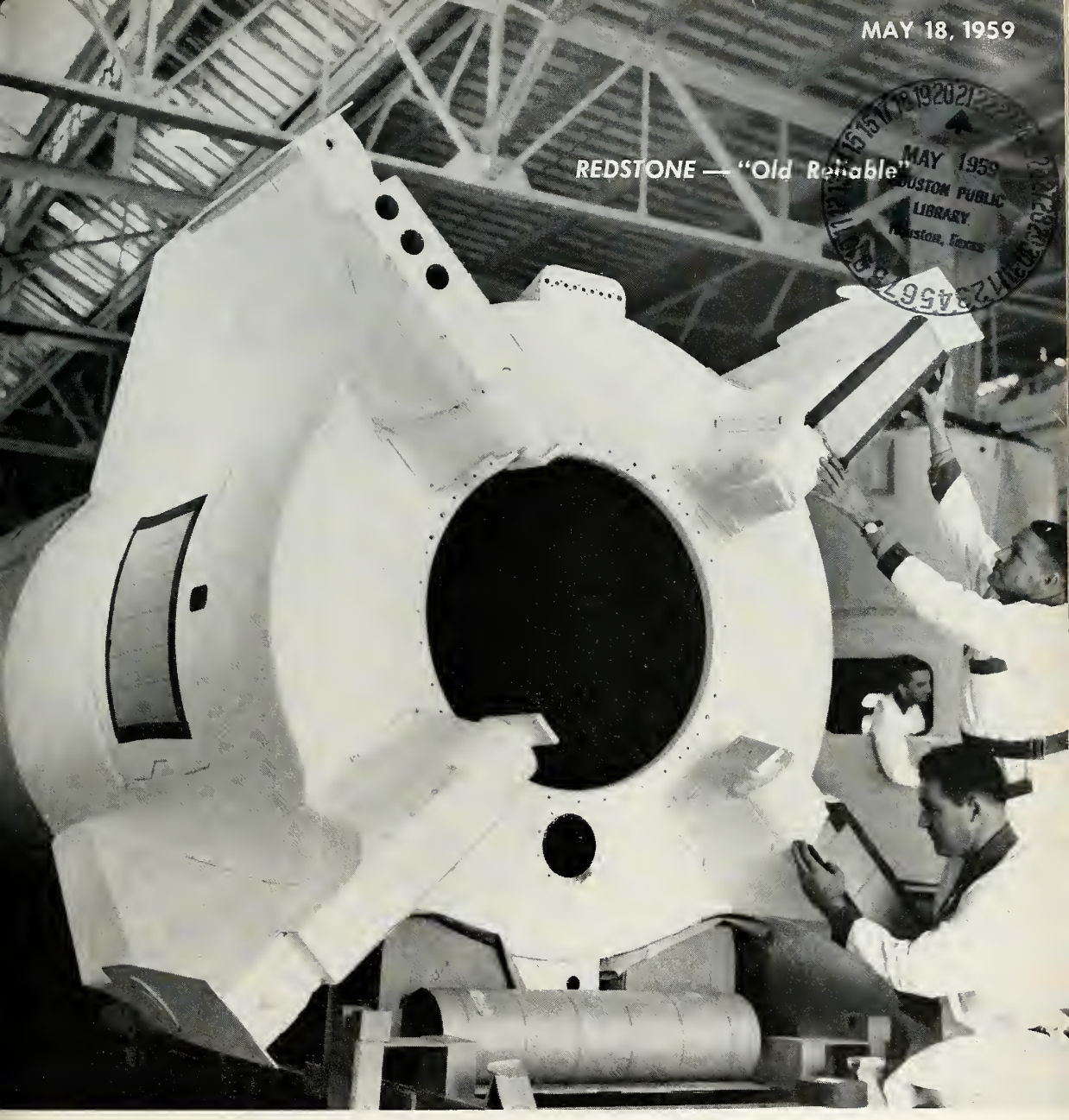


Thiokol® CHEMICAL CORPORATION

TRENTON, N. J. · ELKTON, MD. · HUNTSVILLE, ALA. · MARSHALL, TEXAS
MOSS POINT, MISS. · BRIGHAM CITY, UTAH · DENVILLE, N. J. · BRISTOL, PA.

®Registered trademark of the Thiokol Chemical Corporation for its liquid polymers, rocket propellants, plasticizers and other chemical products.

MAY 18, 1959



MAY 1959
HOUSTON PUBLIC LIBRARY
Houston, Texas

missiles and rockets

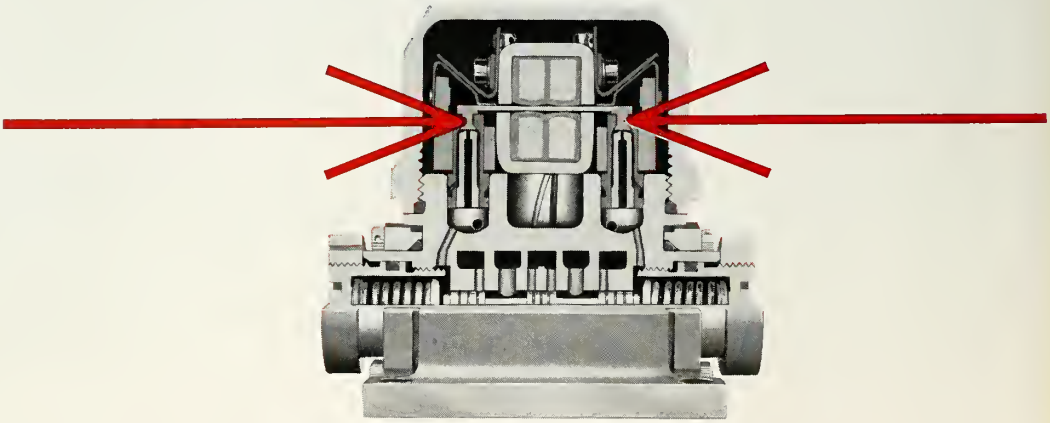
MAGAZINE OF WORLD ASTRONAUTICS

he ALBM Requirements 19
lans for Equator Launch Site . . . 22
Millions for *Mercury* Tracking . . . 26

AN AMERICAN AVIATION PUBLICATION

VOLUME PRODUCTION

HYDRAULIC SERVO VALVES WITH HIGH RESISTANCE TO CONTAMINATION



This is the Bendix-Pacific Electro-Hydraulic Servo Valve with the shrouded nozzles. It offers the advantages of both a dry coil and a wet coil valve by isolating the torque motor from circulating flow. There is no sacrifice in performance normally associated with dry coil sealing devices.

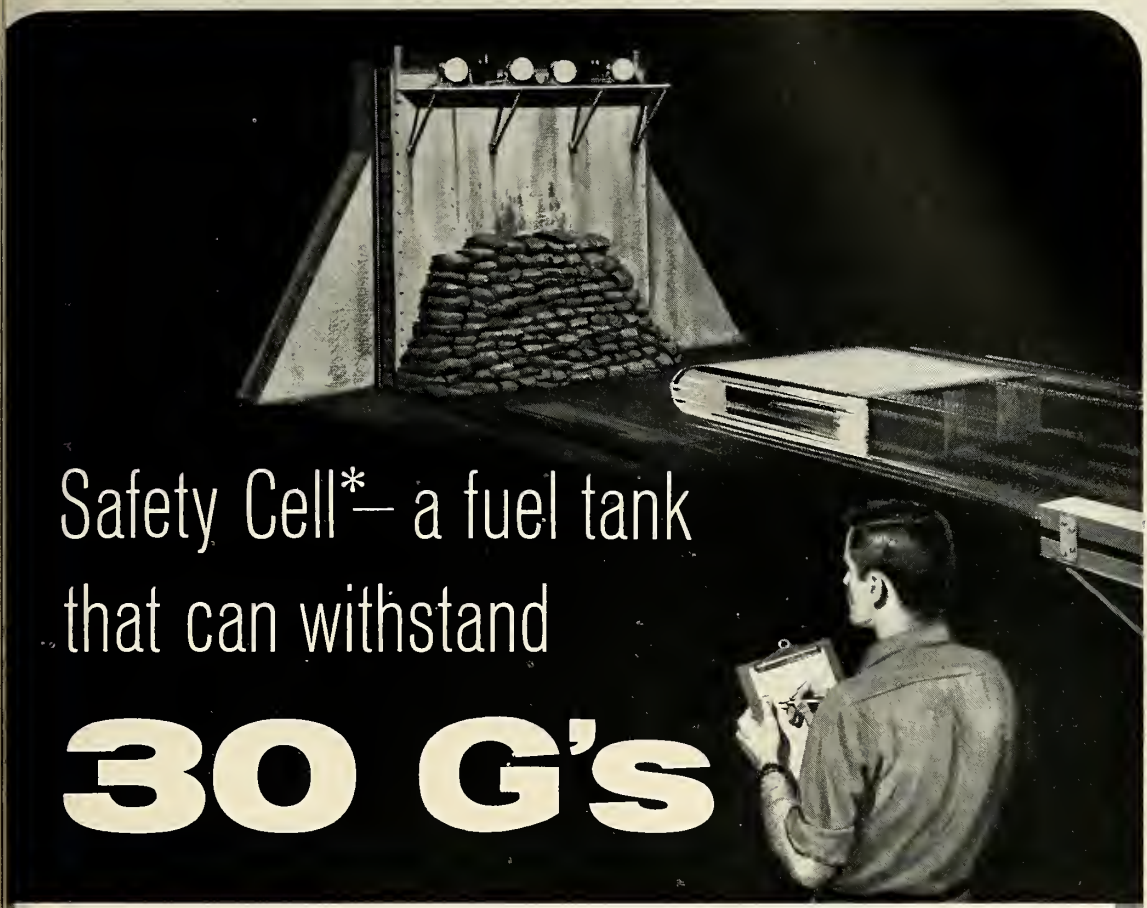
The Bendix-Pacific shrouded nozzles are parallel to each other. This provides a torque motor with two air gaps, doubling available torque. As the armature does not operate about a fixed point three advantages result: (1) Larger flow passages that are less susceptible to contaminants. (2) Higher response is achieved by faster exhausting of spool and pressure chambers and (3) Nozzle back pressure is sustained with reduced supply pressure thereby maintaining stiffness and null stability.

These Bendix-Pacific Servo Valves are in volume production. Application engineers are available to discuss system problems and adaptation of these valves to your specific needs.

Bendix-Pacific
DIVISION OF BENDIX AVIATION CORPORATION
NORTH HOLLYWOOD, CALIFORNIA

NEW YORK CITY • DALLAS, TEXAS • DAYTON, OHIO • WASHINGTON, D.C. • SEATTLE, WASHINGTON

Circle No. 4 on Subscriber Service Card.



Safety Cell*— a fuel tank that can withstand 30 G's

THE PROBLEM: how to control aviation fuel during high-impact conditions so that instantaneous vaporized combustion can be prevented.

THE GOODYEAR ANSWER: Safety Cell, a high-strength, low-weight fuel tank made of super-tough rubberized fabric. Under exhaustive testing, in cooperation with the Federal Aviation Agency, these tanks have successfully withstood impacts exceeding 30 G's—maximum level of human tolerance. This means that the danger of vaporized combustion at impact is substantially reduced. Thus, the opportunity for survival is materially increased. A number of these tanks are already in use.

THE SIGNIFICANCE: personnel and property protection against full vapor combustion far beyond any type previously obtainable.

More information on Safety Cell, the revolutionary new fuel cell, is yours for the asking. Simply write Goodyear, Aviation Products Division, Akron 16, Ohio.

AVIATION PRODUCTS BY

GOODYEAR

*Safety Cell—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

MORE AIRCRAFT LAND ON GOODYEAR TIRES, WHEELS AND BRAKES THAN ON ANY OTHER KIND



CEC pickups measure airfoil pressures to 5000 psi ...at 600°F.

Testing the hot ones is easy for rugged CEC Pressure Pickups...the 4-316A and 4-317, both designed for a wide range of pressure measurements at extremely high temperatures. Hundreds of these unique pickups were used to measure the dynamic and static pressure differential on airfoil surfaces of the Convair B-58 during the testing program for the nation's first supersonic bomber.

Designed for continuous operation at 600°F. without cooling, the 4-316A and 4-317 cover a pressure measurement range of 15 to 5000 psi gage. Among their features: one-piece construction machined from 416 stainless steel... 5/8" and 1/2" normal diameters... weights of 55 and 23 grams with mounting flanges. They are widely used in flightload testing, engine studies and supersonic tests. Where external cooling is practical, an adapter extends the operating range of the 4-317 to 2000°F.

For additional information, call your nearest CEC sales and service office or write for Bulletins CEC 1568-X36 and 1588-X10.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS/300 n. sierra madre villa, pasadena, california

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

Circle No. 5 on Subscriber Service Card.

Executive Editor .....CLARKE NEWLO
Managing Editor ....DONALD E. PERR

EDITORIAL STAFF

News Editor .....REED BUNT
Military & Defense .....BETTY OSWA
JAMES BA
Electronics/Support Equipment ..HAL GETTIN
Electronics Engineering ....CHARLES D. LAFO
Missile Manufacturing .....WILLIAM E. HOWA
Missile Business .....ERICA M. KA
NASA .....PAUL MEA
Los Angeles .....FRED HUNT
RICHARD VAN OST
FRANK MCGUI
London .....G. V. E. THOMPSO
Paris .....JEAN-MARIE RIC
Geneva .....ANTHONY VAND
Art Director .....WILLIAM MART
Ass't Art Director .....COLLIS CAMPBE

CONTRIBUTORS

Propulsion Engineering .....MICHAEL LOREN
Industry .....JAMES J. HAGGERTY,
Soviet Affairs .....DR. ALBERT PAR
Space Medicine .....DR. HUBERTUS STRUGHO
Astrophysics .....DR. I. M. LEVI
Research .....HEYWARD CANNEY,

ADVISORY BOARD

DR. WERNHER VON BRAUN — ROBERT P. HAVILA
DR. PETER CASTRUCCIO — DR. ARTHUR KANTROWI
KRAFFT EHRICKE — DR. EUGEN SAENG
R. F GOMPERTZ — ALEXANDER SAT

BUSINESS STAFF

Assistant Publisher .....E. D. MUHLFI
Advertising Sales Manager .....W. E. BRO
Circulation Director .....L. L. BRETTN
Research Manager .....D. T. FOSS
Promotion Manager .....J. E. MULB
Advtg. Service Manager ..MRS. GLADYS BUSSI
Production Manager .....J. F. WAL
Ass't Production Mgr. .....ELSIE GE
New York .....17 East 48 Str
Eastern Advtg. Mgr. .....P. B. KINN
P. N. ANDERS
A. B. SCHEFFI
Detroit .....201 Stephenson Bl
K. J. WE
Chicago .....139 N. Clark
G. E. YON
Los Angeles .....8929 Wilshire Bl
J. A. CL
C. R. MARTZ,
Miami .....208 Almeria Ave
R. D. HA
Toronto .....12 Richmond St.
ALLIN ASSOCIA
London .....28 Bruton
NORALL & H
Paris ..... 11 Rue Condor
Geneva .....10 Rue Gre

m/r Volume 5 Number 20

Published each Monday by American Aviat Publications, Inc., 1001 Vermont Ave., N. Washington 5, D.C.

WAYNE W. PARRISH .....*President & Publis*
LEONARD A. EISERER ...*Executive Vice Presid & General Mana*
A. H. STACKPOLE .....*Vice Presid*
FRED HUNTER .....*Vice Presid*
ERIC BRAMLEY .....*Vice Presid*
ROBERT R. PARRISH .....*Vice Presid*

Printed at the Telegraph Press, Harrisburg, Second class postage paid at Washington, D and at additional mailing offices. Copyri 1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Post Union Nations—1 year, $8.00; 2 years, $12.0 3 years, 14.00. Foreign—1 year, $10.00; years, $18.00; 3 years, $26.00. Single co rate—$.75. Subscriptions are solicited on from persons with identifiable commerci or professional interests in missiles ar rockets. Subscription orders and changes address should be referred to Circulatio Fulfillment Mgr., m/r, 1001 Vermont Av Washington 5, D.C. Please allow 4 wee for change to become effective and enclo recent address label if possible.

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

MAY 18 HEADLINES

AF Decides to Push ALBM
The story behind the competition which saw Douglas winning contract for design study 19

***Mercury* Range Contract To Be Let July 1**
Details of facilities required by NASA for tracking man in space. Final briefing on contract due May 18 26

Mach 1400 Shock Waves Duplicated
Avco Research Laboratory reproduces shock waves which result from solar flares utilizing 30-inch shock tube 27

MISSILE SUPPORT

U.S. Negotiating with Aussies for Manus Island
ARPA has engineering plan embracing millions in construction for developing equatorial launch site 21

MISSILE ELECTRONICS

Project *Argus* Opens New Experimentation
Detailed discussion of historic tests confirms theories of Christofilos and gives prospects of additional tests 37

THE MISSILE WEEK

Washington Countdown 13

Industry Countdown 17

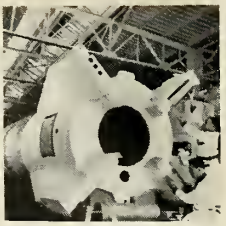
More About the Missile Week 24

NEW MISSILE PRODUCTS

Tape-Controlled Table
It works to tolerance of one-millionth of an inch 28

DEPARTMENTS

Editorial	9	West Coast Industry	56
Propulsion Engineering ...	52	Contract Awards	59
People	53	When and Where	62



COVER: *Redstones* for Project *Mercury* are now being fabricated at Reynolds Metals' Sheffield, Ala. division.

MISSILE BASEBALL







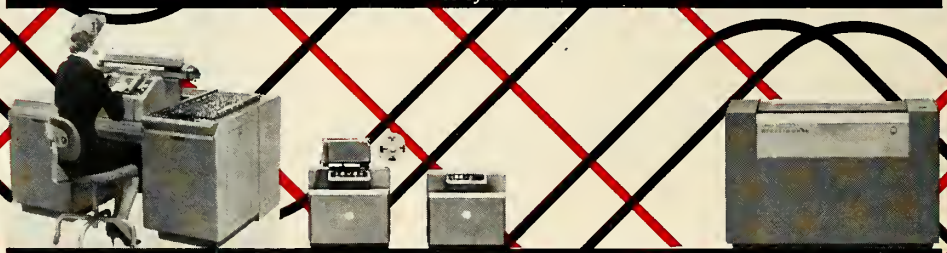
"OPERATION Skycatch" is the newest phase of development of the *Polaris* FBM launching system. At San Francisco Naval Shipyard, as shown in these sequence photographs, a huge overhead assembly catches the multi-ton dummy missile in mid air. The method simplifies retrieval procedure and also permits accurate study of the effects of launch stresses. Westinghouse is prime contractor under Lockheed for the launching system.



220 System

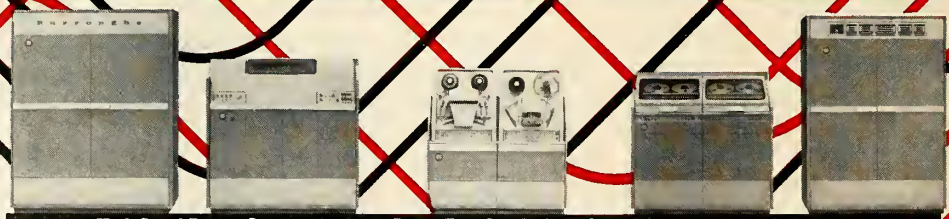


205 System



E101 System

Datafile



220 High Speed Printer System

Paper Tape Reader/Punch

Magnetic Tape Unit

expandable for growing needs:

a full range of Burroughs electronic computers

for science and business

From advanced computer systems to individual computer components... the Burroughs line of electronic data processing equipment spans a full range of varied requirements for both scientific and business applications. • Start at the top if your needs call for giant computer ability: The *Burroughs 220,* first and only available medium-priced computer with expandable magnetic core storage... a powerful multi-purpose system which can grow with your computational requirements. The *220* is now at work and delivering effective results at the lowest application cost. • If present application demands are more moderate, investigate the versatile *Burroughs 205.* First in its field with external magnetic tape storage... complete choice of input/output media with flexible, modular expansion, top capacity and speed. The *205* has thoroughly proven its economic value in a wide variety of scientific and business applications. • Most popular of all low-cost computers is the *Burroughs E101.* Exclusive, simple pinboard programming frees engineering man hours, by reducing manual computation time up to 95%. Machine ability is further extended by optional punched paper tape input/output equipment and new punched card input unit. • Burroughs advanced sub-systems include: *Datafile* magnetic tape unit with vast external storage capacity... up to 50-million digits per unit; *Cardatron*...fastest, most powerful card handling system; *220 High Speed Printer System* ...a transistorized unit with unmatched speeds up to 1500 lines per minute, on-line or off-line operation. *High Speed Photoreaders, Magnetic Tape Units* and other computer system components are also finding wide use in data processing, communications and allied fields. • Currently in production, all these Burroughs products are designed to meet your growing data processing needs... and supporting the entire Burroughs line is an outstanding team of computer specialists for efficient, on-the-spot, technical assistance. Write today for brochure, specifying system or component. • ElectroData Division, Pasadena, California.

Burroughs Corporation *"NEW DIMENSIONS/in electronics and data processing systems"*

Circle No. 6 on Subscriber Service Card.



T/I missile
guidance and telemetry

BEEPS WITH A HIGH IQ

...for missile sensing, guiding and telemetering

Electronic signals that report the truth, the whole truth, and nothing but . . . wring the best performance from missile systems. By pushing beyond known capabilities in sensitivity and accuracy, Texas Instruments is producing "high IQ" systems and equipments for a dozen guided vehicles used in every basic mission: air-to-air, air-to-surface, surface-to-air, surface-to-surface—IRBM and ICBM—plus drone sensors and satellite instrumentation. T exceeds tough specs against tight deadlines, regularly . . . specs asking solutions to problems never posed before. For detailed discussion, cleared personnel please write or call: SERVICE ENGINEERING DEPARTMENT.

RESEARCH/DESIGN/DEVELOPMENT/MANUFACTURING of systems for: *Air traffic control • Airborn early warning • Antimissile • Antisubmarine warfare • Attack control • Countermeasures • Missile system Navigation • Reconnaissance • Space electronics; and on detector cells, engine instruments, infrared, intercon microwave, optics, sonar, telemetering, time standards, timers, transformers and other precision equipment.*

APPARATUS DIVISION

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE
DALLAS 9, TEXAS

Circle No. 7 on Subscriber Service Card.

The Next Deputy Defense Secretary

It would be difficult to over-estimate the importance of choosing wisely the man who will succeed Donald A. Quarles as Deputy Secretary of the Department of Defense. He must be selected with an eye to his scientific background, for his managerial effectiveness, for his familiarity with the Defense Department and its thousands of complexities—and for the problem of maintaining a continuity of experience in this top defense post.

It is difficult to think of a man whose presence in the Pentagon will be more greatly missed than Donald Quarles, who died in his sleep a few days ago, as quietly as he had lived. It would also be difficult to find a man who brought to the job a greater combination of attributes needed to fill it and a greater devotion to duty. Don Quarles literally gave his life for his country. A few weeks ago he was urged to take a vacation. He replied that he hadn't the time. Doctors discovered after his death that the cause of it could have been averted by a little rest and a little relaxation of the tensions he unavoidably built up through the overlong hours and concentration he continually practiced.

Two Secretaries of Defense, Charles Wilson and Neil McElroy, leaned heavily on Don Quarles for guidance, especially in the military scientific field which broadened immeasurably after *Sputnik*. Many of the decisions which brought about our present military and space posture were, whether you like them or not, directly attributable to Mr. Quarles.

Lacking in scientific knowledge himself, Secretary McElroy must now find a man for his deputy who will adjudicate the split personality in the Defense Department which he, himself, has created; the three-headed organization of military space development—Directorate of Science and Engineering, Advanced Research Projects Agency and Special Assistant for Guided Missiles.

The man who helps Secretary McElroy with those decisions must also be prepared to step into the top job should the Secretary adhere to his original determination to return to his corporation position in late summer or autumn. The appointee must be prepared to name his own deputy and to remain on until the new administration. The greatest of all dangers to the country and its military program could be a lack of continuity in the office.

There have been a number of names suggested as a successor for Mr. Quarles and they cover a wide field—Henry Cabot Lodge Jr., the U.S. United Nations representative; Gen. Alfred M. Gruenther, former SHAPE commander and present head of the American Red Cross; Wilfred J. McNeil, assistant secretary and comptroller of the Department of Defense; and William C. Foster, present executive vice president of Olin Mathieson Chemical Corporation.

Also possibly under consideration are Richard Horner, Assistant Secretary of Air Force for Research and Development, and Thomas J. Gates, Jr., Secretary of the Navy. Chiefly against the latter two is the fact that each is identified with one of the services and would draw immediate opposition from the others. Also, Mr. Horner has accepted a new post as general manager of NASA which he will assume on June 1 and which would complicate his acceptance.

On the others: Mr. Lodge, however brilliant otherwise, would be thrown into an unfamiliar field for which he is little prepared. He served in the Army during World War II and was President Eisenhower's campaign manager in 1952. Mr. McNeil is a career Pentagonist and certainly is familiar with all its operations, although his experience has been strictly financial and he would not be a popular choice with the services, where there is a feeling that he sometimes over-controls with the purse strings.

The appointment of Gen. Gruenther would require the passage of a special law because the act creating the office of Secretary of Defense specifies that it must be held by a civilian.

While not the most prominently mentioned, William Foster is possibly the most logical and the best qualified of the men whose names have been suggested. Actually, he was also under consideration for Mr. McElroy's position—if he left in the Autumn and if Mr. Quarles had not been named.

Bill Foster has held a variety of high level government jobs including Under Secretary of Commerce, Deputy Administrator of ECA and Deputy U.S. Special Representative in Europe, a NATO post.

And—he was Deputy Secretary of Defense from September, 1951 to January, 1953, serving under Republican Secretary Robert Lovitt during a Democratic Administration. He was educated at M.I.T. and, importantly, has never been very far away from OSD and its operations since leaving his position there.

As a member of the Gaither Committee, he is credited largely with writing the report of a year ago which recommended sweeping changes and reorganizations in OSD, many of which have been put into effect.

We have no idea who will be selected for the post, but we do feel strongly that the importance of choosing the right man is of vital consequence to the country. Selecting anyone but the best available man would be a great tragedy for it is one of the most important jobs in the world today.

Clarke Newlon



What are your missile fluid line design problems?

When you have problems in the fabrication and design of tube components involving critical tolerances for any missile, power plant and ground handling applications call STRATOFLEX.

For example, two special aluminum elbow tubing assemblies (shown below) were designed to convey liquid oxygen in missile power plants. These assemblies were designed and manufactured to rigid specifications. Made from 4.500 O.D. x .125 wall tube and machined flanges, dimensions between sealing surfaces (up to 16 inches) were held to tolerances of ± .010 on linear and ± 1/2 degree on angular dimensions.

Other design problems are being solved daily by Stratoflex Engineering. Allow your Stratoflex Representative to acquaint you with these specialized services.



STRATOFLEX Inc.

P.O. Box 10398 • Fort Worth, Texas
Branch Plants: Los Angeles, Fort Wayne, Toronto
In Canada: Stratoflex of Canada, Inc.

SALES OFFICES:
Atlanta, Chicago
Cleveland
Detroit, Fort Wayne
Fort Worth
Houston, Kansas City
Los Angeles
New York, Philadelphia
Pittsburgh
San Francisco, Seattle
Toronto, Tulsa

SF6-9



TEPS IN THE RACE TO OUTER SPACE

Nuclear Rocketship

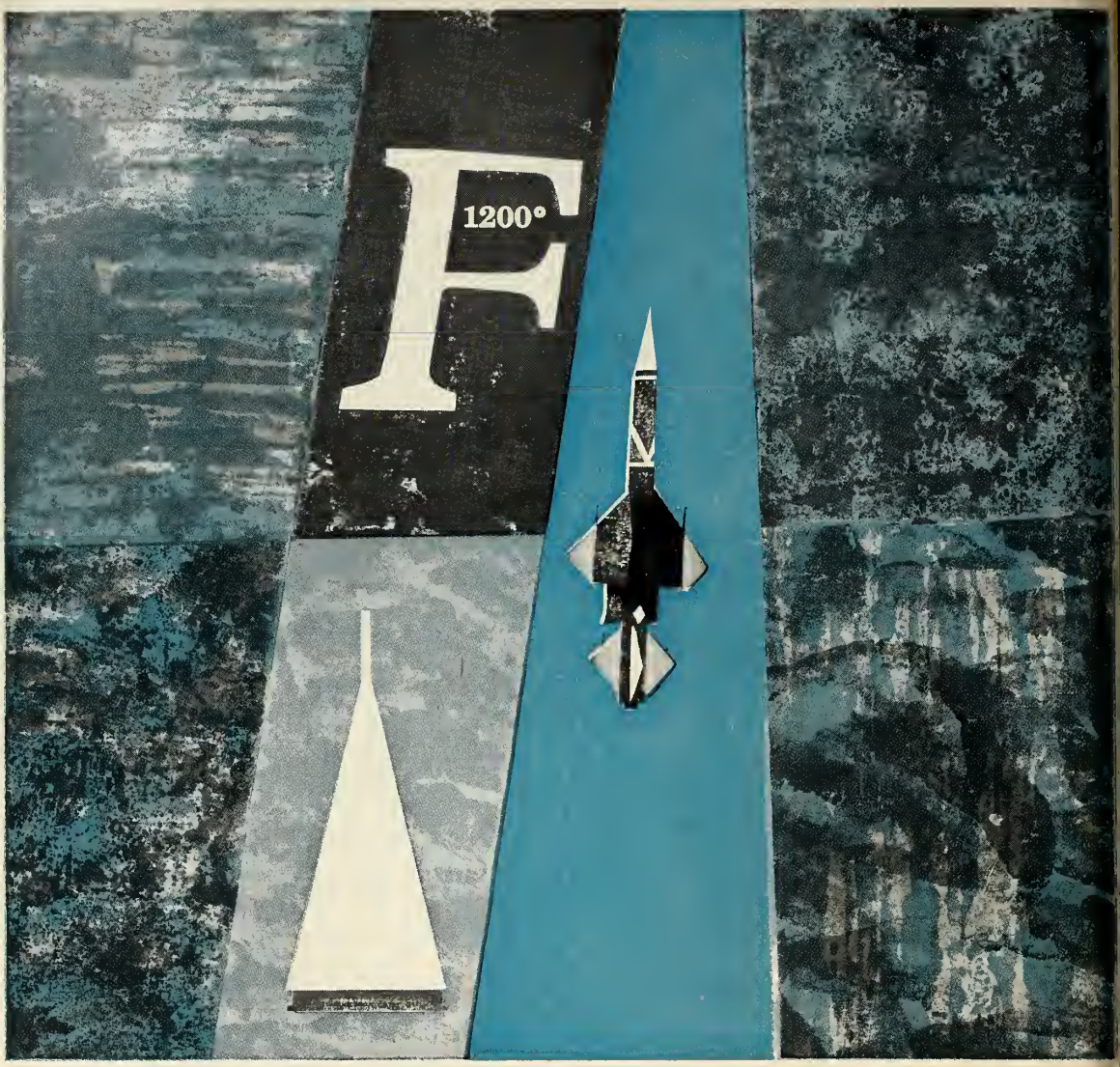
spite the sky-high transportation costs, nar manufacturing should prove eco- mically viable. With unlimited Solar wer, controlled atmospheres and ad- nced automation, a considerable com- erce could be realized in delicate in- uments, rare minerals, reactor cores d other items that might be more ef- iently processed or produced in the on's perfect vacuum.

To supply the Moon colonists, and to rry their production back to Earth, ecial rocketships will be developed. Nuclear energy is the most promising source of propellant power. The ship shown here utilizes nuclear fission for heat and hydrogen gas as a working fuel. From pressurized tanks, the gas is fed through a heat exchanger, expanded, and expelled for the motive thrust.

When the craft leaves Earth, it carries only enough gas for a one-way trip. For, by extracting hydrogen and oxygen from Lunar rocks, Moon settlers will be able to refuel the rocketship for the return voyage. This will permit smaller fuel tanks on the craft and larger payloads.

Inertial navigation systems will play an increasing role in the exploration of outer space. ***ARMA*** is actively supporting the Air Force's program in long range missiles and is in the vanguard of the race to outer space. ***ARMA***, Garden City, N. Y. A Division of American Bosch Arma Corp.

AMERICAN BOSCH ARMA CORPORATION



BRUNSWICK "SHOOTS" THE RADOME RANGE TO 1200° F

Brunswick makes a new breach in the thermal barrier with newly developed non-metallic materials that boost the temperature tolerance of radomes and nose cones to 1000-1200°F for limited exposure periods – almost twice the previous limit. This new advance in Brunswick's Strickland 'B' Process of filament winding opens a new chapter in aircraft and missile designing.

New "SBP" filament winding results in the highest strength-to-weight ratios ever obtained in radomes and nose cones with significant weight savings over conventional structures. With unmatched electrical uniformity, Brunswick builds them to meet the tightest tolerances for dielectric constants and compound configurations. Brunswick offers full electronic testing facilities.

Brunswick radomes and nose cones now slice skyward on such supersonic aircraft as the advanced Convair F-106; on such missiles as the Boeing Bomarc and Lockheed Q5. For details on Brunswick's leadership in research, development and testing, write: The Brunswick-Balke-Collender Company, Defense Products Division, 1700 Messler St., Muskegon, Mich.

BRUNSWICK

MAKES YOUR IDEAS *WORK*

Circle No. 1 on Subscriber Service Card.

washington countdown

IN THE PENTAGON

The Pentagon has cut the number of IRBM squadrons for NATO to eight—five Douglas *Thor* and three Chrysler *Jupiter*. Four 15-*Thor* squadrons go to Britain; probably all three 15-*Jupiter* squadrons go to Italy. That leaves only one *Thor* squadron for Turkey.

• • •

The secret Goodyear *Pinpoint* guidance system now under development will be used in ballistic missiles in conjunction with inertial guidance. *Pinpoint*—successor to topographical map-reading *Atran*—apparently will be used to direct the missile to its target with greatly improved accuracy during the terminal phase of flight.

• • •

The Navy expects to extend the range of Lockheed's *Polaris* considerably beyond 1500 nautical miles during the next four or five years. However, it says the first *Polarises* put into submarines next year will have a 1200-mile range. It says no modification of the submarines will be necessary as the range is extended.

• • •

The Air Force sees the Boeing *Minuteman* as a bargain weapon compared to *Atlas* and *Titan*. Cost of a *Minuteman* including its hardened site and related expenses is expected to run about $1.5 million, compared to more than $10 million for the *Atlas*.

• • •

The Navy is considering the use of inflatable rubber planes as missile-carrying drones. The planes could be flown from carriers.

• • •

Bigger megaton warheads are in the works for both the Convair *Atlas* and the Martin *Titan*. Until recently the *Atlas* has been scheduled to pack a four megaton warhead . . . the *Titan* seven.

• • •

The first of the Martin *Mace* groups being sent to USAF troops in West Germany is expected to be operational this summer. The *Matadors* that the 60-missile *Mace* groups are replacing are going to West German troops. Plans call for quickly replacing all three U.S. *Matador* groups with *Maces*.

Meantime, the *Mace*, which can be fired from mobile launchers, is about to go into hardened sites. The FY 1960 budget calls for spending $10.2 million on hardened *Mace* sites in West Germany. (M/R, May 11.)

ON CAPITOL HILL

The House Defense Appropriations Subcommittee is readying a multi-million-dollar package increase in the FY 1960 budget for ICBM's. Extra money is included for *Atlas*, *Titan* and *Minuteman*. Some say the fattened appropriations bill will reach the House floor by early next month.

• • •

But some Congressmen don't hold out much hope that the Pentagon will pay any attention to the increase even if it clears Congress. The Air Force already has proposed that the nine-squadron *Atlas* program be increased considerably—possibly doubled. However, Defense Secretary Neil H. McElroy has made clear that he is opposed to it. Probable fate of any Congressional increase at this time: The money will be impounded.

AT NASA

A new NASA attempt to take over the Army's Redstone Arsenal appears almost certain prior to the formulation of a supplemental FY 1960 budget or the FY 1961 budget. If the move flops again, attempts will be made to put enough money in the new budgets to give NASA a similar facility. NASA officials have no complaints with the Army's cooperation at Redstone. But they feel that the space agency will need all of Redstone's in-house capability to design and integrate the newer space systems.

AROUND TOWN

The United States is planning to cooperate fully with Britain on its plans to develop a space exploration program of its own. Look for possible joint projects of increasing magnitude. So far the British are planning to turn out instruments for satellites and adapt some of their missiles for possible launchings.

DOW | MAGNESIUM



a comparison:

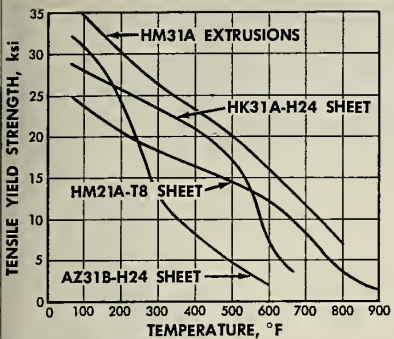
4 MAGNESIUM ALLOYS for elevated temperature service

A wide variety of elevated temperature alloys extends the use of lightweight magnesium into the critical 300°-800°F. temperature range.

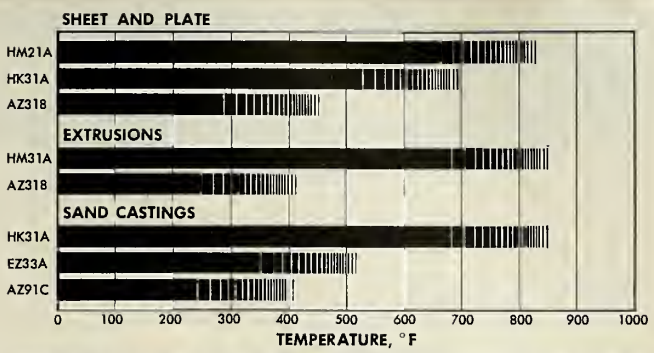
Name your weapon—Jupiter C, Polaris, Talos, Discoverer, Falcon or Bomarc. All make extensive use of elevated temperature magnesium alloys. Improved resistance to creep, increased stiffness and strength and exceptional shop characteristics are the long suit of these materials. At elevated temperatures they maintain a high ratio of fatigue strength to static strength. (About the same ratio as standard magnesium alloys at room temperature.)

SHEET AND PLATE

Alloys HK31A and HM21A have been widely used for many different parts in missiles, rockets and aircraft. Some of the most common applications include body skins, engine air inlets and ducts, nose cowlings and cones, external and internal skins on control surfaces. HK31A extends the usefulness of light-



New alloys have extended magnesium's useful service temperature range.



A comparison of short-time tensile yield strength exhibited by a standard magnesium alloy and the commonly used elevated temperature alloys.

weight magnesium to a temperature of 500°F. and above. HM21A withstands temperatures up to 700°F. and higher for short time periods. And it exhibits better creep resistance above 350°F. and better static properties above 550°F., than does HK31A.

FORGINGS

At operating temperatures up to 800°F., HM21A offers excellent mechanical properties, optimum creep resistance. HK31A has better room and elevated temperature properties up to 400°F. Both have good forgeability.

CASTINGS

Engine air inlets and ducts and housings for electronic guidance systems are examples of the many applications of cast magnesium alloys HK31A and EZ33A. EZ33A has good general properties in the 350°-500°F. range. HK31A is recommended up to 700°F. and above. Components of military systems weighing as much as 105 lbs. have been cast in one piece with HK31A. A new elevated temperature alloy for die casting is now in development and will soon be available.

EXTRUSIONS

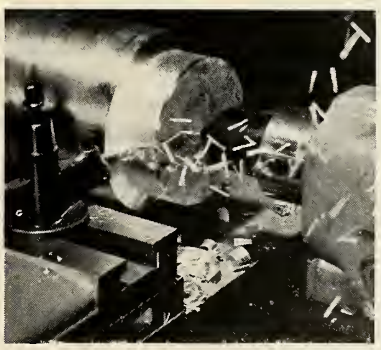
Alloy HM31A has put the many benefits of elevated temperature magnesium into extrusion form. This alloy is used as ribs and stiffeners in missile bodies, instrumentation booms and external tunnel fairings for wiring and plumbing, etc. HM31A maintains high elastic modulus, excellent creep resistance and strength at elevated temperatures. Elevated temperature exposure at 600°F. for 1,000 hours causes no change in room temperature properties and only a slight drop in creep strength.

ELEVATED TEMPERATURE MAGNESIUM EXCELS IN PRODUCTION

The elevated temperature alloys possess the best welding characteristics of all magnesium alloys. Arc welded joints can be easily made and welding compatibility of magnesium alloys is excellent. For example, HK31A sheet can be welded to HM31A extrusions.

Weld efficiencies at room temperature range from 70% to 80%. At temperatures above 400°F., HK31A has a weld efficiency of 100%. The same goes for HM21A above 500°F. In general, preheating and stress relieving are unnecessary with these alloys. They can be readily spot welded and are not subject to cracking.

Machining operations can be carried out at extremely high speeds, with heavier depths of cut and higher rates of feed than are possible with other metals. All chemical treatments used to finish standard magnesium alloys are applicable to the elevated temperature alloys, with the exception of Dow 7, which does not coat satisfactorily on magnesium-thorium alloys. For extended service above 400°F., the anodic treatments are preferred.



Elevated temperature alloys possess the same excellent shop characteristics—such as machining, forming and welding—as the standard magnesium alloys.

MAGNESIUM ALLOYS FOR ELEVATED TEMPERATURE APPLICATIONS

SHEET	HK31A HM21A
PLATE	HK31A HM21A
FORGINGS	HK31A HM21A
CASTINGS	HK31A EZ33A
EXTRUSIONS	HM31A



WRITE TODAY for this new 27-page illustrated brochure on magnesium alloys in aircraft and missiles.
THE DOW CHEMICAL COMPANY, Midland, Michigan, Magnesium Sales Dept., 1301CL5-18

THE DOW CHEMICAL COMPANY · MIDLAND, MICHIGAN

Circle No. 9 on Subscriber Service Card.

Temco AIRCRAFT DALLAS



NAVAL AVIATION MAKES HISTORY
with ALL-JET TRAINING



NAVCAD Earland R. Clark of Stroudsburg, Pa., receiving congratulations from Rear Admiral Joseph M. Carson, Chief of Naval Air Basic Training.

On March 13 at the Naval Air Basic Training Center, Saufley Field, Pensacola, Florida, the first student pilot in Naval Aviation history soloed a primary jet aircraft—without previous propeller-driven aircraft experience. The flight was made in a TT-1 "Pinto" — designed specifically by Temco for all-jet training.

The first primary jet trainer ever purchased by any of the U. S. military services, the Pinto is designed for today's jet age. It is built closely along the lines of high-performance jet fighter aircraft and gives the student pilot the "feel" of jet training from the very beginning.

With its high safety standards, fine handling characteristics, optimum maintenance provisions and overall reliability, the Pinto is an ideal primary jet trainer. From initial cost to operation and maintenance, it is designed to provide better pilots at less cost, in less time. All in all, it gives the Navy a decided edge in the ever-advancing pace of military jet aviation.

TEMCO
ELECTRONICS • AIRCRAFT • MISSILES

SYSTEMS MANAGEMENT	DEVELOPMENT
DIRECTED RESEARCH	PRODUCTION

Circle No. 10 on Subscriber Service Card.

industry countdown

STRUCTURES

Navy is complaining to Congress its 1960 FY request of $35.3 million for *Asroc* and *Subroc* is "about one-half" of what should be spent for ASW torpedoes. Both missiles are now ready for production. Over next five years, Navy plans to spend $100 million modernizing 200 ships for ASW capability, some with the Minneapolis-Honeywell *Asroc* (rocket assisted antisubmarine missile) which has replaced the *Rat* (rocket assisted torpedo.) Goodyear's *Subroc* (anti-submarine rocket missile), Navy says, will furnish submarines with "enormous kill potential."

• • •

Missile procurement is being cut back 15% by Air Force. In the 1960 FY, the AF plans to procure 1232 missiles compared to 1462 in Fiscal 1959. Figures do not include rockets and drones.

• • •

NASA contractors are now eligible for financial backing under the Defense Production Act of 1950. President Eisenhower has authorized the space agency to use the law to guarantee loans and other financial aid to insure delivery of goods or services.

• • •

Chances are good four-year extension of Renegotiation Act will pass Congress as approved by House Ways & Means Committee. Bill eases present provisions for two-year loss carry-forward to five years and provides appeal from tax court findings. Four-year extension is compromise between permanent extension demanded by House Armed Services Committee Chairman Carl Vinson and 27-month continuation sought by DOD.

PROPULSION

Look for speed-up in *Centaur* upper stage space vehicle development as a result of "breakthrough" in large-scale production and storage capability of liquid hydrogen. ARDC says "purest (liquid) hydrogen ever made" is now being turned out in quantities at Air Products plants in Painesville, Ohio, and Palm Beach and at Stearns-Roger Mfg. Co., Bakersfield, Calif. Ample supply may enable Convair *Centaur,* which has Pratt & Whitney LOX and liquid hydrogen second-stage engine, to advance production timetable now scheduled for "sometime" in 1961.

Coming up in June: second-stage flight testing of Martin's *Titan.* Largest second-stage rocket ever to be flown, the Aerojet-General propulsion system develops 80,000 pounds of thrust at altitude using LOX and RP-1 fuel. *Titan* is expected to be "approaching operational" by mid-1960.

ELECTRONICS

BMEWS and SAGE programmed construction in FY 1960 will top $124 million—with $76.3 million going into "hardened" SAGE installations to house completely transistorized computers in supercombat centers.

• • •

At Clear, Alaska, $18 million worth of BMEWS construction is getting underway. Principal contractors for Corps of Engineers are Morris Knudsen and Patti McDonald (surveillance radar and scanner building); Baker & Ford (antenna and transmitter building); William A. Smith (railroad relocation). A&E is by Metcalf & Eddy and Skidmore, Owings & Merrill. Bids will be opened June 10 by Alaska district engineer on a powerplant. BMEWS systems contractor is RCA.

• • •

Keeping industry's doors shut to visiting Communist technical teams is being urged by Sprague Electric Co. President Julien Sprague. With one good look, says Sprague, a competent engineer may save 10 years of research simply by learning that a particular process can be accomplished by a new technique.

• • •

Expenditure of $2 billion on missile electronics in Fiscal 1960 is forecast by EIA President David R. Hull. The weapon systems concept, adds Hull, should be continued because it enables the military to "buy competent management" and fixes responsibilty for production and integration of complicated systems.

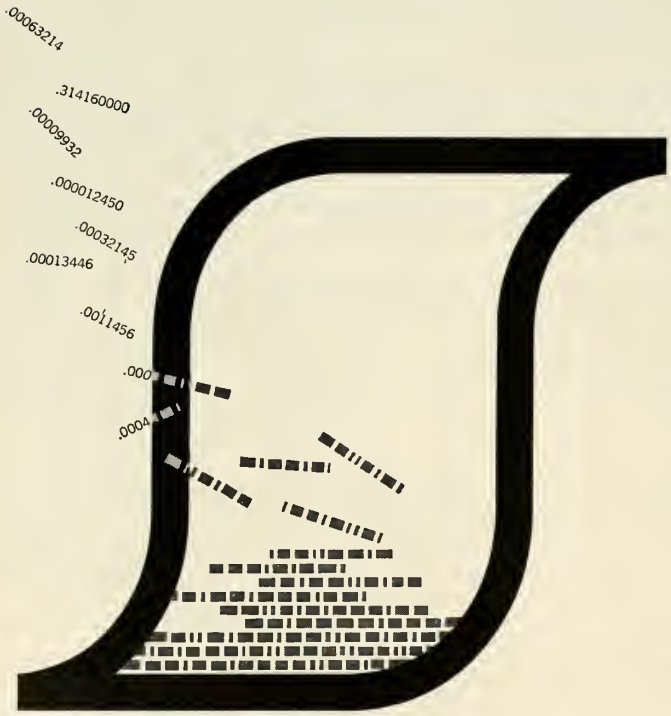
ASTROPHYSICS

Evidence is piling up that solar eruptions have a "braking" effect on the speed of earth satellites. Says Dr. W. O. Roberts of the University of Colorado: "Satellites appear to decelerate more rapidly at times of high solar activity, to experience greater drag." As yet, no explanation for this phenomenon.

More about the missile week on page 24

TAPING CRITICAL INFORMATION?

"SCOTCH" Brand high potency oxides let you pack more bits per inch!

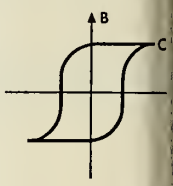


Every day SCOTCH Brand High Resolution Tap are getting the nod for more instrumentation job The reason? Performance. In taping high frequenc data, the sharper resolution lets you pack mo pulses to the inch—a greater density of inform tion to each foot of tape.

At the root of this advance are the high potenc oxides used in the magnetic coating. The high magnetic retentivity of these oxides—about a thir more than standard—offers distinct advantages. permits the use of a thinner magnetic coating whic may be combined with a thinner polyester bas Naturally, this means a more flexible tape — or that conforms for more intimate tape-to-hea contact, automatically improving resolution in th taping of high frequencies.

Even so, you don't have to sacrifice output in lo frequencies. For in addition to the marked increas in sensitivity to short wave lengths, SCOTCH Bran High Resolution Tapes show some increase in sens tivity even to long wave lengths.

These more flexible tapes cut drop-outs, to With better tape-to-head contact, there's less chance that a stray bit of dust can sneak between tape and head to cause a drop-out. The superior magnetic properties of SCOTCH Brand High Resolution Tape No. 159 show up in oscilloscope tests—producing a good squared-up hysteresis curve like that shown at the right, and symbolically illustrated at the left.

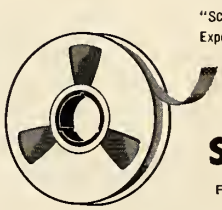


Whatever your application—data acquisitio reduction or control programming—you can cou on SCOTCH Brand technology to create tapes c higher uniformity and reliability for error-fre performance.

SCOTCH Brand High Output Tape No. 128 pr vides the sensitivity for good output in low fr quencies, even under extremes of ambient tempe ature. SCOTCH Brand Sandwich Tapes No. 188 an 189 offer extremely long life and reduced hea wear in digital work and many AM, FM and PD applications. Finally, for top performance at lo cost per foot, SCOTCH Brand Instrumentation Tape No. 108 and 109 remain the standard for th industry.

Where there's no margin for error, there's n tape like SCOTCH Brand. For more details, mail th reader inquiry card or write Magnetic Product Div., 3M Company, St. Paul 6, Minnesota.

© 1959 3M C
"SCOTCH" is a registered trademark of 3M Company, St. Paul 6, Minnesot
Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontari



SCOTCH BRAND MAGNETIC TAP

FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
... WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

Circle No. 11 on Subscriber Service Card.

Y 18, 1959—VOL. 5, NO. 20

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

U.S. Decides to Push ALBM—'Invulnerable' Defense Weapon

Douglas wins competition and begins design study based on concepts tested by Lockheed, Convair and Martin; GE said to have guidance contract

by James Baar

WASHINGTON—U.S. grand strategy the future of missile warfare took harp turn this month. It came with award of an Air Force contract development of America's air-ched ballistic missile—the much-ed-about ALBM.

Douglas Aircraft Co., a dark horse tender who won the contract over competitors, has six months to come with a refined design and cost study first step in its development pro-n.

The solid two-stage ALBM will be erned after the concept already ved feasible in the firing of test icles designed by a Lockheed-vair team and Martin—both losing petitors for the development tract.

General Electric Co. is reported to working on guidance and nose cone the missile. Other subcontractors expected to be announced shortly, Thiokol believed ahead for the tors contract.

The Air Force paid Martin $5 mil- and Lockheed $3.5 million for r feasibility studies. Results were red with all 15 competitors for the elopment contract. The Air Force had an ALBM study contract with Donnell.

Cost of the development contract is known. The Air Force said it ld be negotiated.

• **Program vague**—Meantime, many ails of the program were withheld. if released at all, they were left ue.

But the overall scope and meaning the program was clear. All one had to do was look at the key characteristics the ALBM was expected to have.

• It will deliver a nuclear warhead.

• It will have a range of more than 1000 miles—possibly as much as 1500.

• It will be launched from supersonic bombers flying at up to more than 70,000 feet.

• It will travel a ballistic path out of the atmosphere and back at hypersonic speeds that will make it unstoppable once it is launched.

• It will have greatly improved guidance that will give it considerably greater accuracy than is considered acceptable for missiles with much larger warheads.

In simplest terms, the ALBM is merely an advance on the North American *Hound Dog*. But the advance is tremendous.

The air-breathing *Hound Dog*—recently launched successfully from a B-52 flying over the Atlantic Missile Range—was swiftly developed from off-the-shelf components for service during the years of the Missile Gap.

Its Pratt & Whitney turbo-jet engine enables it to carry a nuclear warhead 500 miles at only about Mach 1.7. It was designed for launching from the B-52G.

• **Use on B-70**—The ALBM will be developed for launching from the B-70 designed to travel at Mach 3 and the Convair B-58 designed to fly at Mach 2. It also will be launched from the intercontinental B-52G.

The B-70, still under early development, will have true intercontinental range. The B-58, scheduled to be operational next year, can be made intercontinental with refueling in flight.

Also, the ALBM is designed to be the Sunday punch of the CAMAL—the much-delayed program aimed at placing subsonic nuclear-powered planes on station in the skies.

And, finally, the ALBM is the obvious stepping stone to development of the space-launched ballistic missile which would be fired from a manned space craft or an orbiting satellite.

• **ALBM strategy**—The strategy involved in use of such a weapon as the ALBM has been hinted repeatedly in speeches and statements by top officials.

Supersonic and hypersonic bombers armed with two or possibly four ALBM's would stand by either on ground or air alert.

On word of a believed attack, they will streak toward their targets. On word that the attack is actual, they will launch their ASM's while still hundreds—possibly more than 1000—miles from enemy borders.

The launched ALBM's will perform at least two key missions:

• They will strike heavily defended areas deep in enemy territory where bombers would come under intense attack.

• They will smash defenses in the path of the bombers much as heavy artillery opens the way for infantry.

Then the bombers with their huge megaton capacity and their great accuracy will strike.

On the other hand, the nearly-sonic CAMAL (Continuously Airborne Missile Launching and Low Level) would carry possibly four to eight ALBM's. However, the plane itself would not be a bomber, too. It would combine being a launching platform with such roles

as providing early warning of attack.

The CAMAL program has been delayed repeatedly while military planners argued over whether they wanted to develop an advanced supersonic nuclear-powered aircraft or merely the best nuclear-powered aircraft that could be put into the air in the shortest time. It appears that the advocates of the latter have almost won.

CAMAL has the same obvious advantage as the *Polaris* nuclear-powered submarine—a means of maintaining an instantaneously ready retaliatory force that would be most difficult to find and destroy.

Some experts say the CAMAL plane could be operational in five years if the program were pushed. Others say considerably less time would be needed.

ALBM itself is expected to be operational much earlier than that.

• **No known defense**—Whatever the method of delivery, there is no known defense against the ALBM once it is launched. The only defense is to destroy the mother planes before launching.

This is one of the prime reasons that the Air Force is developing the North American F-108 with a range of more than 1000 miles. U.S. planners must assume that Russia also is working on development of an ALBM —as well as a long-range supersonic interceptor.

All in all, many in the Air Force believe that the ALBM is such an attractive weapon that it will become the primary method for delivering the Air Force's strategic striking power in the future—both in the atmosphere and in space.

They base this conclusion on the grounds that the ALBM overcomes a number of the drawbacks of the ICBM while retaining most of its principal benefits.

• **ICBM faults**—One of these drawbacks is the stationary ICBM launching site which can be zeroed in by an attacker. Some experts contend that such bases will be vulnerable no matter how hard they are made.

The second prime ICBM drawback is its inflexibility. Once launched it can not be recalled. Also, because its launching site is stationary, the enemy knows the direction of the attack.

Third is the tremendous cost of the hardened ICBM bases. Comparatively, the ALBM is expected to be an economical weapon.

The Navy has also cited these drawbacks as reason for development of the *Polaris*. But some Air Force planners say not even the *Polaris* will have the flexibility of the ALBM.

Therefore, development of the ALBM is a turning point in U.S. strategic planning so far little appreciated either by Congress or the public.

Until now American retaliatory power has been generally seen as twofold: The SAC bomber fleets and the building squadrons of ICBM's.

In many circles, the first of these already partly obsolescent—has be regarded as a weapon of the past tl must be maintained at most five ye or so.

By then SAC is expected to armed not only with the liquid Co vair *Atlas* and Martin *Titan* but t solid Boeing *Minuteman*. Hundreds *Minutemen* are expected to be stalled in hardened bases around t country as well as on such portal platforms as railroad flat cars.

Even before then the United Sta is expected to have a fleet of *Pola* submarines on station.

Many—particularly economy minded Congressmen—have believ there is no need with all of this f the manned bomber, too.

• **ICBM vs. ALBM**—The Air For planners disagree.

They contend that for America rely on the ICBM alone for its ma retaliatory power would be similar France's reliance on the Maginot Li in World War II.

They argue that the ICBM is d signed to meet a particular type threat and strategic situation. But one can say what the threat and st tegic situation may be 10 to 15 yea from now.

Moreover, they argue that relyi principally on the ICBM leads towa molding U.S. retaliatory force sole as a deterrant of terror.

Under such a policy, the Unit States would forget for the most pa about trying to destroy an enem military power and concentrate obliterating X number of his citi and X millions of his people.

Advocates of the policy argue th it would free millions of dollars f building limited war capability. Th also argue that the continuing attem to be ready to destroy enemy milita power can only lead to bankrupt and disaster.

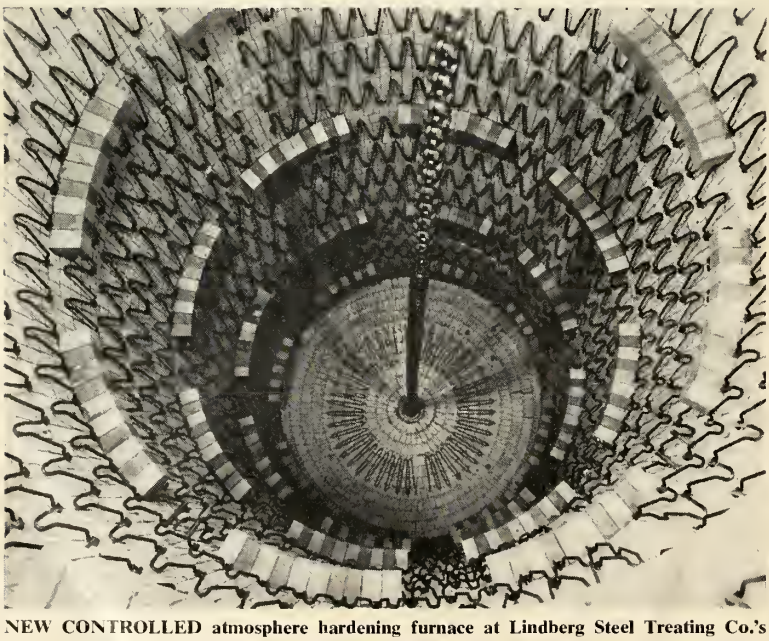
Opponents of the policy arg that it is the highroad to Americ defeat.

They contend that only the abili to destroy Russian military power w deter the Kremlin. For they conte no man can say that the Soviet leade would not be willing to pay 50 milli Russian lives . . . 75 million . . . 1 million . . . if that were all that sto in the path of world conquest.

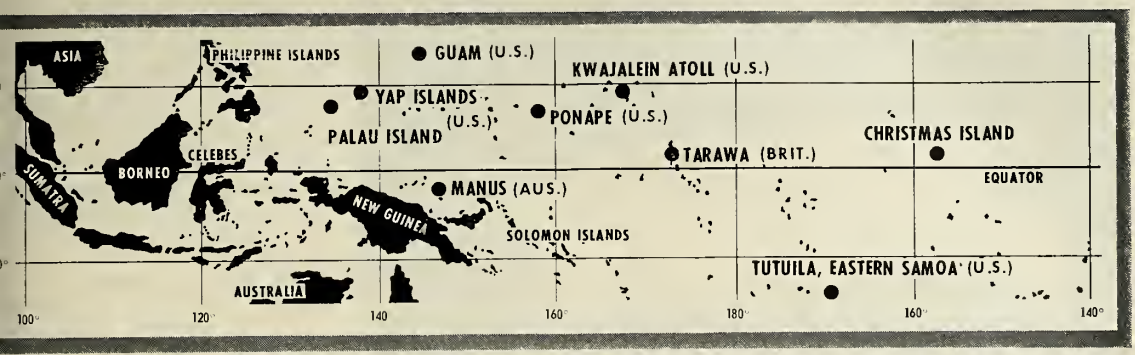
Therefore, they say the Defen Department today must be prepari the flexible forces that may be need to meet the unknown challenges tomorrow.

Key to such a flexible force is t ALBM.

New Furnace Capability



NEW CONTROLLED atmosphere hardening furnace at Lindberg Steel Treating Co.'s plant at Melrose, Ill. Furnace is big enough to take Boeing *Minuteman's* rocket motor case.



POSSIBLE ISLANDS for equatorial astronautics base.

U.S. Seeks Manus Launch Site

ARPA has engineering plan to spend millions on tying island into PMR; NASA may help in development of site when selected

by William E. Howard

WASHINGTON—Scorpion-shaped nus Island crouching a lazy jump n the equator in the far Pacific y be swept up soon by the Space c.

Unbeknownst to its 15,000 woolly- ed inhabitants, whose major pre- upations are growing coconuts and cticing *mana* (magic)—and some- es when things are very dull, can- alism—Manus is being eyed as an atorial rocket and satellite launch- site. All of which spells millions dollars more in support equipment construction.

The United States, M/R has ned, is formally approaching stralia to obtain permission to de- op and integrate the 20x50-mile canic island into the Pacific Missile nge. Australia holds trusteeship over nus. Embassy officials have in- ated they expect no obstacles when otiations reach the firm-up stage.

Just when this may be is uncer- n, for several other Pacific locations o are being considered. Among them the U.S. trust territory islands of au, Yap, Kwajalein Atoll and Pon- e; the U.S. possessions of Guam and tuila in Eastern Samoa; Britain's rawa Atoll, and Christmas Island, ose possession is disputed by the U.S. and Britain.

Second of a Series on MISSILE SUPPORT

Still another proposal being kicked around the Pentagon is to build Texas Towers in the mouth of the Amazon River. But experts are questioning the feasibility of this idea from the standpoint of both cost and size.

• **Money and time**—Authoritative engineering estimates put the cost of fully developing an island like Manus into a self-sufficient launching base at about $100 million—at stateside prices. In remote areas this figure would be multiplied by a construction cost index of 2.00 to 3.00 and it could go still higher if the project is enlarged or put on a crash basis.

And it would take over seven years to complete at an ordinary pace.

However, early launch capability, planners say, could be achieved for about $23 million (stateside) and in about four years. A task force undoubtedly could bring it about a lot sooner.

Significantly, ARPA hopes to establish a global communications network within four years with Project *Courier*, which would utilize a system of three 24-hour satellites moving in orbit 22,400 miles from the equator. Key to early attainment of this project would be an equatorial launching.

Although it would be possible to launch communications satellites from Cape Canaveral or Vandenberg AFB, it would require more than 40% of the payload to shift them into an equatorial orbit. Improvement in the state-of-the-art in guidance and propulsion also would be needed.

Thus, as one military official puts it, an equatorial launch would be "easier and cheaper in the long run."

• **Safety factor**—Development of one-million pound thrust booster rockets and their attendant safety problems also is spurring consideration of establishing launch facilities in a more remote area. Some missilemen fear this point may be proved when the first attempt is made this fall to fire ARPA's *Saturn* booster—a cluster of eight *Jupiters*—at the Cape. They are wondering what will happen to Cocoa Beach if the cluster explodes.

A third factor bearing on the building of one or more equatorial launch sites is the anticipated future acceleration of space programs. They could in a few years completely overtax present facilities.

In looking over possible Pacific



MISSILE NEEDS would rival World War II development of Manus as U.S. naval base.

locations, planners have established these criteria: The potential site preferably should lie within 5 degrees of the equator, although practical considerations such as international agreements and land availability should not rule out sites within 15 degrees of the equator; there should be maximum easterly overwater travel; it should be situated where existing, programmed and proposed tracking, control and communication facilities may be utilized, and the site should be large enough to support required installations. It would also be desirable for the U.S. to own or have a voice in the control of the area.

• **Elevation 3000 feet**—On nearly all counts, Manus more than fills the bill. Largest of the Admiralty Island group, it lies 200 miles north of New Guinea in latitude 2 degrees south and longitude 147 degrees east.

Important to rocket firings, the topography of Manus is hilly, with elevations ranging from 1500 to 3000 feet. Dense, tropical rain forests cover most of the lowlands, but higher areas are grassy and dotted with pine forests. Mean temperature is about 80°F, the mean relative humidity 85-90%. Rainfall averages 150 inches throughout the year.

Some World War II facilities have been restored, so that the island has an abundant water supply, power and sewage disposal facilities. The Australians also have installed a new wharf, dry dock and refueling facilities and repaved the 6000-foot airfield runway.

These physical advantages are far superior to those of Tarawa Atoll (Latitude 1° 30′ N Longitude 173° E) and Christmas Island (Latitude 2°N Longitude 157°W) which also are situated close to the equator. Tarawa's land mass is only 7¾ square miles compared to Manus' 1000 square miles. Its population is 3600, and while the harbor is good, there is a limited water supply. Christmas Island covers 160 square miles, but has limited water and only "fair weather" anchorage facilities. Its disputed ownership is also a drawback.

Kwajalein, already scheduled for *Nike-Zeus* testing, lies farther away from the equator at Latitude 9° N Longitude 167° 40′E. It is comprised of 80 small, low-lying, sandy islands, has an excellent anchorage in a 655 square mile lagoon, but limited water supply.

• **Other possible sites**—Ponape Latitude 7° N Longitude 158° E) and Palau (Latitude 7° 30′ N Longitude 134° 30′ E) are both U.S. trust territories. Ponape has a total area of 160 square miles and Palau, 216 square miles. Both, however, have quite large populations for their size and therefore present limited opportunity for development of a large installation and room for the operational force. The full complement for a launch site is envisioned as numbering 1200 scientists and technicians and 1700 dependents—a total of 3000.

Tutuila in Eastern Samoa (Latitude 14°S Longitude 170° 30′ W), another U.S. possession, extends over only 76 square miles and has a population now of 22,400. Otherwise it has elevations to 2140 feet and excellent harbor facilities. Guam (Latitude 13° 20′ N Longitude 144° 40′ E) offers 225 square miles, but already is crowded with a large U.S. naval installation and a population of 59,500.

Lack of water would be a restrictive factor on the Yap Islands (Latitude 9° 30′ N Longitude 138° 10′ E) along with available land. The area comprising four closely placed islands covers about 80 square miles and is hilly terrain.

Manus, on the other hand, offe the potential for supporting a lar population with its abundant wat supply and land area. As a down-ran subcenter of the PMR, it would well positioned geographically for n only equatorial, but the launching polar-orbited space vehicles. It cou also serve well as a logistic center f future down-range tracking stations.

An all-inclusive preliminary fea bility study of Manus has been ma by the Ralph M. Parsons Co., L Angeles architectural and engineerin firm, which conceives of developme progressing through five phases—star ing with task force capability.

To fit the island for launching the earliest possible date, there wou be a minimum of construction an maximum use made of governmen furnished portable facilities such oxygen generating plants, power ge erators and (bachelor) housing accom modations.

Over the long haul there would l a requirement for complete technica support and community facilities.

• **Launching complex**—Technic facilities embracing the launching bas tracking station and communicatio center would represent the biggest cas outlay—almost $10 million initially an about $34 million (stateside) to com plete.

The launch complex would includ pads, gantry, buildings for contro service and shops; fuel and oxidize storage; missile check-out and assem bly buildings; a warehouse; hydroge generation and oxygen-nitrogen liqu faction plants, and installations fo instrumentation and control systems.

The communications center woul require buildings for programming receiving and transmitting; an emer gency power plant; and antenn "farms" for transmitters and receivers

Tracking station facilities woul embrace structures for telemetry, dat processing, angle and optical trackers a boresight tower, antennas and trans mitters, and the instrumentation system

Support facilities, including supply maintenance and administration, woul be concentrated at Lorengau Harbo and nearby Mokerang Airfield. The would require in addition to warehous and storage structures, a tank farm pipelines and pumping station, dock and tanker unloading buoys.

More buildings would be needed t house administrative offices, personne and security offices, a laboratory, en gineering section, a fire station and the other necessities of a large base.

Whether such a comprehensive

n to change the face of Manus or ne other Pacific island becomes a lity, may be decided soon. ARPA icials are reported to be studying h a plan, and although no money s been budgeted yet for construction, agency could initiate engineering dies at any time. Such a site unubtedly would prove its value parularly in the *Dyna-Soar* program.

NASA also is known to be interested in an equatorial launching site, but is yet to demonstrate any wild enthusiasm—such as allocating money.

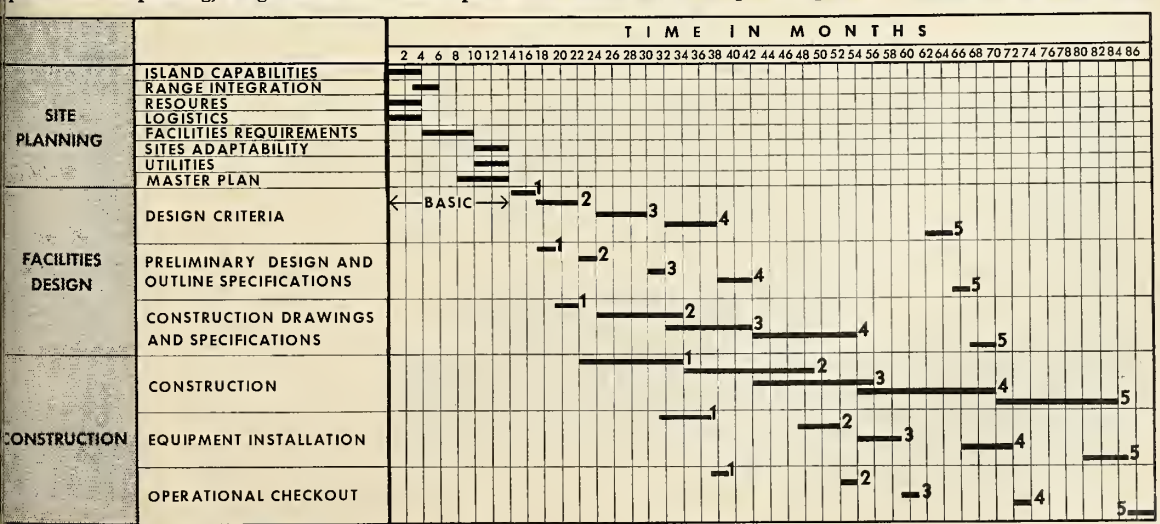
An official of the space agency, aware of the two-year lead time needed to get such a site ready for a shoot, told M/R that "as of this week, anyway" no programs scheduled during the next two years by NASA would absolutely require such a base. He said that an equatorial orbit would not help the *Mercury* manned space capsule project, because launch and recovery will be "much less" expensive and easier technically off the Cape.

Other NASA experts concede that they would be happy to see ARPA go ahead with a Pacific site. And in that event, NASA might help pay for it.

ESTIMATED COSTS FOR DEVELOPING MANUS ISLAND

	PHASE ONE CONSTRUCTION	PHASE TWO CONSTRUCTION	PHASE THREE CONSTRUCTION	PHASE FOUR CONSTRUCTION	PHASE FIVE CONSTRUCTION	TOTALS
CHNICAL FACILITIES						
UNCHING BASE	$8,400,000	$4,750,000	$3,950,000	$7,500,000	$3,750,000	$28,350,000
CKING STATION	520,000	500,000	1,100,000			2,120,000
MMUNICATIONS CENTER	1,030,000	400,000	850,000	580,000	600,000	3,460,000
	$9,950,000	$5,650,000	$5,900,000	$8,080,000	$4,350,000	$33,930,000
PPORT FACILITIES						
MINISTRATION	$ 780,000	$6,110,000	$1,400,000	$ 500,000	$ 510,000	$ 9,300,000
INTENANCE	500,000	885,000	200,000	250,000	300,000	2,135,000
PPLY	4,250,000	1,405,000	600,000	1,450,000	400,000	8,105,000
	$5,530,000	$8,400,000	$2,200,000	$2,200,000	$1,210,000	$19,540,000
MMUNITY FACILITIES						
USING	$3,200,000	$3,200,000	$4,120,000	$3,640,000	$3,640,000	$17,800,000
UCATIONAL			660,000		3,000,000	3,660,000
NICIPAL	250,000		1,000,000		50,000	1,330,000
LIGIOUS					340,000	340,000
RVICES	650,000	235,000	200,000	320,000	50,000	1,455,000
CREATIONAL	20,000	75,000	170,000	40,000	400,000	705,000
	$4,120,000	$3,510,000	$6,150,000	$4,000,000	$7,480,000	$25,260,000
ILITIES AND ANSPORTATION						
WER	$ 950,000	$6,700,000	$6,450,000	$ 450,000	$ 450,000	$15,000,000
TER	1,300,000	900,000	500,000	300,000	400,000	3,400,000
WERAGE	300,000	100,000	470,000	100,000	100,000	1,070,000
MMUNICATIONS	250,000	100,000	150,000	100,000	200,000	800,000
ADS	800,000	500,000	300,000	400,000	500,000	2,500,000
RFIELD						
LIPORTS						
RBOR						
	$3,600,000	$8,300,000	$7,870,000	$1,350,000	$1,650,000	$22,770,000
TIMATED STATESIDE COSTS	$23,200,000	$25,860,000	$22,120,000	$15,630,000	$14,690,000	
UMULATIVE ESTIMATED ATESIDE COSTS	$23,200,000	$49,060,000	$71,180,000	$86,810,000	$101,500,000	$101,500,000

OP TABLE shows estimated costs for five-step development of Manus into self-sufficient equatorial launch base. In table below quired time of planning, design and construction is plotted. Numbered lines correspond to phases of construction in upper table.



Senate Armed Services Committee has virtually dictated to DOD which missile interceptor system to continue —*Nike-Hercules* or *Bomarc*. The committee slashed $17.3 million from the $22.4 million request for *Nike* installations, but approved the full authorization for Boeing's *Bomarc*.

Manned space vehicle applications may be in sight for new "aerial bobsled" pilot ejection capsule developed by 18-member Industry Crew Escape Systems Committee under ARDC for the F-106 supersonic jet interceptor. Capsule is propelled from aircraft by 7000-pound-thrust solid-fueled rocket. Convair has $1.5 million contract to produce first units.

Smithsonian Optical Tracking Station at Woomera, Australia, on May 1, 3 and 4 photographed *Vanguard I* six-inch satellite at its apogee 2500 miles from earth with Baker-Nunn precision camera. Feat was comparable to photographing a golf ball from 600 miles away and indicates significant advance in tracking capability.

The first of three heat shields of laminated phenolic resins for *Mercury* space capsule has been delivered by General Electric to NASA. Shields will be tested in July.

Complete orbit of the Van Allen radiation belt will be possible with *Vega*, says Convair-Astronautics Manager J. R. Dempsey. The NASA space vehicle to boost large payloads into orbit would be capable of carrying powerful telemetering equipment to give more complete data about the belt. Dempsey says *Vega* also will be used to measure the gravitational fields of the moon and planets and the composition of the atmosphere of the planets.

Steel industry sources feel an alloy of chromium, nickel, molybdenum and aluminum may be the structural metal for the first manned lunar space craft. Relatively low in cost, the alloy withstands temperatures up to 1000°F and can be produced in large volume.

Navy reports "entirely successful" a stage-separation, flight control reactions and systems performance test of the Lockheed *Polaris* May 8. Range and impact were not primary objectives, but the solid-fueled missile traveled 700 miles. In addition, the Navy says a problem has been resolved in the missile's jetevators, which were affected by high temperature in earlier flights.

Keel of first U.S. nuclear-powered guided missile frigate—the Bainbridge —has been laid at the Bethlehem Steel Co. Quincy, Mass., shipyard. Besides twin surface-to-air *Terriers* mounted fore and aft, the high-speed 550-foot warship also will carry ASW weapons and conventional armament.

Marquardt Corp.'s Ogden, Utah, plant will begin delivering *Bomarc* engines on a fixed-price basis this month. At Ogden, the company also is starting up production on the Super *Bomarc* IM-99B engine. These will be cost-plus-fixed-fee units.

Solid-propellant production capacity of 500,000 pounds per month is now reported by Grand Central Rocket Redlands, Calif. The company says it has added about $2.5 million in new R&D facilities in the past eight months and revamped its top management.

East Coast-West Coast warfare over defense business is rocking Congress. Easterners have introduced legislation which the Westerners claim is directed at taking contracts away from California companies. Meantime, the Los Angeles Chamber of Commerce has whipped up a "task force" of city officials and manufacturers to "defend" the state's missile-aircraft industries.

Delivery of first thrust chamber for ARPA's *Saturn* H-1 cluster of eight *Jupiter* engines has been completed by the Rocketdyne Division of North American Aviation. Static firing of fully-assembled cluster at ABMA Huntsville, Ala., now reportedly is set for mid-October. First flight test may be attempted in the middle of next year at Cape Canaveral.

Cutter Laboratories Berkeley Calif., pharmaceutical firm, has acquired Olympic Plastics Co. of Los Angeles—a supplier of high-temperature plastics for missiles and rockets. Olympic management and personnel will remain unchanged by the merger.

A second X-15 is being built by North American Aviation to carry out the first powered flight of the rocket research aircraft. X-15 No. 1, which has been taken aloft in captive flight still must pass a glide test before the powered flight test of No. 2 airplane.

Satellite network to aid in the search and rescue of lost or stranded vehicles, nose cones and space capsules is being proposed by Space Electronics Corp. Doppler technique would be applied in locating signals broadcast by subminiature radio transmitter in the object sought.

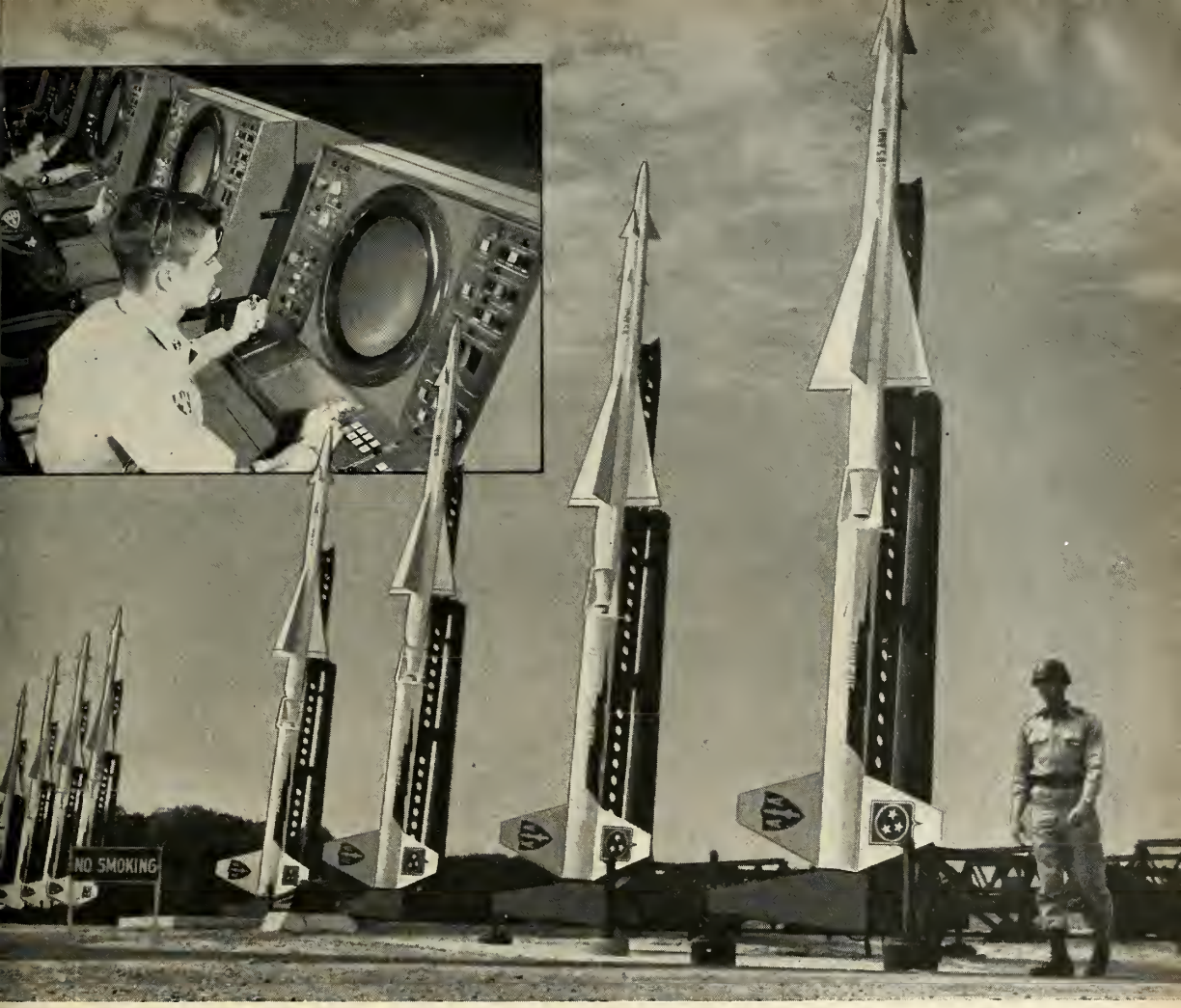
Firing of *Jupiter* IRBM May 6 by AF 864th Technical Training Squadron was to test complete missile operation in tactical configuration—including the warhead and fuzing apparatus working together as a system. The missile successfully completed its programmed 1500-mile flight.

Ryan Aeronautical Co. will break ground this summer for an electronics test facility at San Diego, Calif. New installation will support the company's electronics R&D program.

First Operational *Mace*



THREE TAC missile groups in West Germany are receiving the Martin *Mace*, 1000-mile range all-weather missile capable of delivering nuclear warhead. AF has programmed $193 million for *Mace*, which will be deployed in hard bases.



Martin electronics . . . eyes for missiles

The Missile Master is but one of many complex electronic problems solved by the men of Martin Orlando. Leaping into leadership in today's most dynamic field, Martin Orlando's mastery is soundly based on men with gray matter . . . men who cause new techniques to explode into existence . . . make the future happen today.

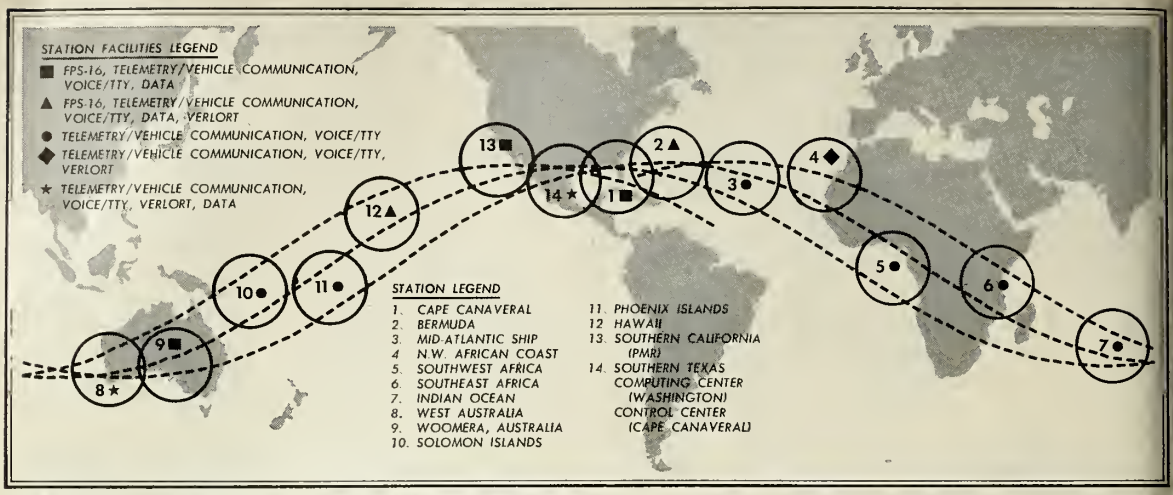
From a remote location, the Missile Master electronic control center detects approaching planes, determines "friend or foe", assigns targets for a whole ground-to-air missile battery and gives command to fire.

Martin's new R&D and production facility, located in beautiful Orlando, Florida, offers unlimited growth potential to the man who can make his mark in missilry and electronics. Gray matter is the priceless commodity we seek. Would you come and bring yours?

Senior level openings for Electronic Engineers, Physicists, and Electrical engineers in these design areas: pulse circuitry, electronic packaging, transistor circuitry, production test equipment, digital and analog computer. Opportunities for men experienced in calculating solid state parameters, molecular distribution and quantum mechanics. Send confidential resume to: J. F. Wallace, Director of Professional Staffing, The Martin Company, Orlando 34, Florida.

MARTIN
ORLANDO

A great name in electronics/missiles



ORBITS AND tracking station locations needed for planned range.

NASA's Project *Mercury* Range To Cost $12 Million Plus

World-wide tracking system with unprecedented reliability must be operating within year

by Paul Means and Hal Gettings

WASHINGTON—Final briefing on the Project *Mercury* Range contract is being given by NASA at Langley Field on May 18 for the 18 competing firms.

NASA hopes to award the contract, initially worth over $12 million, to the winning firm or team of firms by July 1. The range must be in operation by May, 1960, when orbiting of the first six dead loads and six animal loads will get under way.

Responsibilities of the Project *Mercury* range contractor will embrace integration of the entire system including the computers at the Goddard Space Center's temporary headquarters (NRL), the master control center at Cape Canaveral, the world-wide tracking system and the direct data relay lines.

The contractor's duties will also include construction of some of the 14 major stations on the range—three of them to be built at Hawaii, Texas and Bermuda—and integration into the system of 10 sub-stations, which may involve as many as five ships.

• **Unprecedented demands**—The integrated tracking, communications and telemetry facilities for Project *Mercury* will comprise the most complete global data link system yet devised. Requirements for the manned missile will demand links much more complicated and reliable than any needed for unmanned vehicles.

Super-accurate trajectory information, voice communication between vehicle and ground, a world-wide communications link, and complete reliability are all essential to the success of the project.

Plans are to use existing facilities wherever possible. But much new equipment will have to be designed and new facilities installed to complete the necessary instrumentation.

Tracking and communications will be required continuously during launch, post-insertion and re-entry, and periodically during orbit. The system must be adequate for emergencies with impact prediction always available and communication with the vehicle possible.

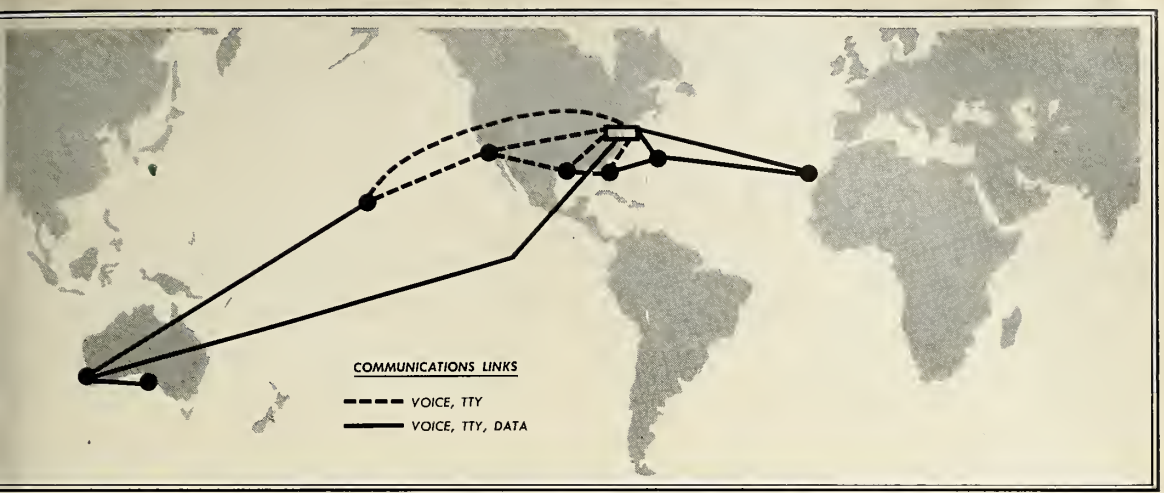
Basic range functions will include: (1) determination of vehicle location; (2) monitoring of vehicle and occupant status, and (3) abort and re-entry initiation control.

Radio communications with the vehicle will call for two voice channels (UHF and HF), one command, and two FM/FM telemetering channels.

Inter-station communications will include voice, teleprinter, and data circuits. Reliability requirements are 99.99% for the U.S.-Hawaii cable circuits and as high as the state-of-the-art will allow for overseas radio.

One of the best-kept secrets will be the frequencies on which the Project *Mercury* radios send and receive. This is to keep curious hams from tuning to the frequency and accidentally setting off the abort mechanism or making the capsule give other premature responses.

• **Hint of Cost**—Entire cost of the



DIRECT COMMUNICATION links needed between tracking stations and computing centers.

ange has not been announced, but revious NASA budgets provide $5,-50,000 for the construction of the outhern Texas station and $12,500,-00 for integration and construction f the range.

Final make-up of the *Mercury* ange will depend a great deal on its erformance during the deadweight nd animal payload orbits beginning n mid-1960. NASA officials think it ill take a year and a half of testing o prove the range, capsule and ooster.

Basic idea is to get the system to perate satisfactorily without manned ontrol of the capsule, so that the di-ect voice communications system and he astronaut's controls in the capsule ill be only added safety measures.

Ideally, the astronaut will not have o use any of the controls at his dis-osal, and NASA will not let man ide in the capsule until the system has roven that it doesn't need him.

Insert into the near circular orbit apogee 120 miles, perigee 110 miles) ill come about 400 miles north and ast of the Cape Canaveral launching ite. Retro-firing will commence on the hird orbit 600 miles from the West Coast, with impact in the Atlantic Ocean about 400 miles from Cape Canaveral.

Almost continuous tracking is eeded in order to get an accurate stimate of impact area at any moment hat the capsule needs to abort from ts orbit.

The orbit is designed to keep the stronaut over friendly territory at all imes so that the capsule can be re-overed regardless of where in the rbit it had to abort.

Meanwhile, training, indoctrination and education of the seven astronauts who will "fly" the *Mercury* capsule has begun at Langley Field, Va.

The initial phase of the program will include: 1) science education; 2) space flight familiarization; 3) operation of the *Mercury* vehicle; 4) participation in vehicle development; 5) high-performance aircraft flight training; 6) familiarization with support equipment and launch crew operation.

The program will use existing research, development, training, and test facilities of the armed services, industry, and educational institutions.

Mach 1400 Shock Waves Created

EVERETT, MASS.—Interplanetary shock waves, which travel at speeds in excess of 1,000,000 mph (Mach 1400), have been duplicated in the laboratory.

Using an electrical charge of 4,000,000 kilowatts in a 30-inch shock tube, scientists at Avco's Everett Research Laboratory successfully reproduced for the first time the thin shock waves which result from solar flares. A temperature of 1.5 million degrees was generated by the ionized gas wave which was contained within a magnetic "cylinder."

These fantastic conditions were obtained under the supervision of Dr. Arthur Kantrowitz and Prof. Thomas Gold. Dr. Gold first advanced the theory that interplanetary shock waves, generated by solar flares, were responsible for "squashing" the earth's magnetic field with great suddenness. He suggested that the shock wave travelled by collision of force fields surrounding hydrogen ions and electrons. The "thin" shock wave produced in the laboratory confirmed this theory.

Avco has been responsible for a great deal of the research work on reentry problems associated with the *Atlas, Titan,* and *Minuteman* missiles. Their advanced shock tube experiments have yielded much data on re-entry heating. The facility was the first to obtain the Mach 25 speeds needed for problem study.

Much of the hypervelocity research has been sponsored by the Air Force Office of Scientific Research in Cambridge, Mass.

Another significance of this experimental work lies in the clearer understanding of very high temperature (ionized) gas called "plasma," its nature and how to confine and direct it by magnetic fields. One and one-half million degree gas temperatures are obtained in the electric shock tube. At this temperature, all known matter would vaporize instantly. In the apparatus, this ultra hot gas is confined within a "magnetic wall."

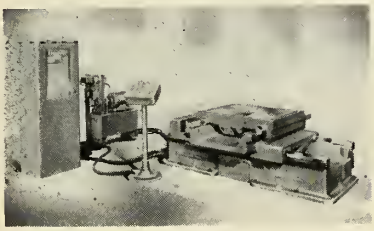
By using a rarefied mass of hydrogen, pushed by a magnetic field tightly confined in the shock tube on every side except one, velocities in excess of 1,000,000 miles per hour were obtained. The four billion watt electrical impulse needed to achieve this is produced by discharge from condensers in two millionths of a second.

The electric shock tube which produced this thin, high-speed shock wave was developed by Dr. Richard Patrick, an Avco physicist, expert in the young science of magnetohydrodynamics (MHD). Earlier experiments at the Avco-Everett Research Laboratory had obtained high temperatures in a "pill-box" apparatus which produced cylindrically converging shock waves in deuterium gas. Drs. G. Sargent James and Harry Petschek and Nelson Kemp, all physicists at the laboratory, are widely known for their contributions to current understanding of MHD.

Tape-Controlled Table Works to Millionth-Inch

A new positioning table capable of accuracy equal to the finest jig borer has been developed by **The American Tool Works Company,** for application to heavy-duty production drilling and boring jobs, both short and long run.

Numerically controlled by an endless punched tape, the 8000-lb. position table is of rugged construction. It can support heavy workpieces, positioning the work anywhere within a 30" x 20"



working area with an accuracy of ±.000250" (non-accumulative) on either axis, or repeating a position within ±50 millionths (.000050"). And, according to company engineers, the table can hold these accuracies even when installed out in the shop.

Unlike a jig borer or a spacer table with set stops or dials, the new machine is fast in positioning and does not depend upon the skill of the operator. The table travels automatically from one position to the next, moving simultaneously on both axes ("x" and "y") at the same speed from start to finish of movement—yet with no over-travel. Actuation is entirely hydraulic, eliminating both traversing screws or nuts and their associated back-lash problems and motors with their inertia problems. Because the hydraulic actuating cylinders are in a balanced closed circuit, the table is rigidly held in position when the pistons are at rest. There are no clamps to produce a shift in table position.

The new tape-controlled table, reports American Tool, is suited for job-lot runs, large or small. With the endless punched tape, as soon as one workpiece is complete the machine is ready for the next without rethreading of the tape. Intermediate positions on the endless tape cannot be lost, since the hole pattern, once punched, remains in proper relationship for the entire life of the tape—good for thousands of pieces. The tape's small size also facilitates economical storage.

The complete tape control system of the machine is housed in a pressurized cabinet, designed to keep out shop dust and dirt. An operator's control panel is mounted on a separate stand which can be moved about for maximum convenience.

A punched tape can be installed in the control system cabinet in a few seconds. It can be inserted under the reader in any position inasmuch as the control unit will automatically locate the "start." This "start" is usually the loading position directing the table to travel to its furthest front position. This permits the operator to load and unload his workpiece with a hoist, if needed.

During operation, the punched tape is read pneumatically by a flow of low-pressure air. This air, passing through the holes in the tape, actuates a selected series of switches, signalling the electronic control system where the positioning table is to move (in terms of "x" and "y") to arrive at the next working location. The electronic circuits then actuate the machine's hydraulic system to perform the required travel.

Feed-back signals—which tell the electronic system (product of **The Sperry Gyroscope Company)** where the table is presently located and announce its arrival at the new position—are supplied by two Farrand electronic scales, one each on the "x" and "y" coordinates. Each scale is made of glass with embossed wiring, and is read by a slider which maintains a .005" air space away from the scale surface. By virtue of this air gap, wear of any kind is prevented. These electronic scales are located in two hermetically sealed housings.

The use of air pressure for reading the punched tape prevents elongation or opening up of the punched holes and preserves accuracy of the original tape. There are no mechanical steel tape-reading fingers of any type in the system. The same air pressurizes the control cabinet, keeping out dust and dirt.

Circle No. 238 on Subscriber Service Card.

Valve Assembly Features Titanium Bellows

Packless valve stem assemblies with seamless bellows made of titanium, believed to be the first ever made from the light metal, are being produced for a homogeneous reactor project at Oak Ridge National Laboratories by Fulton Sylphon Division, **Robertshaw-Fulton Controls Company.**

The assemblies are being used in an all-titanium primary reactor loop de-



signed to carry a highly corrosive uranyl sulphate solution at high temperature and pressure.

Experiments showed that gold-plated bellows were unsatisfactory.

Performance requirements for the bellows assemblies were unusually high. They called for operation at 300°C at pressure of 2500 psig (constant), with 1/8" stroke, spring rate not over 1250 lbs. per inch. Outside diameter of the finished bellows is about 1¼".

Problems in manufacture of the bellows concerned basic difficulty in forming titanium, due to its low elongation properties. The bellows were made from grade 55 sheet titanium.

Circle No. 239 on Subscriber Service Card.

Safety Claimed for Bi-fluid Tester

Amthor Testing Instrument Co. announces "the first successful bi-fluid tester, type 472, that can test oxygen equipment, and still employ oil or glycerine in the separate piston-cylinder chamber, without any danger or hazard."

The Amthor BI-FLUID tester offers critical performance in testing all types of equipment that might present the same problems as oxygen equipment.

Constructed with a 2-piston hydrau-

From drawing board conception to outer space performance—CDC offers complete responsibility. Building systems on paper is one thing. Building them in the shop is another. Hardware currently performing in the upper atmosphere and out in orbit attests to the fact that CDC does both, and does them well. CDC offers you across-the-board services in rocket and missile systems: propulsion, electronics, telemetry, instrumentation and ground support. One responsibility for all! Cooper Development Corporation
2626 South Peck Road, Monrovia, California
A SUBSIDIARY OF MAR-JAROT AIRCRAFT CO.
GET THE FULL STORY IN OUR HANDSOME 32-PAGE BROCHURE—YOURS ON REQUEST



SCIENTISTS, CREATIVE ENGINEERS—INVESTIGATE THIS FIELD WITH A FUTURE. CHALLENGING WORKING ENVIRONMENT IN SOUTHERN CALIFORNIA.

lic hand pump, this new tester, the company claims, surpasses any other previous tester in operating performance due to its ease of operation. The volume per stroke of the large pump piston is approximately 8 times greater than that of the small pump piston, thereby allowing quick filling of the unit under test. The large pump piston automatically becomes inactive with increasing pressure, thus enabling the operator to create 10,000 P.S.I. with approximately 17 lbs. hand pressure.

This new BI-FLUID design is said to be economical, accurate and safe and eliminate the possibility of contamination and risk of oxidation. Pure water which may be used as the hydraulic fluid for the gauge or unit under test is easily removed and never reused; thus production time is saved, while the use of oil or glycerine as the hydraulic fluid for the piston-cylinder assures accurate and sensitive performance.

Circle No. 225 on Subscriber Service Card.

Pressure Control Snap Switch Is Marketed

United Electric Controls Co. now offers an aneroid absolute pressure control which incorporates a double-throw, high-temperature-witbstanding, snap-action switch, for rockets and missiles. This small, rugged, lightweight control is ideal wbere space and weight are important factors.

For specifications covering this type of controls and other pressure and temperature controls manufactured by UE, write to the company.

Circle No. 226 on Subscriber Service Card.

Instrument Measures Material Erosion Rate

A new technique for measuring erosion is provided by **Era Engineering Inc.'s** Material Erosion Rate Instrument (MERI). This instrument will measure the thickness of any material under free flight or laboratory conditions. The output is in the form of an electrical signal which can be recorded on magnetic tape or telemetered to a remote receiver.

This new technique for continuous thickness measurement consists basically of impregnating a small element of the eroding structure witb a radioactive material and measuring the resulting radiation as a function of time. The radioactive material is uniformly distributed throughout a small cylindrical hole drilled perpendicular to the surface to be studied.

As the surface is removed, the activated material is carried away in proportionate amounts. The output of the instrument is a direct measure of the amount of activated material remaining as a function of time and thus a measure of the thickness as a function of time. For any given material (metal, metal oxide, plastic, etc.), a binder with essentially the same physical and thermal properties as the original material can be procured to hold the few micrograms of radioactive emitter used. This insures that the surface of the activated plug coincides with the surface of the structural material.



The MERI consists of a small detector probe, electronic circuitry for measuring the radiation level, and an activated plug. The entire system is subminiaturized and has been tested for operation in a rocket vehicle environment. It can be supplied with internal batteries, or can operate from external power supplies.

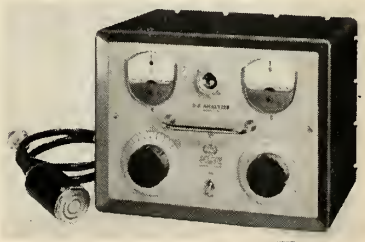
Circle No. 227 on Subscriber Service Card.

D-K Analyzer Detects Contaminants

Delsen Corp. has developed the "D-K Analyzer," a portable, nondestructive, direct reading instrument which measures the dissipation factor and dielectric constant of any non-conductive media. Several probe forms are available which facilitate use of a single instrument for measurements of both solid and liquid media.

The instrument can be used to investigate effects of processing and formulation variables on the dielectric properties of solid insulating materials, to detect non-uniformities in the electrical properties of insulators, and to inspect incoming materials for both uniformity and conformance to standards.

In many cases tbe "D-K Analyzer" can be used to detect the presence of moisture or other contaminants in solids, powders or liquids, as well as to measure the dielectric properties of electrical insulating liquids such as transformer oils. As a tool of the physical chemist, dielectric properties can be used to distinguish between isomers of the same organic compound to detect tbe presence of weak organic acids, and to detect moisture in many organic liquids.



The "D-K Analyzer" is available as a battery-operated unit for portable use, or as a laboratory instrument with a plug-in power supply. In either form the "D-K Analyzer" measures 9" x 12" x 9" and weighs less than 15 pounds.

Circle No. 228 on Subscriber Service Card.

Coaxial Switch Fits In Small Package

The Miniature Coaxial Switch series was developed by the **General Communication Company** to provide the characteristics of its Standard Coaxial Switch series in the smallest possible package.

Features are:

High reliability, low VSWR, low crosstalk, low input impedance and long life.

Dimensions: 3-7/32" height x 1-1/2" diameter. Electrical Characteristics: frequency range—0 to 6000 mc.; VSWR—1.3:1 max. to 6000 mc.; insertion loss—less than 0.2 db at 1000 mc.; less than 0.5 db at 6000 mc.; RF Power Rating—100 watts at 3000 mc.; voltage rating—500 volts peak; crosstalk—greater than 60 db at 1000 mc.; greater than 40 db at 6000 mc.; impedance—51 ohms; operating voltage—20 to 30 volts DC; operating current—1.5 amp. max. at 28 volts.

Mechanical Characteristics: type—single-pole, two-position; operative life—100,000 cycles minimum; temperature range— −55°C to +55°C; switching rate—40 cycles per minute; switching time—0.15 second; RF connector—Type N; Power connector—Type GS02-10SL-3P-113; weight—12 ounces.

Circle No. 229 on Subscriber Service Card.

Eder-Lite Speeds Flaw Detection

The Eder-Lite made by **Eder Instrument Co.,** is a miniature transformer in a cylindrical handle that fits in the palm of your hand. Slender extensions of various lengtbs screw into this transformer. A tiny tungsten bulb is threaded to fit into tbe extension. Using various extensions and bulbs, you can assemble exactly the ligbting unit you need for your work. The different extensions and bulbs are interchangeable and can be used with a

What the eye would see on the other side of the moon has intrigued and defied the imaginations of scientific minds for centuries. But there's another way to look at moon trips—from a very much down-to-earth point of view. The Space Age is built upon the ingenuity and capabilities of American scientists and engineers who have solved the myriad problems of the space arts—propulsion, stabilization, and control of launching vehicles—and the transmittal, reduction, and analysis of data so that man can comprehend the scientific import of his achievement. The Telecomputing Corporation, through the specialized activities of its six divisions, has contributed significantly to advancements in each of these areas of the space arts. Look to the skills, experience, and facilities of Telecomputing for the solution of your control and data processing problems. Write today for your copy of the TC story—"Blueprint For Progress."



DIVISIONS AND SUBSIDIARIES
OF TELECOMPUTING CORPORATION

BE — BRUBAKER ELECTRONICS An R & D leader in the field of ground and airborne IFF components, test & checkout equipments—IFF systems analysis—Air Traffic control systems—radar beaconry—detection equipments.

WG — WHITTAKER GYRO Leading producer of electrically driven and spring-wound free gyros, rate and floated rate gyros for advanced missile systems—rate of roll, pitch, and yaw indicators for manned aircraft—bank and turn indicators.

DI — DATA INSTRUMENTS Pioneers in equipments for fast and accurate analysis of test data, with automatic recording of punched cards, tapes, or printed lists—for aircraft and missile flight tests, industrial and scientific applications.

ES — ENGINEERING SERVICES Specialists in rapid, accurate reduction and evaluation of military and commercial data. Currently handling data reduction for daily missile firings at Holloman Air Force Base.

WC — WHITTAKER CONTROLS The largest developer and builder of custom-built high-performance hydraulic, pneumatic, and fuel valves, controls, and regulators for advanced missile, aircraft, and industrial applications.

NI — NUCLEAR INSTRUMENTS Designers and builders of high quality, reliable equipments for prelaunch checkout and testing of nuclear special weapons.

TELECOMPUTING CORPORATION
915 North Citrus Ave., Los Angeles 38, California

TC

Circle No. 13 on Subscriber Service Card.


NEW AVCO RESEARCH CENTER



Space age research gets a new headquarters

One of the largest and best-equipped research facilities in the nation is the new 16-million-dollar Avco Research Center at Wilmington, Massachusetts. Here, research and development in space age technology is already being conducted in areas ranging from missile re-entry to satellite design. From work such as this—and equally important work at the nearby Avco Research Laboratory—will come further contributions to national security and the conquest of space!

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY

Avco

AVCO MAKES THINGS BETTER FOR AMERICA / AVCO CORPORATION / 750 THIRD AVENUE, NEW YORK 17, N.Y.

single transformer for different jobs. The Eder-Lite slender extension tubes fit through holes, inside crevices, around corners. Use a flexible tube, semi-flexible, or rigid tube of various lengths and angles. You get a bright beam of light right on the area you are examining.

Mirrors provide vision and illumination around corners and curves and through holes (such as spark plug holes in engines). The new 1/8" diameter Eder-Lite will get light into the tiniest crevice. Magnifiers provide light and 10-time magnification for precision work. The "Bull's Eye" attachment gives a beam instead of diffused light.

Eder "directed light" eliminates glare. The illuminated inspection area stands out by contrast, improving visibility. The metal housing also protects the light bulb from breakage and prolongs its life.

Circle No. 230 on Subscriber Service Card.

Electron Diffractograph Offered For Metallurgy

A new model of the Trueb, Taeuber Electron Diffractograph is announced by the United States distributors, **New England Scientific Instruments Co.** This instrument is useful for research on the structure of materials. It is currently being used in solid state studies, in metallurgy, in chemistry, and in many other applications. It is valuable for the study of thin layers and of surfaces including changes induced thereon by processes of friction, lubrication, polishing, corrosion, temperature variation, catalysis, radiation damage, chemical agents, phase changes and so on.

The diffractograph can be used either for direct observation of the diffraction pattern on a fluorescent screen or for photographic recording. Photographs can be taken on plates, roll film, or on a special cinematic camera which permits structural changes to be continuously recorded. The observation chamber has three viewing ports with a fluorescent screen three inches in diameter which can be pivoted externally.

The instrument contains a metal discharge tube with a cold cathode of effectively infinite life which generates the electrons. The beam is accelerated through a variable potential of 20 to 50 KV applied to an anode diaphragm which is positioned in a self-centering cone. The beam axis adjustments are easily made by means of independent plane and spherical movements of the alignment sections. The beam diameter is less than 10 microns which results in an optical line width of less than 100 microns. Specimens more than an inch in diameter can be introduced into the air lock and studied under variable temperature conditions up to 900°C, a continuous measurement of the temperature being provided by a thermocouple element. The sample can be moved and rotated so that its entire surface can be explored. A special device has been provided to neutralize the charge which would otherwise collect on the sample during an exposure.

The Trueb, Taeuber Electron Diffractograph is suited for the currently used methods of electron diffraction study: Debye-Scherrer, Kikuchi, convergent beam of large aperture, paral-

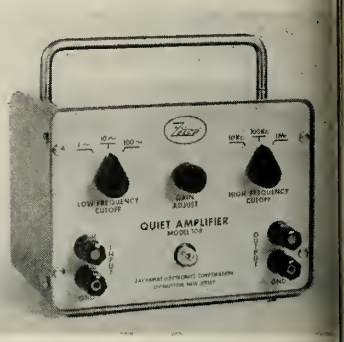


lel beam and so on. Two electromagnetic lenses of variable focal length make possible the following arrangements: focussing on the fluorescent screen for powder diagrams, focussing on the sample for small beam diffraction, focussing above the sample for shadow microscopy, observing an image of the sample at 50 times magnification, and observing magnified reflections from the sample.

Circle No. 231 on Subscriber Service Card.

Quiet Amplifier Has Varied Use

The model 108 Quiet Amplifier of **Zacharias Electronics Corp.** is an ultra low noise instrument which features a gain of 100 over a frequency range of 1 cycle-per-second to 1 megacycle-per-second. The equivalent input noise is 1.5 microvolts maximum for a 10 kilocycle bandwidth anywhere between 10 cycles-per-second and 1 megacycle per second, and 4 microvolts maximum for a 100 kilocycle bandwidth. An input impedance of 8 megohms minimizes loading of circuits under test. The 600 ohm output impedance is suitable for driving a wide variety of loads. A maximum output of 10 volts RMS is available for high level applications. Selectable low-frequency and high-frequency cutoffs further improve the sensitivity of the instrument when the entire bandwidth available is not required. Typical applications of the model 108 include its use as an ultra-sensitive preamplifier for null detection apparatus, A-C vacuum tube voltmeters, oscillographic and magnetic tape recorders, medical and geophysical electronic instruments, accelerometers and many types of transducers.



Circle No. 232 on Subscriber Service Card.

'Thumper' Cable Shows Insulation Faults

Associated Research Inc.'s "Thumper" is a device used to pinpoint within a few feet defective insulation determined through high-potential testing of electric power cables, or faults developed in service. This precision fault locating is achieved regardless of length of cable by the conversion of high-voltage, low-current output of a DC high-potting instrument into a high-voltage, high-current impulse supply.

A sphere gap is adjustable from the outside of the unit so that the breakdown voltage may be varied to suit the fault of the cable being tested. The test potential and repetition rate of the pulse voltage may be varied to suit existing conditions. The exact location of the fault may be determined in many cases by moving along the cable and listening for the point at which the tracer signal breaks across the fault.

The "Thumper" Fault Locator is rated at 25 KV. The great available energy permits high instantaneous peak currents which result in an extremely loud discharge, even though the fault is some distance from the point of test.

This instrument is designed for use as an accessory with any DC high-voltage breakdown tester or power supply.

The unit is approximately 15" wide x 5" deep x 15" high and weighs about 90 pounds. Price is $995.00.

Circle No. 233 on Surbscriber Service Card.

what is entropy?



Heat lost except at absolute zero?

A measure of disorder?

A statistical probability of state?

The gradient of a scalar?

Macrocosmic phenomenon or microcosmic, too?

The fundamental concept of entropy is involved in many phases of our technology. Hence we have a fundamental need to know everything we can about its significance. This knowledge is critical to our work of energy conversion.

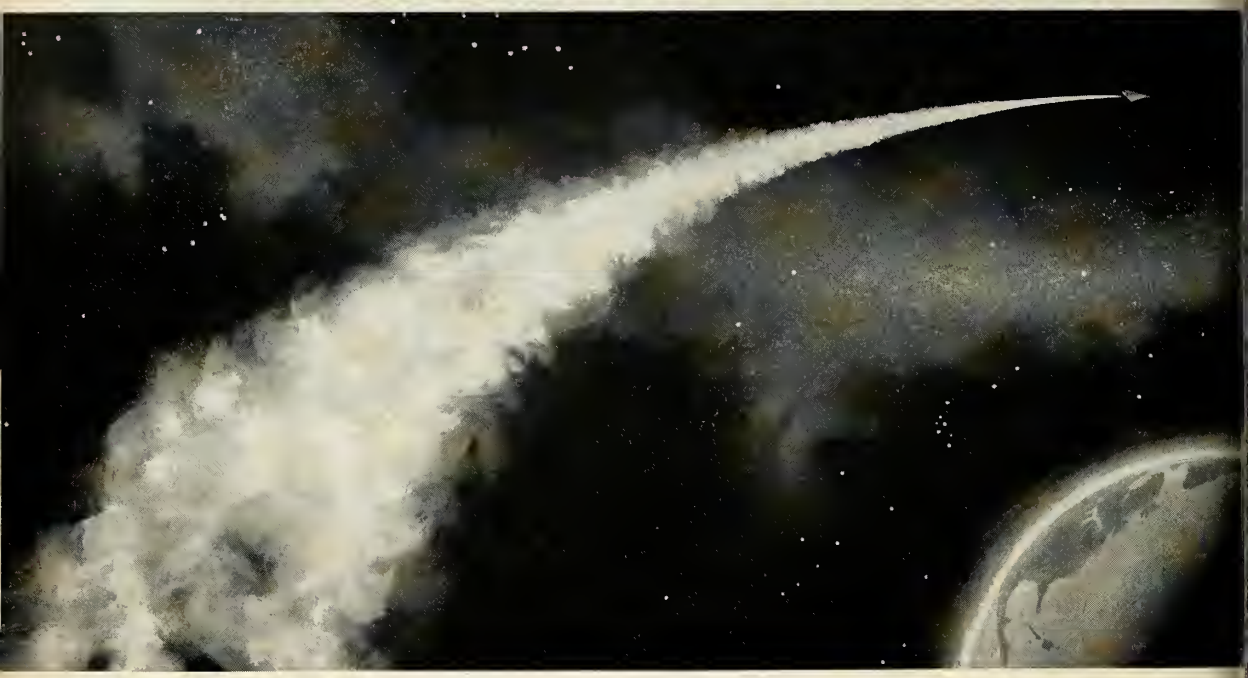
Thus we probe and inquire, search without wearying — call upon the talents of General Motors Corporation, its Divisions, and other individuals and organizations — for a complete appreciation of all phases of scientific phenomena. By applying this systems engineering concept to new research projects, we increase the effectiveness with which we accomplish our mission — exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business

ALLISON

Division of General Motors,
Indianapolis, Indiana

DYNA-SOAR



Dyna-Soar (for dynamic soaring) is a joint project between the Air Force and the NASA, and is an attempt to solve the technical problems of manned flight in the sub-orbital regions. Advance knowledge on the project indicates how a boost-glide vehicle can operate from the outer fringes of the atmosphere where it can maneuver and be recovered undamaged. Studies show that by varying the original rocket boost, and thus the velocity, and with the control available to the pilot, the Dyna-Soar aircraft can circumnavigate the earth, followed by a normal and controlled landing. Boeing Airplane Company, one of the competing companies for the development contract for the complete boost-glide system, has delegated to RCA the responsibility for the development of important electronic components of Dyna-Soar.

RCA Tmk(s) ®

RADIO CORPORATION of AMERICA

DEFENSE ELECTRONIC PRODUCTS
CAMDEN, N. J.

Circle No. 14 on Subscriber Service Card.

Top Scientists Find *Argus* Opening New Avenue of Experimentation

First detailed discussion of historic tests confirms theories of Christofilos, who calls for further projects

by Charles D. LaFond

WASHINGTON—Three small A-mbs, detonated high in the atmos-re over the South Atlantic in the mmer of 1958, created a new avenue scientific experimentation.

The significance of the experiment, w well known as *Argus*, was stagger-. For the first time in history, geo-sical phenomena on a world-wide le could be measured and related to quantitatively-known cause. This, of rse, was the injection into the th's magnetic field of a known quan- of electrons of known energies at rticular time and position in space.

The results of this experiment con-ed the theories presented to the ernment in a proposal for the ture by Nicholas C. Christofilos in 7. Although the overall story of *gus* was broken earlier this year, ly recently have the details been re-sed. This is a summary of the whole ies of events we now call the *Argus* eriment.

• **History of effort**—Prelude to *gus*, according to Dr. Richard W. rter, Chairman of the Technical nel of the Earth Satellite Program the U.S. Committee for the Inter-tional Geophysical Year, was pro-led by the first U.S. IGY satellite, *plorer I*, launched on Jan. 31, 1958. e existence of a belt of high-in-sity corpuscular radiation near the th was discovered accidentally while mary cosmic rays were being mea-ed in the upper layers of the atmos-ere.

Telemetered data indicated that the ellite was passing through regions of h high intensity that the counting cuits, including the Geiger-Mueller e itself, were saturated. The levels d lower limit for the radiation mag-ude were established approximately

The joint space symposium at the 96th Annual Meeting of the National Academy of Science, co-sponsored by the American Physical Society and the National Aeronautics and Space Administration, drew upon the aristocracy of this nation's scientific community.

Response to the symposium was overwhelming. Open-to-the-public advance notices resulted in standing room only in the Academy's Great Hall and latecomers were queued out of the building.

Discussion of the problems, recent results, and future research in space science were presented in three principal sections: a detailed discussion (for the first time) of the Argus experiment, and a two-part program on problems in space exploration.

by subsequent laboratory comparative studies. Data from *Explorer III* in March, 1958, further substantiated the earlier findings.

Preliminary conclusions on existence of a radiation belt by Dr. James A. Van Allen and his staff at the State University of Iowa were presented before the Academy last year. The belt, beginning at just beyond 1000 miles from the earth's surface, was postulated to extend another 2000 miles in depth (outward).

Because the observed intensity increased so rapidly between 700 and 1000 km, it was concluded that the primary radiation was being restrained or trapped by the earth's magnetic field and thus consisted of charged particles with energies much less than those associated with cosmic rays.

To continue the research, the IGY Committee requested and received two additional *Jupiter C* vehicles. Of these, only *Explorer IV* attained orbit.

At the same time that IGY planning was in progress for *Explorer IV*, Advanced Research Projects Agency of the DOD was planning the *Argus* experiment. Thus, Dr. Porter made it clear that despite erroneous reports *Argus* was a Pentagon project, not IGY. The confusion resulted from the fact that *Explorer IV*, although intended to gather natural radiation phenomena, would also be in a position and was instrumented to measure the artificially-produced radiation to be injected by the *Argus* effort.

On Aug. 27, 1958, the first *Argus* nuclear blast occurred, producing a 1 to 2-kiloton yield (altitude 480 km; long. 12° W, lat. 38° S). This was the first of three rockets to be fired from the U.S.S. Norton Sound in the South Atlantic.

As *Explorer IV* continually passed through the *Argus I* artificial radiation shell, its radiation instruments measured and reported to ground stations the absolute intensity and position of the trapped radiation. Electron-density rate of decay as a function of altitude and observations of shell thickness were studied to provide a better understanding of natural radiation electrodynamics.

Two more firings on Aug. 30 and Sept. 3 resulted in similar recorded phenomena.

Near the end of September—its batteries exhausted—*Explorer IV* sent its last observation. The intensity at that time was barely discernible above the natural radiation background.

• **Original proposal**—As has been fully reported before, the proposal for detonating a small thermo-nuclear bomb in space originated with Christofilos of the Livermore Radiation Laboratory, University of California, in October 1957. His proposal, in short, was based on these theories:

• Charged particles released in the



Bloodhounds ready for launching during acceptance trials at Woomera

EFFECTIVE

More advanced Bloodhound for defence of UK confirms particular suitability for European defence needs

Already in operational service with the RAF and adopted by non-NATO Sweden, Bloodhound Guided Weapon System is now to be further developed for the RAF.

This developed Bloodhound possesses substantially increased operating range and altitude, with advanced technique ensuring still greater lethality at these increased ranges and heights. Low altitude performance is further improved to counteract the threat of low-flying targets.

By developing Bloodhound to meet a threat, the RAF is making use of an existing system which obviously economic and operational advantages.

Proved in many hundreds of test firings; built Europe's largest missile-manufacturing complex; particularly suited to European defence needs, Br Ferranti Bloodhound forms *the world's most effecti fence system now and for many years to come.*

Security forbids publication of full details, but following facts about Bloodhound can now be given:

WEAPON DESIGN AND CONSTRUCTION BY BRISTOL · GUIDANCE AND CONTROL BY FER



CROWN COPYRIGHT RESERVED

DEFENCE

r. The Bloodhound is powered by two Bristol
y ramjets—jet engines with no moving parts.
s ensure power and range flexibility, burn kero-
e simple and safe to handle.

ng System. Semi-active: i.e., ground crew directs
eam on to target, which is reflected to a receiver in
ound, ensures highest accuracy—regardless of
Missiles may be fired, singly or in salvoes, using
e radar.

me. Employs unique and advanced monoplane
wing configuration—two advantages: quicker
re precise response, as well as greater accuracy of
interception; superior at high altitudes. This configuration was selected at initial design stage to embody maximum development potential.

BRISTOL/FERRANTI
Bloodhound
GUIDED WEAPON SYSTEM

BRISTOL AEROPLANE CO (USA) INC
400 PARK AVENUE, NEW YORK 22, NY

E ILLUMINATING RADAR BY BTH · SYSTEM SALES ORGANISATION BY BRISTOL AIRCRAFT LIMITED

earth's magnetic field would be trapped under certain conditions; thus, it might be possible to extrapolate the electron-layer idea into a global experiment.

• By its nature, an A-bomb burst releases very energetic electrons. These, injected at one point in the atmosphere, could follow the earth's magnetic lines. A portion of these electrons would be trapped in the magnetic field and thence oscillate in a north-south direction.

• Because electrons in this field would drift eastward, an A-bomb burst could envelop the earth with a thin shell of trapped electrons.

• Moreover, within a relatively short time, scattering and diffusion would dissipate the radiation shell. Calculations indicated a survival time for the radiation shell of the order of several days with proper burst position and altitude.

• Finally, calculations showed that the desired effect could be established and measured using a small A-bomb.

The Christofilos proposal to carry out such an experiment was examined and accepted as feasible by a scientific review group; the decision to proceed with the experiment by ARPA was made in April, 1958.

• **Initial planning**—The detection instruments and associated electronics for the *Explorer IV* satellite were designed and produced within Dr. Van Allen's department of physics at the State University of Iowa. As indicated earlier by Dr. Porter, the instruments were designed around the dual need for studying both the natural and the artificially injected radiation belts. A breakdown of the characteristics of the detectors employed is shown in Table 1.

To meet numerous requests from readers, M/R has made available reprints of the recent series of articles by Dr. S. Fred Singer on the meaning of Project Argus. Copies of the combined series may be obtained by writing to the magazine. The rate is 50¢ for a single order (bulk rates on request).

In addition to their cognizance over detection instrumentation, the Van Allen group also studied and made recommendations for firing sites. Several considerations led to the choice of bomb-burst sites, said Van Allen:

• Safety reasons demanded an isolated firing area.

• To maximize trapped particle lifetime, an intermediate latitude was needed to permit comprehensive observations. A low latitude would decrease lifetime because of particle collisions in the denser air. At a high latitude, the corresponding magnetic line of force extends farther from the earth in the equatorial plane. Perturbations in the extremities of the geomagnetic field would cause a decrease in trapped life time.

• The radiation-shell position had to permit satellite interception at a low altitude and through an orbit inclined at a maximum of 51° to the equatorial plane. (This was a practical limit imposed by the existing U.S. facilities at that time.) Also, an intermediate latitude was preferable because the satellite orbit would intercept the shell at a less oblique angle.

• Since it was known that the natural radiation intensity diminished rapidly at a given altitude with distance northward or southward from the magnetic equator, background radiation would be less at an intermediate latitude.

• In the South Atlantic, the scalar magnitude of the geomagnetic field is less than that at any other point on earth at intermediate latitudes. Therefore, trapped lifetime of charged particles, for a given burst altitude, would be longest there.

• A good observation site near the point conjugate to the firing point was needed—preferably an island. (The Azores met these requirements.)

• **Observations**—During the month preceding *Argus I* (July 26 to Aug. 26), many observations served to establish the detailed spatial dependence of the natural, trapped radiation and many of its properties in terms of the characteristics of the detectors devised for the two-fold observation program, Van Allen said.

The geometric relationships between the orbit of *Explorer IV* and the chosen magnetic shell are easily calculated in theory. In a favorable case, the satellite orbit would intersect the *Argus* shell four times during each revolution around the earth. These intersections would be at various altitudes, latitudes and longitudes.

Van Allen indicated that in practice the number of observed intersections from which significant data were obtained was much less than four per orbit due to a variety of reasons (i.e. low altitude, shell tilt, excessive radio range, points of relatively high background radiation).

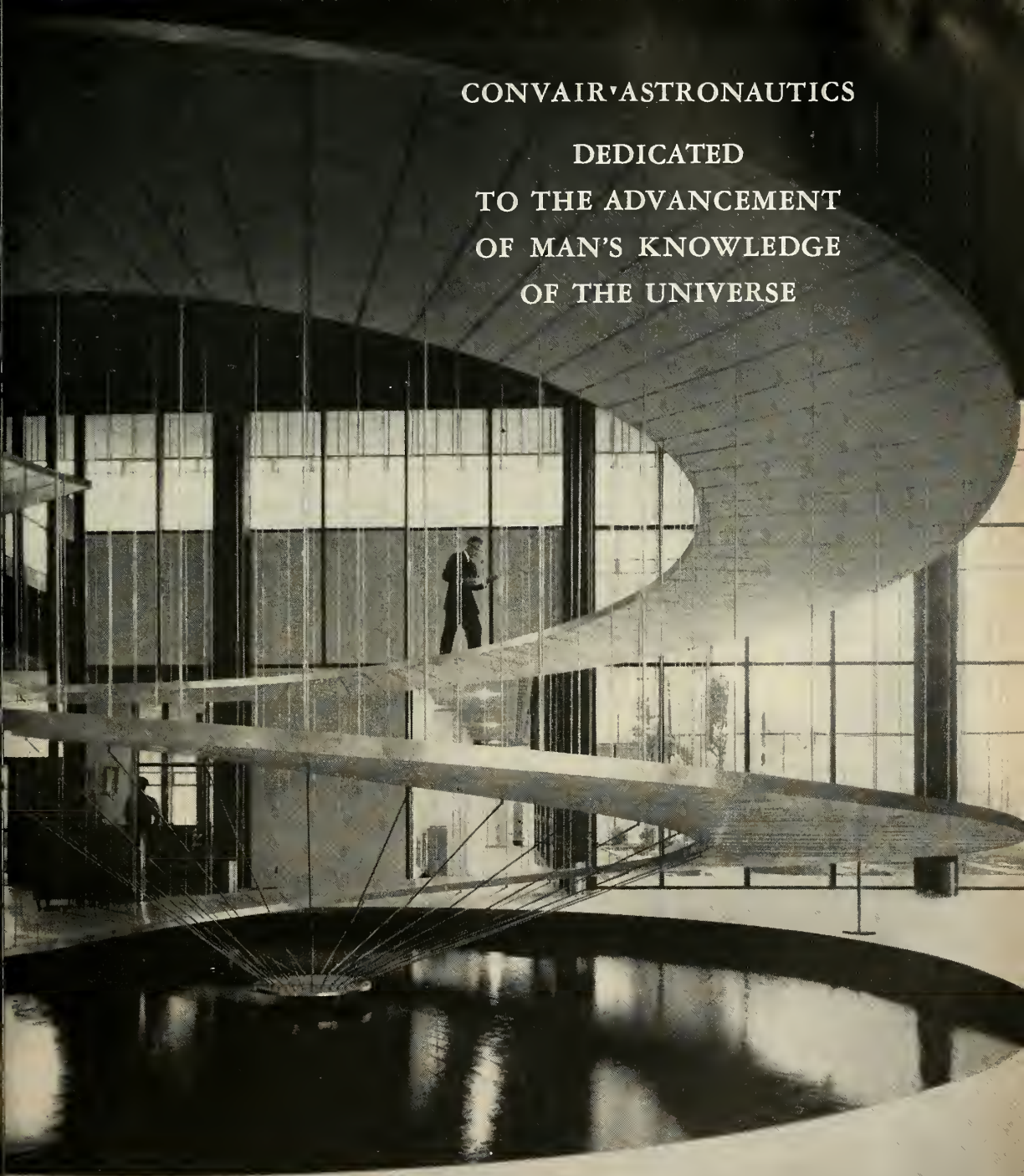
Supplementing the use of *Explorer IV* for observing the *Argus* effects, the Air Force Special Weapons Center participated with Project *Jason*. This consisted of firing a series of five-stage solid-propellant, high-altitude sounding rockets from three primary sites: Cape Canaveral, Wallops Island, Va., and Ramey AFB, Puerto Rico. To measure background radiation prior to *Argus*, a preliminary firing from Patrick AFB was accomplished on Aug. 15, 1958.

• **High success**—Thirteen successful firings were accomplished in all (out of 19) during the *Argus* effort. Each delivered a 50-lb. payload to an average 550-mile height. Instrumentation consisted of eight Geiger counters employing varying shielding and different degrees of collimation (to observe

TABLE I. Summary of Detector Characteristics
(Explorer IV)

CHANNEL	DETECTOR	SHIELDING	SENSITIVE TO:	GEOMETRIC FACTOR
1	Geiger-Mueller counter (Anton 302); cylinder approximately 7mm x 9mm	1.2 g/cm² Fe + 1.6 g/cm² Pb (minimum)	Electrons of E > 5 Mev; Protons of E > 40 Mev; X-rays of E > 80 kev; with low efficiency	Omnidirectional geometric factor 0.14 cm² for min. stopping power; 0.82 cm² for penetrability 7 g/cm²
2	Plastic scintillator 0.76 cm dia., 0.18 cm thick; pulse detector	0.14 g/cm² of aluminium over window	Electron of E > 580 kev; Protons of E > 10 Mev. Axis to detector ⊥ to payload axis	0.040 cm² steradian for min. stopping power; 4.2 cm² steradian for penetrability > 5 g/cm²
3	Same as Channel 1 except less shielding	1.2 g/cm² Fe (minimum)	Electrons of E > 3 Mev. Protons of E > 30 Mev. X-ray of E > 20 kev with low efficiency	Omnidirectional geometric factor 0.14 cm² for min. stopping power; 0.70 cm² for stopping power > 5 g/cm²
4	Cesium-iodide Crystal 0.76 cm dia., 0.20 cm thick; total energy-d.c. electrometer	1.0 mg/cm² of nickel and aluminum over window	Electrons of E > 20 kev; Protons of E > 400 kev; X-rays Axis to detector ⊥ to payload axis	0.0235 cm² steradian for min. stopping power; 4.4 cm² steradian for penetrability > 5 g/cm²

Circle No. 35 on Subscriber Service Card.



Engineers and scientists interested in working on the Atlas and Centaur projects are cordially invited to submit a resume for professional evaluation to Mr. G. N. McMillan, Engineering Personnel Administrator, Department 130-90

CONVAIR | ASTRONAUTICS
Convair Division of
GENERAL DYNAMICS
5517 Kearny Villa Road, San Diego, California



MinIRcooler developed by ADL. Available from Hamilton Standard for IR applications. High altitude glove by David Clark Co., Inc., courtesy of U. S. Air Force.

The ADL MINIRCOOLER

maintains IR detectors down to –350°F

Detection of very long wave length infrared or extremely small temperature differentials requires that IR cells be cooled to cryogenic temperatures. The ADL MinIRcooler provides closed-cycle refrigeration to –350°F. in a miniaturized, low-pressure (300 psia), lightweight system of high reliability —

— the only moving part below ambient temperature is a tiny plastic piston!

Hamilton Standard Division, United Aircraft Corp., has been licensed exclusively for manufacture and sale of the MinIRcooler for IR applications above –405°F.

ADL is now developing similar devices for spot cooling at temperatures down to –420°F.

See the ADL MinIRcooler in the ADL Display at the National Space Age Industry Show, Washington, D. C., May 25-29.

Arthur D. Little, Inc.

CAMBRIDGE • CHICAGO • SAN FRANCISCO • NEW YORK • WASHINGTON • SAN JUAN • EDINBURGH

You may be interested in the following literature:

☐ *Specification Sheet* — ADL MinIRcooler.

☐ *"High-Temperature Research in Space-Vehicle Design,"* P. E. Glaser.

☐ *"Cryopumping for High Vacuum With Low Power,"* Bruce M. Bailey & Raymond L. Chuan, Fifth National Vacuum Symposium.

☐ *"A New Technique for Measuring the Spectral Emissivity of Solids at High Temperatures,"* P. E. Glaser & H. H. Blau, Jr., *Journal of Heat Transfer.*

☐ *"Superconductive Switching Circuits,"* A. E. Slade & H. O. McMahon, Proceedings of the National Electronics Conference.

☐ *"The Optimization of Research: Management's Use of Change,"* James M. Gavin, delivered before American Management Association.

Your request will receive the prompt attention of
Director of Public Relations, Arthur D. Little, Inc. • 24 Acorn Park, Cambridge 40, Mass.

ngular distribution of electron flux). Telemetry gear was also included. The package was designed and constructed by Lockheed Missiles and Space Division.

In a cooperative effort by AF Cambridge Research Center and Stanford Research Institute, an additional program was instituted for observing side effects of *Argus*. Artificial aurora, radio propagation characteristics in the VLF range, and ionospheric absorption all were observed and analyzed.

The observation of auroral ionization was performed using two radar equipments (backscatter sounders) operating at a frequency near 27 mc. One was installed on the U.S.S. Albemarle, operating south of the Azores; the other on a U.S. Navy vessel (not identified) near the detonation area.

For the VLF observations, several locations were used employing a broadband receiver, loop antenna, magnetic tape recorder, and associated calibration equipment. Each setup was similar to the whistler recorders used in the IGY program. Signals from radio stations GBZ-England (19.6 kc), NPG-Seattle (18.6 kc), and NDT-Japan (17.1 kc) were analyzed for variations in signal strength.

Three IGY riometer stations, on frequencies near 30, 60, and 120 mc, were used to measure ionospheric absorption in the higher frequency band. The antennas were vertically-directed, three-element, Yagi arrays of approximately 60° half-power beamwidth.

• **Results**—In all, the *Explorer IV* made 162 passes through the radiation shell during which significant data were obtained. The three radiation shells were determined to be from 70 to 220 km thick at the low altitude of observation. Also, Van Allen observed that the *Argus* shells occurred within the "slot" between the two natural radiation zones, probably because atmospheric density is anomalously high there.

This radiation-free zone may have been explained in a recent paper by Dr. Alexander J. Dessler, a scientist of the Lockheed Missiles and Space Division. A weak spot in the earth's magnetic field known as the "Capetown Anomaly" is approximately 1000 miles long by 300 miles wide. Dessler theorized that radiation particles, reflected back and forth in the magnetic field, fall into this area and are absorbed by the atmosphere below. Radiation in this area is 1/30 the intensity of the lower Van Allen radiation belt.

Although the exact cause of the radiation decay has not been deter-

high-energy fuel briefs from Callery

Plenty of HiCal® by August 1, for authorized users—HiCal high-energy fuel production will run well ahead of immediate military test program requirements for the next few months. So Callery will have substantial quantities of HiCal-3 available for authorized users about August 1. If you have been waiting to test HiCal-3 in engines or components, write now for specific information. *New HiCal-3 Handling Bulletin is available on request.*

Lower-cost Diborane from Callery—Production quantities of Diborane are available from Callery at recently reduced prices. Investigations now under way on new process economies will mean even lower prices in the near future.

NASA awards contract to Callery for rocket propellant study—NASA has just announced the Government's first major contract award to Callery Chemical Company for research and development work in the field of rocket propellants. The NASA contract is to determine feasibility of a radically new propellant system.

New HiCal-3 fire-fighting film available for loan—This film shows the relative ease and safety with which a stable mechanical foam blanket can be established over burning HiCal liquid.

Handling of pyrophoric fuels—A new bulletin summarizes safe-handling practices for Triethylborane and Tri-*n*-butylborane. Also available: a 15-minute Triethylborane-Tri-*n*-butylborane fire-fighting film.

R & D on fuels and propellants —Callery's credentials in this demanding field record over ten years of successful studies in fuels and propellants. A limited number of new projects can be handled by Callery now in the area of fuels and propellants, component testing, inorganic and organometallic chemistry. Your inquiry is invited.

Callery to open new office in Los Angeles—Sometime in June, fuel and propellant users in the Los Angeles area can contact Callery's Dr. R. G. Brault, Market Development Engineer, for helpful technical service. Dr. Brault formerly was coordinator of high-energy fuel projects in Callery's R & D program.

For information or loan of films, write to Defense Products Dept., Callery Chemical Company, 9600 Perry Highway, Pittsburgh 37, Pa.

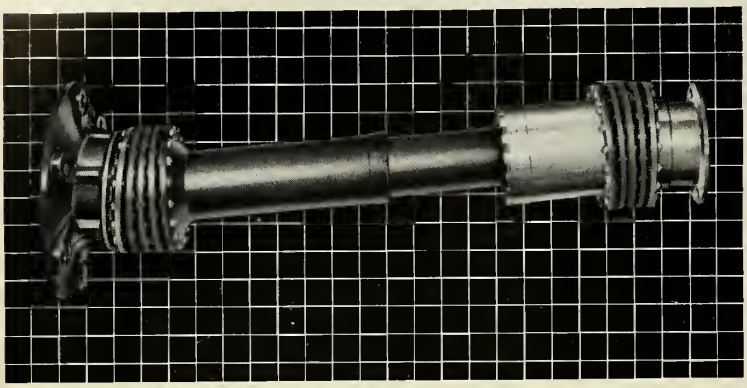


CALLERY CHEMICAL COMPANY
9600 PERRY HIGHWAY PITTSBURGH 37, PENNSYLVANIA

Dr. Robert G. Brault
Market Development Engineer
Defense Products Department
Callery Chemical Company

Circle No. 17 on Subscriber Service Card.

BENDIX FLEXIBLE POWER DRIVE SHAFT SOLVES MISALIGNMENT PROBLEM



POSSIBLE IN-USE DEFLECTION *of a Model 19E29-3 Flexible Drive Shaft. This standard 20-inch-long unit weighs 12 pounds, is rated 42.5 h.p. at 2800 RPM to 11,000 RPM, and includes a torque limiting clutch.*

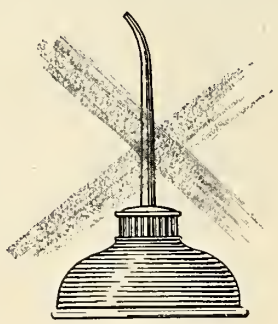
Transmission of power to accessories mounted remotely from aircraft engines is no problem when one of Bendix Utica's flexible drive shafts is used.

High speeds are possible . . . because of symmetrical shaft design. Two constant velocity ratio flexible joints, made up of high alloy steel diaphragms, permit up to plus or minus 10° intermittent deflection and plus or minus 5° continuous deflection while maintaining rotational balance in the shaft at any speed.

High operating temperatures won't affect efficiency of a Bendix Utica shaft. Unique joint design permits continual operation at maximum speed, at any temperature up to 600° F.

We can solve virtually any power take-off problem using one of our standard or special design flexible shafts. Special designs can be engineered for unusual applications involving almost any degree of misalignment and power/speed requirements. A mechanical disconnect can be provided integral with the shaft to disconnect driven accessories from the driving source.

We've gained wide experience in successfully solving all kinds of intricate drive shaft problems. No matter what your aircraft power transmission problem, you'll get the best answer to it from Bendix Utica.



NO LUBRICATION NECESSARY

NO LUBRICATION *is required for flexible torque carrying members. The flexing diaphragms transmit load, with no rubbing or sliding surfaces. They generate no frictional wear and little heat, resulting in long shaft service life.*

West Coast: 117 E. Providencia, Burbank, California
Canada: Aviation Electric, Ltd., 200 Laurentien Blvd., Montreal, Quebec
Export Sales and Service: Bendix International, 205 E. 42nd Street, New York 17, N. Y.

Bendix Utica Division
UTICA, NEW YORK

Bendix AVIATION CORPORATION

Circle No. 18 on Subscriber Service Card.

mined, it is however, a composite of both atmospheric and magnetic effects, he said. "A very rapid drop in intensity of *Argus I* and *Argus II* on Sept. 4 suggests that the great solar magnetic storm of that date may have caused a greatly enhanced rate of loss of stored particles."

The attempt by Project *Jason* to observe the electron shell produced by *Argus I* was not entirely successful, although some data was obtained. Following *Argus II*, a total of ten rockets were fired successfully and much information was obtained. The rockets penetrated the shell at an altitude of 200 to 300 miles. A region of very high radiation was observed to be about 12 miles thick, although increases in radiation levels were observed 400 miles to either side. Both the width and location of the shell remained constant (plus or minus five miles) for the period of observation which was 100 hours. This extreme constancy, considering the fact that electrons traveled from north to south more than a million times or drifted around the world more than one hundred times, verified hypotheses as to the earth's magnetic field and the character of space as far out as one earth's radius. Also, a narrow region of intense counting rate was observed, initially 100,000 times normal.

Analysis of the data indicated the intensity of the shells decayed approximately inversely as the time from the burst. This is consistent with the theory that the electrons are predominantly lost through scattering in the atmosphere near the mirror points.

According to the Air Force, the angular distribution of the flux was measured and the electron flux was observed to be confined to a plane within the resolution of the counters (plus or minus 15°). Rocket orientation was determined by analyzing telemetry signal strength records; it was thereby determined that the plane of the flux was perpendicular to the magnetic field lines (plus or minus 5°). This measurement confirmed the supposition that the electrons were trapped. The energy spectrum was measured and found to be deficient in high-energy electrons when compared to a fission beta spectrum.

Auroral radar echoes were obtained on all three explosions by radar near the launch end and on Events I and III by the radar near the Azores. Negactive results on the Albermarle's radar for Event II were probably caused by unfavorable location of the ship. The echoes appeared within seconds after the explosion at the launch radar, and



How To Specify Ground Communications For a Missile Base

First, consider the supplier's experience and reputation. DuKane Corporation, pioneer in electronic communication systems, has installed ground communication equipment on such bases as White Sands, Patrick AFB, and Fort Churchill . . . *Second*, get help from an expert. DuKane's engineers are ready to help you. They've had wide experience in all phases of communications, including giving direct help to architects and consulting engineers in designing systems to meet any combination of needs . . . *Third*, consider equipment and flexibility. Of all the manufacturers of voice communication equipment, only DuKane offers a truly complete selection: intercom, public address, paging, background music, private automatic telephone, wireless paging for key personnel, emergency and evacuation systems, and hospital communication systems—in any combination to form an integrated system of any size, a few stations to hundreds.

For missile base ground communications, come to the experts . . . Write or wire DuKane Corporation, Dept. MR-2, St. Charles, Illinois. If you specify electronic equipment, ask also for DuKane's chart of electronic equipment symbols.

DuKane CORPORATION
St. Charles, Illinois

Job-engineered sound installations . . . Flexifone intercom systems . . . Private automatic telephone systems . . . Hospital communications systems . . . Ionovac hi-fi tweeters and ultrasonic generators . . . Sound slidefilm projectors for education and industry . . . Electronic production facilities for industry and for defense.

Circle No. 19 on Subscriber Service Card.



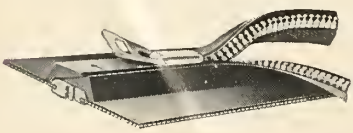
Zippered nose cone cover foils moisture, dust, abrasion

To protect the polished finish of missile nose cones from assembly to countdown, B. F. Goodrich fabricated unique zippered "all-weather" Nose Cone Covers for Avco's Research and Advanced Development Division.

Made from neoprene coated nylon fabric, this shipping cover has non-rigid neoprene ribs and spacers that keep it from riding down on the cone. Special B. F. Goodrich Pressure Sealing Zippers provide easy access and removal—yet seal positively against dust, dirt, grime, damaging impact.

B. F. Goodrich was asked to engineer this special project because of its widely-known ability to manufacture coated fabrics to any shape or size—as in aircraft baggage panels. In addition, the space-saving B. F. Goodrich Zipper—used widely for air ducts, inspection ports, access doors, and aileron gap seals—withstands any pressure up to the maximum strength of the zipper itself. And it, too, can be fitted to complex contours.

Tricky sealing problems like this one are just part of the day's work at B. F. Goodrich. Next time you have such a problem and need an answer—fast—write or call *B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. MR-59, Akron, Ohio.*



B.F.Goodrich ***aviation products***

Circle No. 20 on Subscriber Service Card.

somewhat later, although less than a minute, at the conjugate region radar. Echoes were observed in one case for one hour and fifteen minutes at the conjugate region radar, and in one case for five hours at the launch region radar.

The radar echoes moved outwards in range, and although initially there was a single well-defined echo, at some stages in the echo development more than one trace was visible, and the echo at times became widely spread in range. It is believed probable that part of the time a sporadic ionization patch existed, producing "ground-scatter" echoes; however, it is believed that most observed echoes were directly back-scattered from field aligned irregularities.

A combination of visual auroral observations and the radar records permitted the location of the conjugate magnetic point to be determined; this measured conjugate point agreed with theoretical expectations to within about 100 km.

• **Signal changes**—VLF recordings of GBZ in England taken in the Azores and in Spain showed abrupt decreases in signal strength, following *Argus II* and *III*, amounting to from 6 db to 12 db. At Stanford, signals from NPG in Seattle and NDT in Japan were analyzed for Events II and III. Both showed slight increases in signal strength for some minutes following the explosions.

A possible explanation for these observations is that the electrons scattered from the *Argus* shell (and near the conjugate area the ionized debris) changed the ionization in the lower ionosphere, apparently penetrating to low heights near the conjugate area and producing absorption.

All riometer units operated satisfactorily during the experiments, but results were negative in the sense that no significant absorption increases were recorded following the *Argus* effort. The measurements demonstrated that although there was sufficient perturbation of the ionosphere to produce reduced signal strength or absorption of VLF signals, the perturbations were either not large enough or not widespread enough to be detectable on equipment sensitive to absorption in the high-frequency range.

As a result of the satellite particle-counting experiments in the *Argus* effort and comparison of electron density in the trapped electron shells with counting rates in the Van Allen belts, it is now believed that the level of synchrotron noise from the *Argus* experiments should have been below the



DIT-MCO Is Faster and More Reliable Than Other Methods

Toke tape reod-out tests, for exomple. This method requires extro mochines to tronslote test informotion or o genius to remember the code used on the tope. Either woy, it's o costly process. Compare this to the DIT-MCO Automotic Circuit Anolyzer ond its exclusive Motrix Chort.

The DIT-MCO Circuit Anolyzer performs the entire test itself. There's no need for complex mochines to tronslote test informotion. All doto concerning errors, circuit numbers, type of flows, etc., oppeors on the Motrix Chort, so there's no need for complicoted wiring diogroms or chorts! And, the DIT-MCO Circuit Anolyzer checks one circuit ogoinst oll others . . . over 2,000 in obout three minutes . . . with occurocy never before possible in ony test system.

Some testers ore o moze of colored, floshing lights. Operotors of such test mochines must refer to 100, 500 or even 1,000 minioture lights to try ond locote errors. Chorts ond diogroms must olso be used . . . with o resultont high number of humon errors.

The DIT-MCO Circuit Anolyzer injects humon decision into every test but in such o woy thot chonces of humon errors ore nil. The eosy-to-reod Motrix Chort employs only two lights to quickly pinpoint every circuitry flow. Yet, onyone, with less thon one hour's instruction, con operote the DIT-MCO Automotic Circuit Anolyzer ond perform test functions once thought impossible!

These ore just o few reosons why DIT-MCO is foster ond more relioble thon other methods in electricol circuitry tests. Why not get the complete story? Write todoy for free Motrix Chort booklet.



DIT-MCO, INC.

ELECTRONICS DIVISION

Box 05-28, 911 Broadway
Kansas City 5, Missouri

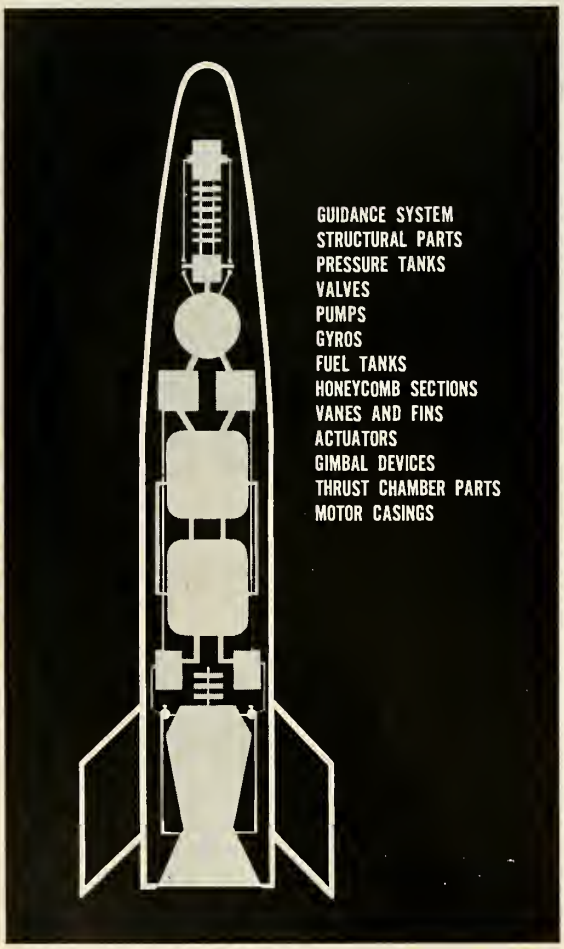
Partial List of DIT-MCO Users

Aircroft Rodio Corp. • AiReseorch Monufocturing Co. • Americon Bosch Armo Corp. • Americon Mochine & Foundry Co. • Americon Motors • Amphenol Electronics Corp. • Autonetics, A Division of North Americon Aviotion, Inc. • Bell Aircroft Corp. • Bendix Aviotion Corp. • Boeing Airplone Co. • Cessno Aircroft Co. • Chonce Vought Aircroft, Inc. • Chrysler Corp. • Convoir • Douglos Aircroft Co., Inc. • Dukone Corp. • Electronic Products Corp. • Foirchild Aircroft Division • Fornsworth Electronics Co. • Fronkford Arsenol • General Electric Co. • Generol Mills, Inc., Mechonicol Division • Generol Precision Loboratory, Inc. • Goodyeor Aircroft Corp. • Grummon Aircroft Engineering Corp. • Hozeltine Electronics Division, Hazeltine Corp. • Hughes Aircroft • Internotionol Business Mochines Corp. • Jefferson Electronic Products Corp. • Lockheed Aircroft Corp., Missile Systems Division • Mortin, Boltimore • Minneopolis-Honeywell, Aeronouticol Division • Motorolo, Inc. • Northrup Aircroft, Inc. • Pocific Mercury Television Mfg. Corp. • Rodio Corp. of Americo • Rodioplone Co. • Roytheon Monufocturing Co. • Servomechonisms, Inc. • Sikorsky Aircroft • Sperry Gyroscope Co. • Summers Gyroscope Co. • Sun Electric Co. • The Swortwout Co., Autronic Division • Temco Aircroft Corp. • Thompson Products • Topp Industries Inc. • Trons World Airlines • U. S. Novol Air Stotion Overhaul ond Repoir Depots • U. S. Novol Ordnonce Loborotory, White Ook • Vertol Aircraft Corp. • Western Electric Co. • Westinghouse Electric Corp.

Circle No. 21 on Subscriber Service Card.

New steels are born at Armco

17-4 PH
Armco 17-7 PH Stainless Steels
PH 15-7 Mo
HELP INSURE RELIABILITY



Armco's Precipitation-Hardening Stainless Steels help insure production of reliable missile components because they possess a unique combination of properties.

Armco's space-age metals provide—

High strength-weight ratios

Minimum tensile yield strengths in the heat treated condition:
Armco 17-4 PH (H 900)—170,000 psi
Armco 17-7 PH (RH 950)—190,000 psi
Armco PH 15-7 Mo (RH 950)—200,000 psi

Good corrosion resistance

Superior to the standard hardenable stainless steels, eliminates the weight and cost of surface protection.

Excellent fabricating characteristics

Easily formed in the annealed condition on standard equipment, weldable, and heat treatment is simple. Economical producibility means more hardware per dollar.

Available in all forms

Commercially produced in the form of sheets, strip, foil, plates, bars, wire, and billets. Can be forged or cast.

Use the advantages of these reliability-insuring Armco Stainless Steels in the missile components you produce. Their performance has been proved in a wide range of parts for all types of missiles. Write Armco Steel Corporation, 1969 Curtis Street, Middletown, Ohio, for complete data on properties and fabrication.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Circle No. 22 on Subscriber Service Card.

detectable level. The riometer experiments during *Argus* provide confirmation that the noise level was in fact below the level of conventional cosmic noise radiometers even in the 30-mc frequency range. No detectable increases in noise levels were observed on the riometers which were operated in the *Argus* experiments.

• **Further analyses and tests**—Data received from the *Argus* experiments are not completely analyzed, but Van Allen said the work will continue at the S.U.I. Data Reduction Center. All of the theories postulated by Christofilos appear to have been verified in the experiment. Based on the almost unqualified success of the *Argus* project, Christofilos said that repeated tests of this kind are needed to obtain more data on the earth's magnetic field, the polar aurora borealis, and many other geophysical phenomena. It already has been useful interpreting the Van Allen belt, he said.

Christofilos emphasized the harmlessness of using small A-bombs in space with respect to creating a radiation hazard to manned space travel. But he warned that bombs of megaton strength would create a radiation menace of lethal dosage (400 roentgens) to a satellite-borne man within 3 hours.

New High-Temperature Carbon Theory Formed

BERKELEY, CALIF.—Scientists at the University of California have formed a corrected theory of the behavior of carbon at extremely high temperatures. The data is considered highly useful in the operation of nuclear reactors and may have a bearing on operation of nuclear rocket engines.

According to Dr. Kenneth S. Pitzer, Dean of the College of Chemistry at U.C., present nuclear reactors have not been operated at temperatures and efficiencies allowed by the graphite structural components. This is laid to the lack of knowledge concerning the temperature ceilings of graphite.

Previously, it was assumed that when carbon is heated to temperatures high enough to vaporize it, heat drives the atoms apart so that the resulting gas is composed almost entirely of single carbon atoms, with a few molecules composed of two atoms.

A theoretical study of the problem by Dr. Pitzer and Dr. Enrico Clementi —assuming that the carbon gas is in contact with and in equilibrium with solid carbon—finds that above 2000°C there should be very few single carbon atoms.

NEW PROGRAMS

have created

IMMEDIATE OPENINGS

for top quality engineers with experience in—

Preliminary Analysis
Aerodynamics
Flight Dynamics
Structural Dynamics
Aero-Thermodynamics
Flight Simulation
Space Communication
Space Instrumentation
Radar Systems & Techniques
Electronic Countermeasures
Guidance
Instrumentation
Electronics Test
Design
Computing
Reliability
Human Factors

Well paid jobs for qualified people.

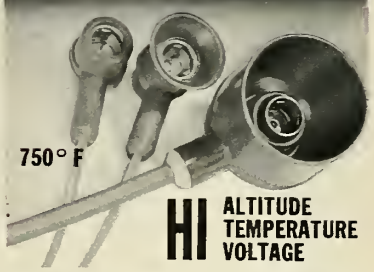
Relocating expenses paid.

For information on these and other engineering positions, write:

B. J. Ralph, Dept. 451 M
Missile Division
North American Aviation, Inc.
12214 Lakewood Blvd.
Downey, California

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.

SILICONE INSULATED TUBE CAP CONNECTORS



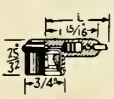
HI ALTITUDE TEMPERATURE VOLTAGE

This is a new series of Tube Cap Connectors using special silicone components for high reliability applications. They provide the highest degree of resistance to temperature extremes and are virtually unaffected by ozone and corona. The excellent dielectric characteristics make them ideal for high voltage. Skirts and sealed-in leads guard against flashover at high altitudes. Additional features include anti-corona cup and long-life spring contacts.

Clip this out—keep handy for part numbers and specs on connectors below for either ¼" or ⅜" top caps. Prefix 90 for ¼"; 91 for ⅜". Lead wire 18" long from center of cap or length to your specs.



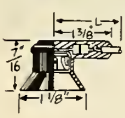
=90 or 91SCCSL beryllium copper contact, cadmium plated nests in anti-corona cup. Silicone rubber insulation throughout.



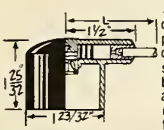
=90 or 91SCCRSL beryllium copper contact, cadmium plated nests in anti-corona cup. Silicone rubber insulation throughout. Takes up to one watt resistor — specify value and tolerance.



=90 or 91SCCOSL beryllium copper contact, cadmium plated nests in anti-corona cup. Skirt clings to tube — guards against flash-over. Silicone rubber insulation throughout.



=90 or 91SCCORSL beryllium copper contact, cadmium plated enclosed in anti-corona cup. Skirt clings to tube — helps suppress corona—guards against arc-over. Takes up to one watt resistor. Specify value and tolerance.



=90 or 91CCSTLRL beryllium copper contact, cadmium plated nests in anti-corona cup. Glass-filled silicone insulation on cap; silicone rubber on lead. Long skirt for arc-over. Takes up to 2 watt resistor. Specify value and tolerance.

Besides new silicone types — Alden provides a complete series of connectors for ¼", ⅜" and 5/16" cap in your choice of phenolic, mica, polyethylene, nylon and Kel-F. Complete hi-voltage cable assemblies are available using Alden hi-voltage disconnects and tube cap connectors.

TELL US ABOUT YOUR CONNECTING PROBLEM. FOR PROMPT RECOMMENDATIONS—WRITE OR PHONE JACK POLLARD NOW.

ALDEN PRODUCTS CO.
5175 North Main Street, Brockton 64, Mass.
Circle No. 23 on Subscriber Service Card.

Some Highlights of AWA's Convention

Missile-launching nuclear airshi is Goodyear proposal; GE for ablative nose con

WASHINGTON—The General Electric Co. is putting its bets on the ablative nose cone—rather than the heat sink type—as the "best solution" for the ICBM.

The Goodyear Aircraft Corp. wants to build for the Navy a fleet of huge nuclear-powered blimps capable of launching ALBM's and fighting submarines.

These were two of the top disclosures at the Aviation Writers Association's week-long meeting that opened May 11.

• **Benefits**—H. W. Paige, GE Missile and Space Vehicle Department general manager, said GE is turning away from the heat sink nose cone because the ablative nose cone is:

- Considerably lighter.
- Less expensive.
- Not made with toxic beryllium.

The new GE RVX-2 ablative nose cone—shown publicly for the first time—weighs about one ton. The dunce-cap shaped cone is about 12 feet high and about five feet wide at the base.



ARTIST'S IDEA of the 4,500,000 cubic foot airship proposed by Goodyear.

So far it has been flown once. However, the *Atlas* that carried it from Cape Canaveral failed to travel the full 5000-mile course and the nose cone was lost in the Atlantic.

Paige said the RVX-2 succeeds the RVX-1 which has been repeatedly a *Thor-Able*.

The RVX-2 is being designed f *Atlas*. However, it may later be us on such second generation missiles *Minuteman*.

• **The nuclear blimp**—The propos missile-launching blimp would be 4.5 million cubic foot non-rigid a ship. That is about three times larg than present Navy blimps but still n as large as the huge German airshi of the 1930's.

The missile blimp would fly 10,000 feet at speeds of 70 to knots. Its range would be practical unlimited.

The 540-foot airship would made of a newly-developed dacr cloth coated with adduct synthet rubber. The cloth is highly resista to radiation.

An 86-foot control car would pr vide roomy accommodations for officers and men. It would have t decks.

• **Possible first**—The ship's gre length would make possible the placi of the nuclear reactor far enough b hind the control car to provide radiation-safe environment no mo dangerous than an atomic plant.

The blimp's turbo-prop engin also would be capable of operati on chemical fuel during taffeoffs a landings in order to avoid contamin tion. Goodyear officials said the actor would have to provide or about one-twentieth of the power quired for a plane because of t blimp's buoyancy.

Goodyear officials said they ha told the Navy they could produce operational missile airship by 1963 far sooner than experts have said nuclear-powered plane could be veloped even if the program we greatly accelerated.

Officials said the missile blimp, b sides being a missile launcher and su marine fighter, could be used as powerful early warning station.

They brushed aside possible arg ments that the huge blimp would an easy target.

"It would be extremely mobile a could carry powerful defensive wea ons," one said. "And it would harder to find than an aircraft carrie

INERTIAL GUIDANCE

Represents one of many applications of

Autocollimation

to solve Alignment Problems of a highly precise nature.



The KERN DKM2

When equipped with the new No. 356 Autocollimating Eyepiece, this famous one-second theodolite has a total magnification of 23x and an operating range from zero to at least 100 feet for autocollimation.

Write for technical data and specifications. No. 12

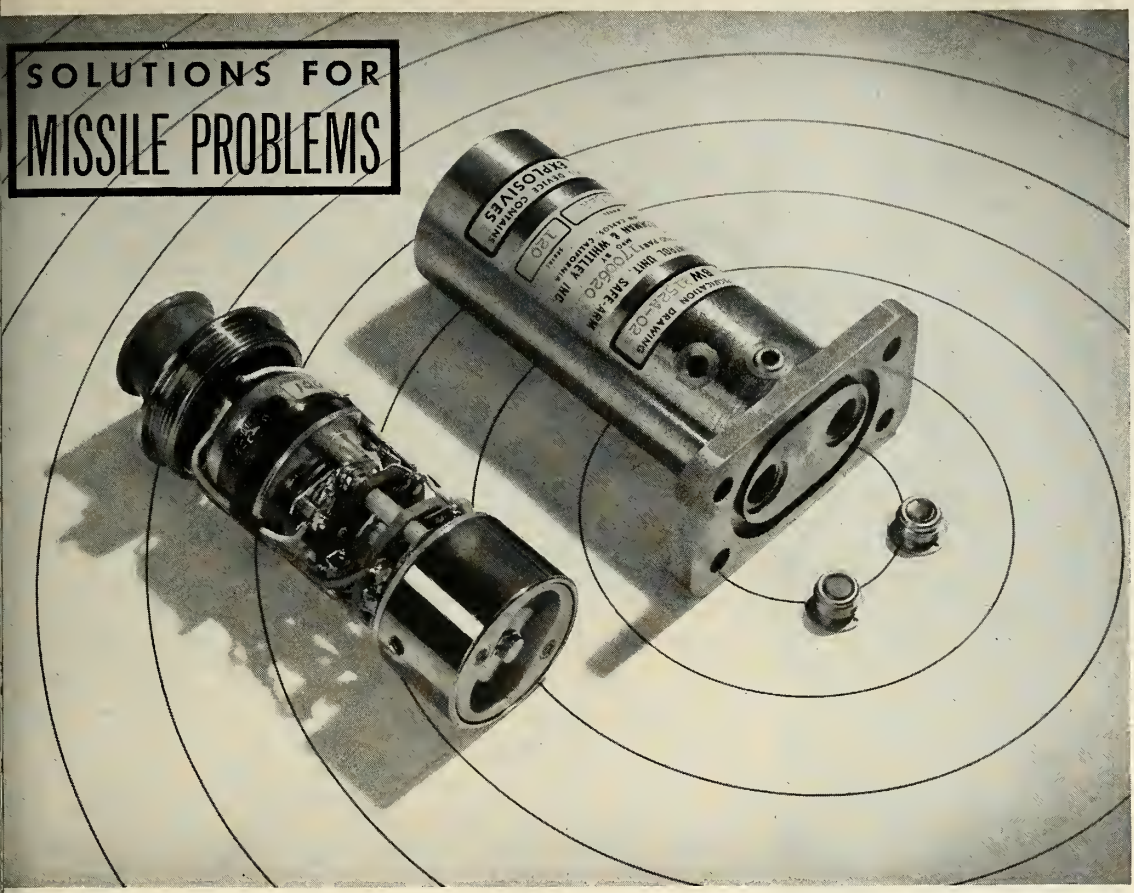
Kern SWISS

The FINEST in SURVEYING EQUIPMENT

KERN INSTRUMENTS INC.

120 Grand St., White Plains, N. Y.

Circle No. 24 on Subscriber Service Card.



safe/arm initiators

Ten years of pioneering in the missile component field has made possible this new line of Beckman & Whitley solenoid-operated safe/arm explosive initiators. Unit on the left has cover removed to show internal arrangement.

Weighing only 1.85 lb loaded, this model is 5 in. by 3 in. by 1¾ in. It was designed to military requirements. It can be armed or disarmed by remote electrical signal and includes both visual and electrical telemetering facilities for indication of armed or disarmed condition. On reception of a command firing signal, the unit will initiate associated primacord, low-energy detonating cord, (LEDC) or bulk charges.

This may be just what you need. On the other hand, Beckman & Whitley can provide the engineering capability, the production facilities, and perhaps most important, the speed necessary to give you anything you *do* need in the line of propellant-actuated devices.

Just tell us your problem.

Beckman & Whitley INC.

SAN CARLOS 16, CALIFORNIA

Circle No. 25 on Subscriber Service Card.



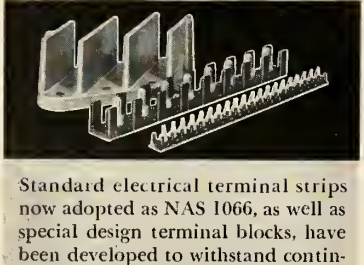
high temperature
PLASTICS



Continuing research in the field of high temperature plastic molding has enabled Olympic to create fiberglass missile components such as nose cones, radomes and heat reflective shields.



High strength, heat resisting structural parts and exhaust deflectors, insulators and nozzles have been produced that perform as high as 5000° F.



Standard electrical terminal strips now adopted as NAS 1066, as well as special design terminal blocks, have been developed to withstand continuous service to 600° F.

OLYMPIC
Plastics Company, Inc.
3471 S. La Cienega Blvd., Los Angeles, Calif.

Circle No. 26 on Subscriber Service Card.

propulsion engineering

Advantages of hybrid nuclear-chemical rocket engines are pr sented in the American Rocket Society Journal by Leon Green, Jr and James M. Carter, Aerojet-General. Chief merit of the wate light metal preheated propellant system is that it removes the pe formance limitations to which light metal fuels are restricted by hig latent heats of vaporization.

Other advantages: performance limits imposed on convention nuclear heat transfer systems by mechanical strength of the co structure are avoided by operation of the core at reduced ten peratures; problems connected with cryogenic liquids are eliminate reactor power requirements are eased by using chemical energ as a supplement.

A water-magnesium hybrid system is cited as a low-cost syste that can be built with today's materials and knowledge. Howeve Green and Carter say advanced systems, such as those using highe performance lithium, would involve additional study and would b more costly.

Pacific Engineering's new ammonium perchlorate semiworks Henderson, Nev., is using a new type of electrolytic cell. The pla has been operating "quite well" for about five months, but only no does Pacific Engineering President Fred Gibson talk about the cos cutting cell. It features a nonmetallic anode that avoids use platinum. However, he won't say what it is, only that the cell "appreciably more efficient" than the usual cells.

Puzzled by cermets? Here's a thumbnail rundown of how, whe and where to use the carbide-base cermets—chromium, titaniun and tungsten carbide. Chromium carbides have relatively low mel ing points, high resistance to corrosion, extremely high resistance oxidation, high thermal expansion and low density. Use them f valve parts, bearings, nonmagnetic applications. Titanium carbid have very high melting points, remain quite strong at high temper tures, offer good resistance to oxidation and thermal shock. Use torch tips, hot dies and guides, gas turbine nozzle vanes. Tungste carbides nowadays usually feature enough cobalt to give them hig impact strength. They offer excellent abrasion resistance. Use the in structures, precision rolls, wire drawing dies.

Graphite nozzles are coated with carbides of titanium, zirconiu niobium, tantalum, and silicon by a new metal vapor technique d veloped at Battelle Institute. Halides (chlorides, fluorides, bromide iodides) of the metals are vaporized in a pressure-temperature ran that will not let the metal deposit on the graphite surface, but wi cause reaction of the metal with the graphite to form the met carbide. Coating rate can be controlled for uniform coating. Th developers, J. M. Blocher, Jr., and I. E. Campbell, are now at N tional Steel, Weirton, W.Va.

Stauffer Chemical and Hercules Powder will use a Ziegler proce to make pyrophoric fuels in a new joint venture. The product aluminum trialkyls and other aluminum alkyls, will be produce at the rate of only 1 million lb/yr, and will be used as intermediat in production of industrial chemicals as well as for fuels and hig altitude flame sustainers.

Look for lithium perchlorate—one of the best solid-propella oxidizers hit upon yet—to roll out of the HEF (Hooker Chemic and Foote Mineral) Columbus, Miss., ammonium perchlorate pla before many more months. The industry says commercial productio is not yet feasible because of lack of demand. But the new Columb plant was designed for easy conversion to the lithium oxidizer. An insiders say big enough demand appears on the horizon.

Allied-Kennecott Titanium Corporation has postponed plans build a large-scale Ti plant "because of excess capacity for the met due to defense cutbacks." Instead, the company will increase r search to broaden the metal's commercial uses.

people

Appointment of **Richard E. Horner** as ociate administrator of the National ronautics and Space Administration will e administrator **T. Keith Glennan** and sistant **Hugh L. Dryden** from operanal management and allow them to ote full time to planning and policy isions. Horner's current post as Asant Air Force Secretary for Research l Development is expected to go to **I. Joseph Charyk,** chief AF scientist. e move is scheduled for June 1.

NASA has also appointed former *Vanard* director **Dr. John P. Hagen** as sant director for program coordination review and coordinate the space ncy's scientific and technical programs. e *Vanguard* staff will be intergrated o other NASA projects.

David H. Newby, space and aeronautl scientist. has been appointed represtative of NASA at the Army Ordnance ssile Command, Huntsville, Ala., where duties will include technical monitorl of NASA-funded projects.

Dr. Clifford C. Furnas, onetime Assista Secretary of Defense, R&D, has been ned vice-chairman of the Army Scieific Advisory Panel. Furnas, currently ancellor of the University of Buffalo, sceeds **Dr. James W. McRae,** who retly was named chairman. Outgoing airman **Richard S. Morse,** in turn, will sceed **Dr. William H. Martin,** retiring the Army's Director of Research and velopment.

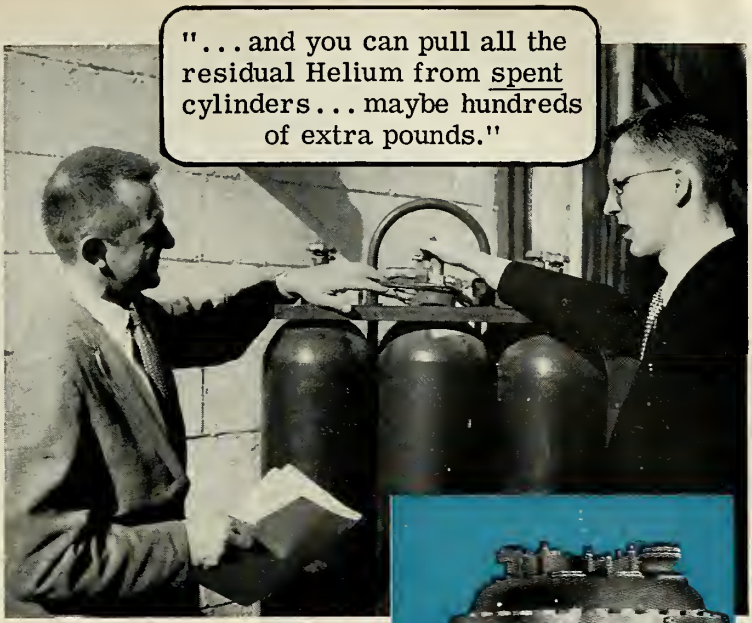


RANDALL

Frank Randall, president of Amperex Electronic Corp., has been elected vice president of North American Philips Company, Inc. Amperex is an affiliate of N. A. Philips. Randall retains his position as president of Amperex as well as vice president and direct of Ferroxcube Corp. of America, also affiliate of N. A. Philips.

Karel J. Bossart, assistant to the vice sident-engineering for Convair Divisl of General Dynamics Corporation, vs named the California Air Force Assoction's "Man of the Year in Science." ssart, "Father of the *Atlas*" intercontital ballistic missile, last year received Air Force Exceptional Civilian Service ard for his leadership in developing free world's first ICBM.

From the *Atlas* program's inception as MX 774 *Hiroc* research rocket in 46, Bossart has been intimately assoted with the *Atlas* throughout its design d development period. He served as ief engineer on the *Atlas* program and March, 1957, was promoted to techal director of Convair-Astronautics. nong the breakthroughs in rocketry deloped by Bossart and his associates in MX 774 and *Atlas* programs are the st separable nose cone, the first integral l tanks and the first swiveling engines directional rocket control.



..without contaminating the Helium!

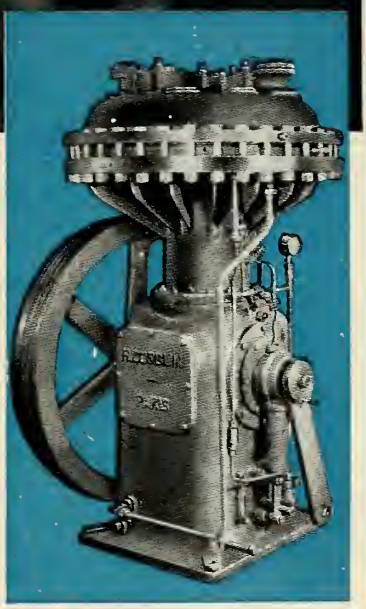
All residual helium may be pulled from cylinders previously thought to be "spent" by using a Corblin Diaphragm Compressor.

Any number of used cylinders may be hooked together and tied to a Corblin Compressor. The unused helium is pumped out of the cylinders ... into the compressor which pressurizes the gas and pumps it into other cylinders.

A single stage compressor, because of the high compression ratio at which it works, may be used to suck all the helium (or other rare gases) from "spent" cylinders, depressurizing them down to atmospheric pressure. The gas is sucked by the compressor directly at tank pressure; there is no need to use bothersome pressure regulators to reduce pressure prior to suction.

Besides helium, Corblin Compressors may be used to pump carbon monoxide, carbon dioxide, chlorine, fluorine, ethylene, argon, oxygen, air, etc.

Send for FREE BULLETIN K-2



CORBLIN Diaphragm
COMPRESSORS

- No contact between gas and hydraulic fluid or lubricant insures freedom from contamination.
- Compressors lend themselves readily to automatic operation.
- Units operate efficiently with fluctuating input pressure, without need for pressure reducers or expansion vessels.
- Pressures available to 15,000 psi.—capacities to 60 s.c.f.m.

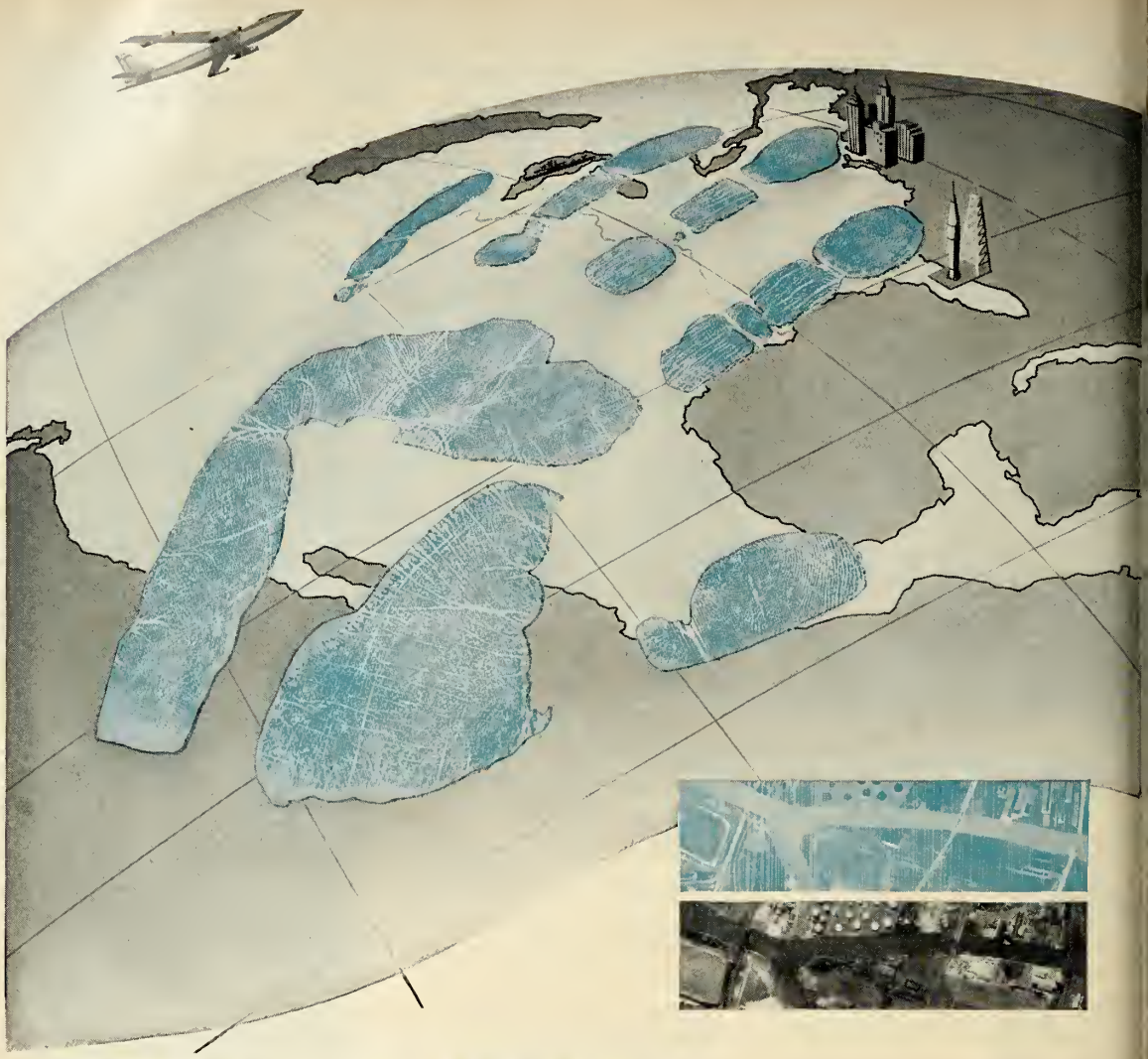
distributed exclusively in U.S. and Canada by

AMERICAN INSTRUMENT Co., Inc.

8030 Georgia Ave.,
Silver Spring, Md.

SUPERPRESSURE DIVISION AMINCO

Circle No. 2 on Subscriber Service Card.



INFRARED FINGERPRINTS

for reconnaissance, interpretation and prediction

Aerial reconnaissance systems of the future will depend on infrared detectors and scanners for operation around the clock. Each surveillance target or object of military or geophysical significance will have its own characteristic fingerprint in the infrared spectrum.

Infrared scientists at Bendix Systems Division, backed by years of experience in these techniques, are developing important new approaches to the interpretation and prediction of infrared reconnaissance data.

Extensive flight test data are being analyzed and catalogued to provide the guide to infrared interpretation. Also, test results are being correlated with laboratory techniques to predict the response of sensors and synthesize the infrared pictures they will produce. Thus, it will be possible to plan missions exactly as they will appear to the infrared observer.

Other infrared work includes target and background radiometric studies, detector studies, and infrared instrumentation for geophysical satellites, seekers, search, track, fire control, early warning, aerial intercept, collision warning, communication, mapping, horizon sensing, and infrared augmentation for target drones. Progress in infrared research and development exemplifies Bendix leadership in "the systems of tomorrow." Major Programs include the AN/AMQ-15 Weather Reconnaissance System and the Eagle air-to-air missile system. Inquiries are invited with respect to positions for better engineers and scientists.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

Circle No. 3 on Subscriber Service Card.


KAUFHOLD

Crosley Division, Avco Corp., has appointed **Gerard W. Kaufhold** sales manager for infrared systems. Kaufhold was formerly at Republic Aviation Corp., Farmingdale, N.Y., as research and development project administrator, and fighter plane project engineer with he Air Force Air Materiel Command.

The National Aeronautics and Space dministration and the Department of Defense have set up a joint working roup on search and recovery aspects of he Project *Mercury* manned orbital vehicle program and have named as co-hairmen of the group **Edmond C. Buck-y,** assistant NASA director for Space light Operations, and **Rear Adm. J. W. Cannon,** assistant Chief of Naval Operations (Fleet Operations).

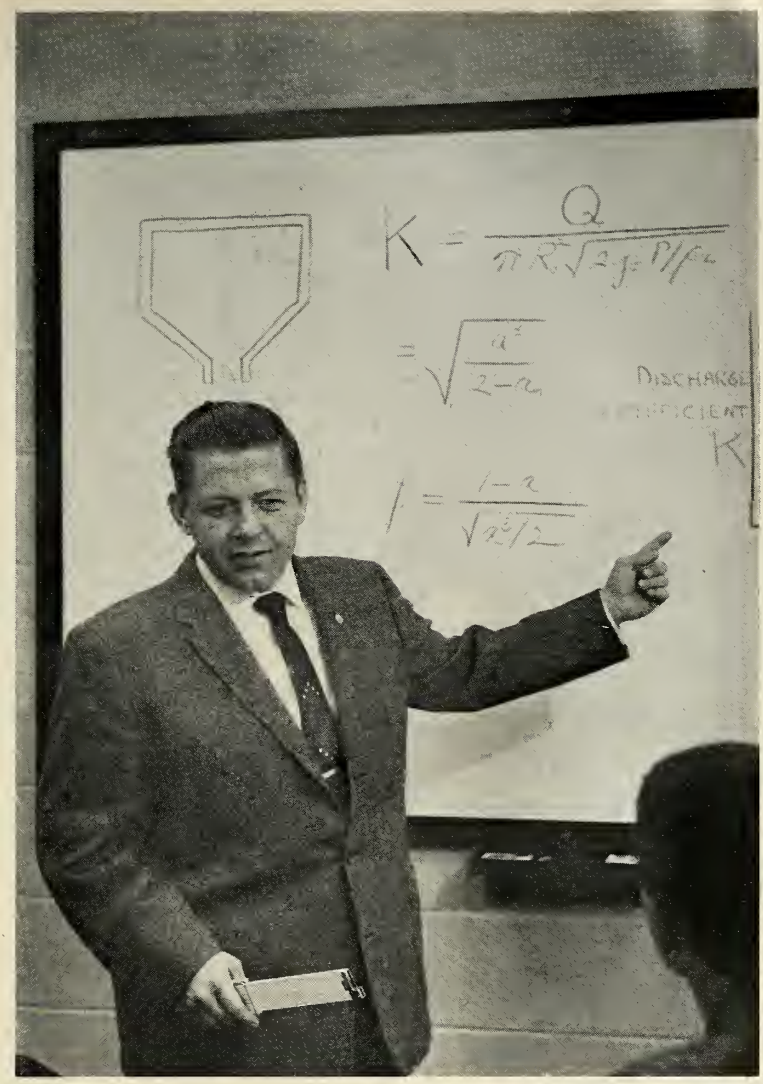
David E. Shonerd, 37, has been appointed assistant program director for he *Minuteman* ICBM program, Space echnology Laboratories, Inc. An author f four technical papers who has three atents pending, Shonerd was formerly ith Aerophysics Development Corp., Hughes Aircraft Co., Jet Propulsion Laboratory and the Naval Ordnance Test tation at Inyokern, Calif.

Two new divisions have been set up s a result of reorganization of the engineering group at Ramo-Wooldridge division of Thompson Ramo-Wooldridge nc. The Systems Technology Division ill be headed by **T. B. Bissett,** with ernard **Berman** as associate director. **filton E. Mohr** will be acting director f Data Processing Division.


GREY

Dr. James T. Grey, recently scientific adviser to the USAF director of research and development, has been appointed director of the research planning staff, Rocket Divisions, Thiokol Chemical Corp. His responsibilities will include study of non-military or commercial applications for rockets, rocket components nd propellants. His work for USAF was mainly in fuels, combustion, propulsion, hemistry and materials.

Marvin G. Whitney has been appointed vice president in the Semi-conductor ivision, Hoffman Electronics Corp. and anager of the division's new West Coast lant. Whitney, previously a vice presilent of the company's Consumer Prodcts Division, joined Hoffman in 1953 as he division's director of engineering and anufacturing, and later served as an dministrative assistant to the president.



Here is a man you should know
he's a DELAVAN FUEL INJECTOR SPECIALIST

His name is Paul D. Burgess. He's a senior project engineer on Fuel Injector Development, specializing in injection devices for thrust augmentation and primary fuel injection. He's been with Delavan 5 years, and has designed and developed fuel injectors for use on some of the most advanced aircraft engines, scheduled for production in the near future. Men like Paul Burgess, concentrating their talents on fuel injector development, have made Delavan the world's largest nozzle specialist. They're the main reasons leading turbo-jet, rocket and APU manufacturers rely on Delavan for fuel injection problem solving.

If fluid metering and atomization are part of your product, take advantage of Delavan's specialized experience and proven ability to deliver aircraft quality. Send specifications to the address below for obligation-free recommendations.

DELAVAN *Manufacturing Company*

West Des Moines, Iowa

World's largest nozzle specialist

Circle No. 27 on Subscriber Service Card.



missile tracker for china lake

Kollmorgen Missile Tracking Binoculars are an integral part of an acquisition and photography system which records tactical air-to-air missile performance at China Lake Naval Ordnance Testing Station. These binoculars, adapted from a basic Kollmorgen design, are high magnification, wide-field instruments with unusual light-gathering power. An operator is able to spot a missile-launching aircraft and track the missile from the time it is fired until it finds its target—all at extreme ranges. Among other Kollmorgen contributions to the missiles field are the bunker periscopes at Cape Canaveral.

By combining optics, mechanics and frequently electronics, Kollmorgen designs many different types of instruments and systems for industrial and defense viewing and inspection applications. A new illustrated brochure describes our design and manufacturing facilities and primary fields of interest. For your copy, write Dept. 105.

KOLLMORGEN
optical corporation
NORTHAMPTON MASSACHUSETTS

Circle No. 28 on Subscriber Service Card.

west coast industry

by Fred S. Hunter

There appear to be several good reasons why the proposed merger of Thiokol Chemical Corp. and Marquardt Aircraft Corp. would benefit both companies, their managements and their stockholders. Uppermost, however, is that the consolidated company would have systems capability. In other words, it could expand in the missile field up to and including the production of a vehicle.

Thiokol, a chemical company, has little in the way of hardware, except for its Reaction Motors division. Consolidated with Marquardt, it would have three propulsion systems, airframe capability, guidance experience, ground support equipment, test equipment—everything necessary to become a big operator in the missile picture.

The proposed merger is expected to go through to consummation with the consolidated company to be known as the Thiokol-Marquardt Corp. J. W. Crosby, now president of Thiokol, would become chairman of the board, and Roy E. Marquardt, now president of Marquardt, would become president. The top level of management probably would be expanded by two executive vice presidencies; one for supervision of the present Thiokol enterprises, the other for the present Marquardt operations.

In view of the fact that Thiokol will be the acquiring company, headquarters for the merged concern might remain in Trenton, N.J., but a more logical development could be establishment of general offices in a new location such as Salt Lake City. Thiokol's Utah division is at Brigham City, only 20 miles from Salt Lake, and Marquardt's *Bomarc* manufacturing plant is at Ogden in the same area.

Machine shops in southern California are at a low ebb because airframe volume is down, but missiles, particularly in the ground support phase, are picking up some of the slack. The Langley Corp. in San Diego, for example, had a net loss of $73,768 in 1958. But this year it will make some money, its President M. B. Laddon reports.

In the last five months Langley's level of unfilled orders has climbed from $800,000 to $1.2 million and the missile portion of the backlog has increased to about 25% currently from 10% a year ago. A further gain is anticipated. Among Langley's missile products are an assembly for a *Hawk* missile launcher and swivel joints and valves for fueling the *Atlas* ICBM. "We are looking for products, techniques and activities that will continue to take us out of the job-shop field," said Laddon in reporting his company's interest in favorable acquisitions that could broaden the base of the business.

Bidding on ICBM launching site installations seems to have become very tight. Wells Benz, Inc., a San Diego and Phoenix construction company which has done considerable of the work at Point Mugu and Point Arguello, was the low bidder at $5,314,872 for the job at Spokane, which the government had estimated would cost $8,553,000.

Louis D. Statham, president of Statham Instruments, Inc., says the operations of the company's Puerto Rico subsidiary have far exceeded "our fondest profit and production expectations," and have helped triple the size of the parent company in Los Angeles. The Statham subsidiary is soon to open a second plant on the island.

Joint test program on the Convair F-106 and its weapons subsystems is being completed at the Air Force Missile Test Center, Holloman Air Force Base. The F-106 incorporates Hughes Aircraft's new MA-1 fire control system and carries the new GAR-3 *Super Falcon*. In combat, it can carry a mixed load of *Falcons* and Douglas *Genie* air-to-air rockets.

Rear envelope of the Douglas C-133B, redesigned specially to carry the *Atlas* ICBM, opens up like an airplane hangar.

FLIGHT CONTROLS

Expanding the Frontiers of Space Technology

Flight Controls offers one of the most challenging areas of work at Lockheed's Missiles and Space Division.

From concept to operation, the Division is capable of performing each step in research, development, engineering and manufacture of complex systems. Rapid progress is being made in this field to advance the state of the art in important missile and spacecraft projects under development at Lockheed.

Flight controls programs include: analysis of flight data and sub-systems performance, design and packaging of flight control components, development of transistorized circuits, operation of specialized flight control test equipment, and fabrication of flight control prototypes. Other work deals with the design, development and testing of rate and free gyros; accelerometers; programmers; computer assemblies; guidance control systems; circuitry; and hydraulic systems and components.

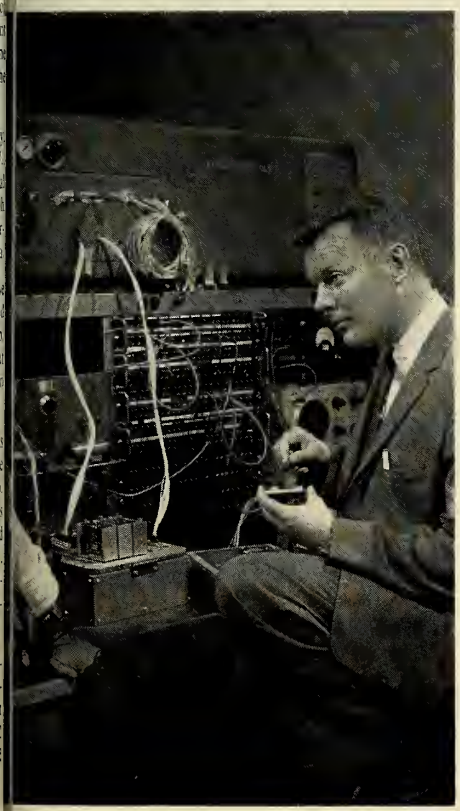
In the flight controls simulation laboratory, mathematical representations of elements in a control system are replaced one by one with actual hardware to determine acceptability of specific designs. From these studies, Lockheed obtains information which is used in further refinement and improvement of final control systems designs.

Lockheed Missiles and Space Division is weapons systems manager for such major, long-term projects as the Navy Polaris FBM; Discoverer Satellite; Army Kingfisher; Air Force Q-5 and X-7; and other important research and development programs.

Scientists and engineers desiring rewarding work with a company whose programs reach far into the future are invited to write: Research and Development Staff, Dept. E2-29, 962 W. El Camino Real, Sunnyvale, California, or 7701 Woodley Avenue, Van Nuys, California. For the convenience of those living in East or Midwest, offices are maintained at Suite 745, 405 Lexington Ave., New York 17, N.Y., and at Suite 300, 840 N. Michigan Ave., Chicago 11, Ill. U.S. Citizenship required.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics."

NATIONAL MISSILE INDUSTRY CONFERENCE AWARD



Transistorizing missile flight control systems by Lockheed scientists has meant significant reductions in weight and space requirements.

Pre-flight check-out on final assembly on X-7 missile. The X-7 holds free-world's speed and altitude records for air breathing missiles.





One of Lockheed's test stands with dynamic thrust mount to simulate flight environment.

Lockheed / **MISSILES AND SPACE DIVISION**

Weapons Systems Manager for Navy POLARIS FBM; DISCOVERER SATELLITE, Army KINGFISHER, Air Force Q-5 and X-7.

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

REPUBLIC VALVES
FOR EVERY INDUSTRY

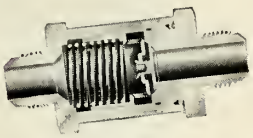
CHECKS
THAT FILL YOUR NEEDS

MINIATURE CHECKS



Mini-Valve — Regular Size Valve

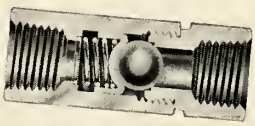
Save weight and space with Mini-Valves. They have same rated flow as regular size, but are only ¼ the size and weight. Good pressure drop characteristics. Temp. range −65° to plus 400°F. Operating pressure to 5000 psi. One-piece stainless steel body, in tube sizes 4 to 16 (¼" to 1" O.D.) Meets or exceeds requirements of MS MIL-V-25675. Port threading MS33514 flareless.



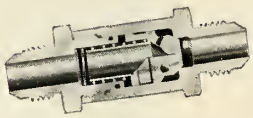
FREE-FLOW CHECKS

Extremely low pressure drop, with wide open flow. Molded elastomer seal and spherical seat prevent leakage at any pressure. Sizes ⅛" to 2" in brass and aluminum alloy up to 3000 psi, and stainless steel to 4000 psi. Opens at 2 psi. Temp. range −65° to 200°F. Pipe, internal straight thread and flared tube connections standard; MS33514 flareless available.

BALL CHECKS



Ruggedly constructed for intermittent non-shock hydraulic service up to 500 psi at temperatures −65° to 350°F. Sizes ⅛" to ¾". Brass, aluminum alloy, stainless steel. Pipe and flared tube connections.



HY-PRESSURE CHECKS

Built for continuous service in high velocity systems at pressures up to 5000 psi in steel and stainless steel, and 3000 psi in aluminum alloy. Low pressure drop. Metal-to-metal seal. Operating temperatures −65° to 250°F. Sizes ⅛" to 2", with pipe, internal straight thread and flared tube connections. MS33514 flareless available.

Distributors in principal cities coast to coast

CHECK RELIEF SELECTOR GLOBE NEEDLE PLUG



258

RM REPUBLIC MANUFACTURING CO.

15655 BROOKPARK ROAD • CLEVELAND 35, OHIO

Circle No. 29 on Subscriber Service Card.



A wide selection of the new Bristol stock ⅞" OD capsular elements is now available in pressure ranges from 15 to 350 psi.

These are the latest of Bristol's long-life, Ni Span C pressure sensing elements widely used in the aircraft and instrument fields. For applications requiring miniaturization, this new ⅞" OD is the optimum size. Nominal deviations from linearity of these precision miniatures is less than 1%.

Other Bristol stock capsular elements range from 1 5/32" to 2 11/32" OD and have a nominal deviation from linearity of less than ½% (deviation due to hysteresis of less than ¼%). Normal operating temperature range is −65° to 300° F. . . . for higher temperatures to (550°) a slight 2% travel change may be expected.

Bristol has been manufacturing pressure sensing elements for 70 years. For further information on these capsular elements with outstanding linearity characteristics write for Bulletin AV2001: Aircraft Components Division, The Bristol Company, 173 Bristol Road, Waterbury 20, Conn. e.54

BRISTOL FINE PRECISION INSTRUMENTS FOR SEVENTY YEARS

Circle No. 30 on Subscriber Service Card.

NAVY

,000,000—**Westinghouse Electric Corp., Electronics Div.,** for advanced shipboard radar systems.

,464,023—**Federal Electric Corp.,** Paramus, N.J., for operation of range instrumentation equipment at Point Arguello. (Sub-contractors—Rheem Manufacturing Co., Marquardt Aircraft Company, for ordnance handling toxic fuels.)

,033,550—**Westinghouse Electric Corp.,** Washington, D.C., for design and furnishing core handling and refueling equipment.

57,605—**Bendix Radio Div., Bendix Aviation Corp.,** Baltimore, for companion units of action Minitrack electronics.

7,093—**Aircraft Armaments, Inc.,** Cockeysville, Md., for guided missile telemetering antennas, reproducible record dwellings and pamphlets.

6,800—**General Electric Co.,** Lynn, Mass., for research on gas-lubricated bearings.

ARMY

1,900,165—**Thiokol Chemical Corp., Longhorn Div.,** Marshall, Tex., for production of rocket motors and plant maintenance.

.671,100—**Western Electric Co., Inc.,** for research and development of *Nike-Zeus.*

,988,895—**Virginia Engineering Co., Inc.,** Newport News, Va., for *Bomarc* facilities at Langley AFB.

,190,767—**Douglas Aircraft Co., Inc.,** for missile launching items.

723,000—**Allied Chemical Corp., General Chemical Div.,** for supporting research on high-energy oxidizers for advanced solid rocket propellants.

581,654—**Northrop Corp., Radioplane Div.,** for target missile research and development.

538,793—**Douglas Aircraft Co.,** for launching area parts and repairs.

516,625—**Olin Mathieson Chemical Corp.,** for research and development on high-energy fuels for advanced solid rocket propellants.

294,041—**Western Electric Co., Inc.,** N.Y., for *Nike* spare parts and components (four contracts).

279,106—**Western Electric Co., Inc.,** for *Nike* spare parts and components (four contracts).

100,000—**California Institute of Technology,** for research and development.

97,550—**RCA, Service Co. Div.,** Camden, N.J., for research and study of signals transmitted from satellite and space vehicles.

84,185—**Sylvania Electric Products, Inc.,** for research and study of *Nike-Zeus* acquisition radars.

81,635—**Raytheon Mfg. Co.,** for electronic assemblies for *Hawk* missile system (40% subcontract work will be available).

57,750—**North American Aviation, Inc., Rocketdyne Div.,** for design and development.

$38,663—**Barnes Engineering Co.,** Stamford, Conn., for research in measurement of re-entry bodies of missiles.

$29,724—**Gilfillan Bros. Inc.,** Los Angeles, for repair parts.

AIR FORCE

$10,000,000—**The Martin Co.,** Baltimore, for auxiliary equipment for the TM-76B *Mace.*

$850,000—**Kollsman Instrument Corp.,** Elmhurst, N.Y., for components of MD-1 automatic astro compass. Installation and spares for B-52 aircraft.

$800,000—**Marquardt Aircraft Co.,** for radar target simulators, spare parts, ground support equipment, data and service.

$500,000—**Bohanan Manufacturing Co.,** Compton, Calif., for follow-up production of force ejection systems for external stores for use on the F-101-B aircraft. (Contract awarded by McDonnell Corp.).



Our most potent weapon in the battle of time:

QRC*

In advanced military electronics research, the ability to do the job *isn't good enough.* The job must be done *reliably* and *on time.*

Hallicrafters' QRC program was originated to provide not only the finest of engineering facilities and people, but the flexibility required for immediate, crash effort on critical electronics problems.

Hallicrafters has provided our military forces for the past six years with a Quick Reaction Capability that has played a major role in helping to win the battle against time.

* Quick Reaction Capability: Refer to Air Force Reg. No. 80-32

The tough jobs get off the ground in a hurry at . . .

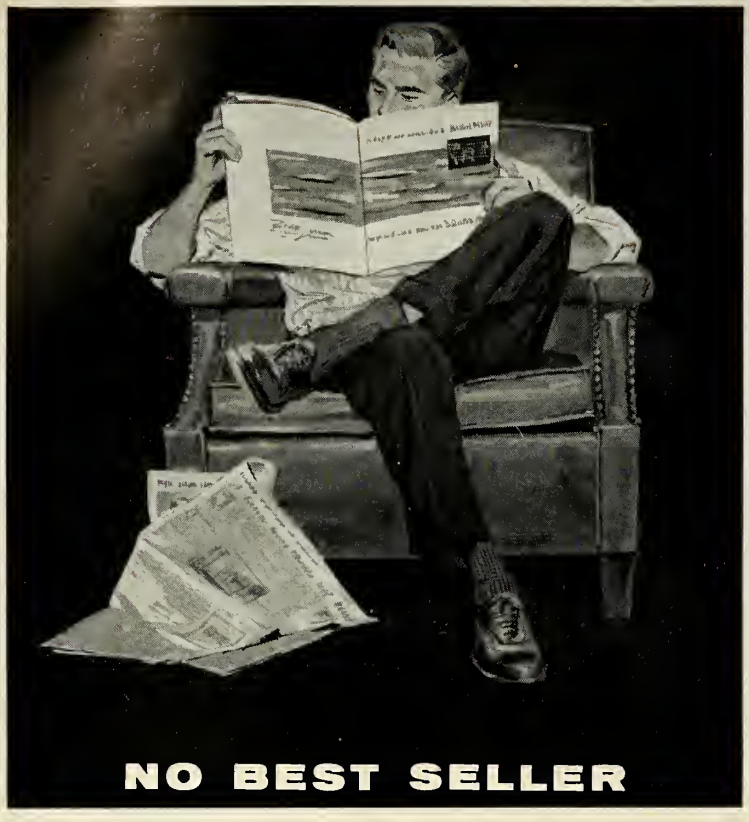
hallicrafters

Chicago 24, Ill.



Qualified Engineers: new contracts have created openings. Contact William F. Frankart, Director of Engineering.

Circle No. 31 on Subscriber Service Card.



. . . but it may be the most significant book you've ever read

There's a whole new way of life for you between the covers of "Opportunities Abound at Bendix Missiles" —and a four-cent stamp will bring it to you by return mail. If you have the qualifications, Bendix can offer you an enviable career in the guided missiles field, working with men who have been responsible for some of the most significant missile engineering advances of recent years.

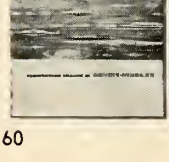
At Bendix, you will be in a major missile program. Bendix as prime contractor has responsibility for the Talos guided missile, one of our most vital defense weapons. Using the finest equipment, you'll learn fast and grow fast, both professionally and financially. There's opportunity here—opportunity to do important, stimulating work.

You'll like living in the Middle West. The climate is pleasant and Chicago, Lake Michigan and other fine recreational areas are easily accessible. There is also opportunity locally to pursue graduate engineering studies. Mail the coupon below. The book may not be a best seller, but it has been the instrument which started many a talented engineer on a fine career in engineering.

Bendix PRODUCTS DIVISION Missiles

Bendix AVIATION CORPORATION

PRIME CONTRACTOR FOR THE TALOS MISSILE



Bendix Products Division—Missiles
412C So. Beiger St., Mishawaka, Ind.
Gentlemen: I would like more information concerning opportunities in guided missiles. Please send me the booklet "Opportunities Abound at Bendix Missiles".

NAME _____

ADDRESS _____

CITY _____ STATE _____

. . . contract awards

$126,000—**Hughes Aircraft Co.,** for continuation of SAGE integration program.

$78,837—**Continental Aviation & Engineering Corp.,** Detroit, for six J69-T-29 engines for Q-2C drone aircraft.

$63,800—**Raytheon Manufacturing Co., Microwave and Power Tube Div.,** for miscellaneous tubes.

$62,660—**Eagle-Picher Co., Chemical Div.,** for water-activated batteries.

$60,688—**Instrument Corp. of Florida,** for mobile shelters for mounting BC-4 cameras and other related items.

$57,910—**Columbia University,** for research in the physics and chemistry of gases at high temperatures.

$49,107—**PSP Engineering Co.,** Maywood, Calif., for solenoid-electrical.

$40,756—**University of Colorado,** for research directed toward design and development of Biaxial Pointing Controls and rocket-borne telemeter systems.

$40,009—**University of Rochester,** Rochester, N.Y., for continued research on problems of gas dynamics of cosmic scales.

$39,623—**North American Aviation,** for miscellaneous spare parts used in 2.75 Rocket Package Assembly.

$37,000—**Southwest Research Institute,** San Antonio, Tex., for additional facilities for missile lubrication research and test development.

$36,275—**University of Minnesota,** for rocket sled ballistics to be used in support of Project 7856.

$25,826—**Chromcraft Corp.,** St. Louis, for intervalometers used with launcher rocket.

$20,554—**Swanson & Youngdale, Inc.,** Minneapolis, for construction of storage base, LOX addition Project Ellsworth.

UCLA Undertakes 3 Year Study of Free Radicals

LOS ANGELES—A three-year study of free radicals has been begun by scientists at UCLA in order to clarify the basic electronic structure of the molecule.

The work will involve use of a new technique—electron paramagnetic resonance spectroscopy—allowing measurement of the energy levels of the electrons in the radicals by varying the applied magnetic field and the frequency of the exciting electromagnetic radiation.

The research will be conducted by Dr. Daniel Kivelson, who has received a $27,400 grant from the National Science Foundation.

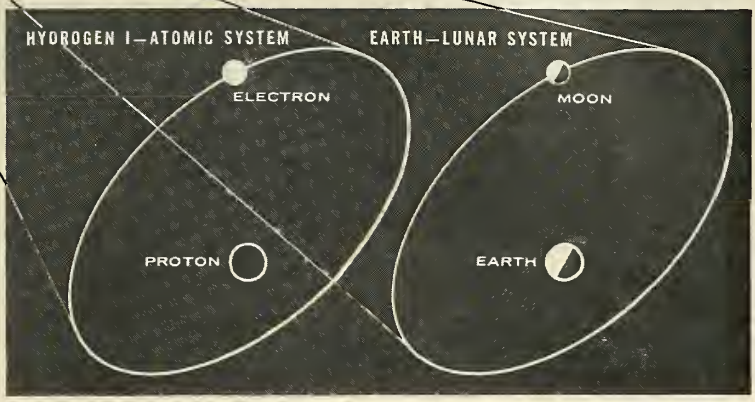
The free radical can be created artificially, but is rarely found in nature. Nearly all natural molecules have an even number of electrons, while the free radical contains an odd number. It is an important link in many chemical reactions, serving frequently as an intermediate between the stable, natural molecules.

ENGINEERS – SCIENTISTS

$$P(k_1, k_2, \ldots, k_m) = \frac{n!}{k_1! k_2! \ldots k_m!} p_1^{k_1} p_2^{k_2} \cdots p_m^{k_m}$$



Is order and organization in MACROCOSM and MICROCOSM an underlying principle of the universe... or does a fundamental state of randomness prevail in the cosmos as might be expressed by the multinomial formula at left?



BOLD MINDS

THROUGHOUT HISTORY..... BOLD MINDS have sought to understand the forces at work in the universe, and as they developed working hypotheses, endeavored to turn all knowledge to their own purposes, devising philosophical and mechanical systems of their own.

As old hypotheses become inadequate or untenable, thinking men devise new ones. So the concept of a "flat" world has changed to an oblate orbiting spheroid—mere speck in a vast and expanding universe; so "empty" formless space is regarded as a curved continuum occupied by random knots of turbulence (creating the new branch of mechanics—hydromagnetics).

Today new horizons of discovery and surmise arise before the speculative mind.

ENGINEERS AND SCIENTISTS AT REPUBLIC FEEL KINSHIP WITH ALL BOLD MINDS OF PAST AND PRESENT. AS THEY FACE THE EXHILARATING CHALLENGES OF CREATING VEHICLES TO FLY IN ENVIRONMENTS WHERE NEW APPROACHES IN THERMO/AERODYNAMICS MUST BE MADE...AS WELL AS APPROPRIATE PROPULSION AND ELECTRONIC SYSTEMS TO POWER AND GUIDE TRANSIT IN SPACE

Groups of Research, Development and Experimental Engineers and Scientists at Republic Aviation are now working on projects over the whole range of aeronautics and astronautics—from supersonic and hypersonic weapons systems, both manned and unmanned, to plasma propulsion and space electronics.

Imaginative professional men at many levels of experience are invited to inquire about opportunities indicated below:

ELECTRONICS
- Inertial Guidance & Navigation
- Digital Computer Development
- Systems Engineering
- Information Theory
- Telemetry-SSB Technique
- Doppler Radar
- Countermeasures
- Radome & Antenna Design
- Microwave Circuitry & Components
- Receiver & Transmitter Design
- Airborne Navigational Systems
- Jamming & Anti-Jamming
- Miniaturization-Transistorization
- Ranging Systems
- Propagation Studies
- Ground Support Equipment

THERMO, AERODYNAMICS
- Theoretical Gasdynamics
- Hyper-Velocity Studies
- Astronautics Precision Trajectories
- Airplane/Missile Performance
- Air Load and Aeroelasticity
- Stability and Controls
- Flutter & Vibration
- Vehicle Dynamics & System Designs
- High Altitude Atmosphere Physics
- Re-entry Heat Transfer
- Hydromagnetics
- Ground Support Equipment

PLASMA PROPULSION
- Plasma Physics
- Gaseous Electronics
- Hypersonics and Shock Phenomena
- Hydromagnetics
- Physical Chemistry
- Combustion and Detonation
- Instrumentation
- High Power Pulse Electronics

NUCLEAR PROPULSION & RADIATION PHENOMENA
- Nuclear Weapons Effects
- Radiation Environment in Space
- Nuclear Power & Propulsion Applications
- Nuclear Radiation Laboratories

A new $14,000,000 Research Center—to be completed this year—is part of Republic's far-ranging R&D programs aimed at major state-of-the-art breakthroughs in every flight regime & environment.

Send resume in complete confidence to:
Mr. George R. Hickman, ENGINEERING EMPLOYMENT MANAGER — DEPT. 4E-4

REPUBLIC AVIATION
FARMINGDALE, LONG ISLAND, NEW YORK



Rx FOR INTERNAL INSPECTION

● **0.10" AND UP** . . . That's the point of entry requirement . . . to provide your inspectors the chance to use the outstanding National Fontar Borescope and thus give them the brightest, distortion-free, close-up view of the defect in "inaccessible" interior surfaces of the cast, drawn, welded or molded product . . . from inches deep to many feet.

Find out how its use can be a time and cost saver while it up-grades your Quality Control. Just send for our "Borescope Catalog."

ENGELHARD INDUSTRIES, INC.
NATIONAL ELECTRIC INSTRUMENT DIVISION
92—21 Corono Avenue • Elmhurst 73, New York

Circle No. 32 on Subscriber Service Card.

Now Available

NUCLEAR EXPLOSIONS IN SPACE

by Prof. S. Fred Singer

the story behind

Project ARGUS

Reprints of this exclusive M/R report are now available due to repeated requests.

A series of four illustrated articles combined, this important M/R special contains scientific explanations of:

* **project ARGUS**
* **creation of an artificial particle belt**
* **effect on manned space vehicles and nuclear warheads**
* **effects on radar and long-range communications**
* **scientific techniques for detecting such explosions**

50 cents per copy
(bulk rates on request from publisher)

missiles and rockets
1001 Vermont Ave., N.W.
Washington, D.C.

Advertisers' Index

Alden Products Co. 49
Agency—Robotham Adv. Agency

Allison Div., General Motors Corp .. 35
Agency—Kudner Agency, Inc.

American Bosch Arma Corp. 11
Agency—Doyle, Kitchen & McCormick, Inc.

American Instruments Co., Inc. 53
Agency—Advertising Inc. of Washington

Armco Steel Corp. 48
Agency—N. W. Ayer & Son, Inc.

Avco Mfg. Corp. 32, 33
Agency—Benton & Bowles, Inc.

Beckman & Whitley, Inc. 51
Agency—Gerth, Brown, Clark & Elkus of San Francisco, Inc.

Bendix Aviation Corp.
Bendix Systems Div. 54
Utica Div. 44
Agency—MacManus, John & Adams, Inc.

Bendix-Pacific, Div.-Bendix Aviation Corp. 2
Agency—The Shaw Co.

Bristol Aircraft Limited 38, 39
Agency—Young & Rubicam, Ltd.

Bristol Co., The 58
Agency—James Thomas Chirurg Co.

Brunswick-Balke-Collender Co. 12
Agency—McCann-Erickson, Inc.

Callery Chemical Co. 43
Agency—Ketchum, McLeod & Grove, Inc.

Cooper Development Corp., Sub.-Marquardt Aircraft Co. 29
Agency—Allen, Dorsey & Hatfield, Inc.

Consolidated Electrodynamics Corp. 4
Agency—Hixson & Jorgensen, Inc.

Convair, Div.-General Dynamics Corp. 41
Agency—Barnes Chase Co.

Delavan Mfg. Co. 55
Agency—W. D. Lyon Co.

Dit-Mco, Inc. 47
Agency—Jones & Hangar, Inc.

Dow Chemical Co. 14, 15
Agency—MacManus, John & Adams, Inc.

DuKane Corp. 45
Agency—The John Marshall Ziv Co.

Electro Data, Div. of Burroughs Corp. 6, 7
Agency—Carson/Roberts/Inc.

Electro Instruments, Inc. 64
Agency—Clyde D. Graham, Adv.

Engelhard Industries, Inc. 62
Agency—Stuart Sande Adv.

B. F. Goodrich Aviation Products Div.-B. F. Goodrich Co. 46
Agency—Batten, Barton, Durstine & Osborn, Inc.

Goodyear Tire & Rubber Co., Inc., The 3
Agency—Kudner Agency

Grove Valve & Regulator Co. 63
Agency—L. C. Cole Co.

Hallicrafters Co. 59
Agency—Henry B. Kreer & Co., Inc.

Kern Instruments, Inc. 50
Agency—Richmond Adv. Service, Inc.

Kollmorgen Optical Corp. 56
Agency—Wilson, Haight, Welch & Grover, Inc.

Arthur D. Little, Inc. 42
Agency—Henry A. Loudon Adv., Inc.

Lockheed Aircraft Corp., Missile & Space Div. 57
Agency—Hal Stebbins, Inc.

Martin Co., The 25
Agency—Henry Quednau, Inc.

Minnesota Mining & Mfg. Co., Magnetic Products Div. 18
Agency—MacManus, John & Adams, Inc.

North American Aviation, Inc., Missile Development Div. 49
Agency—Batten, Barton, Durstine & Osborn, Inc.

Olympic Plastics Co., Inc. 52
Agency—The Rouse Co.

Radio Corp. of America 36
Agency—Al Paul Lefton Co., Inc.

Republic Mfg. Co. 58
Agency—J. N. Paterson & Associates

Stratoflex, Inc. 10
Agency—Magnussen

Telecomputing Corp. 31
Agency—Anderson-McConnell Adv. Agency, Inc.

Temco Aircraft Corp. 16
Agency—Rogers & Smith Adv. Agents

Texas Instruments, Inc., Apparatus Div. 8
Agency—Don L. Baxter, Inc.

EMPLOYMENT SECTION

Bendix Aviation Corp., Bendix Products Div. 60
Agency—MacManus, John & Adams, Inc.

Republic Aviation Corp. 61
Agency—Deutsch & Shea, Inc.

CLASSIFIED

Missile Photos—For your office, den or collection. We produce B&W and color prints, slides, murals, and display photographs. For catalog and sample slide send 35¢ to—Camber Company, Box 1051, Cocoa, Florida.

when and where

MAY

Society of Aeronautical Weight Engineers 18th Annual National Conference Hotel Henry Grady, Atlanta, Ma 18-24.

Engineering Institutes, The University o Wisconsin, University Extension Di vision and The College of Engineering The New Wisconsin Center Bldg. Madison, May 19-20.

American Institute of Electrical Engi neers, Middle Eastern District, Satel lite Tracking Session, Lord Baltimor Hotel, Baltimore, May 19-21.

The Society for Experimental Stress An alysis, 1959 National Spring Meeting Sheraton Park Hotel, Washington D.C., May 20-22.

Instrument Society of America, 1959 Ohi Valley Instrument and Automatio Exhibit and Symposium, Cincinnat Section, Music Hall, Cincinnati, Ma 21-22.

Institution of Electrical Engineers, Th Radio and Telecommunication Sec tion, International Transistor Exhibi tion and Convention, Earl's Court London, May 21-27.

Federation Aeronautique Internationale Annual Meeting, Moscow, May 24 June 5.

The National Missile Industry Conference sponsored by The National Rocke Club in cooperation with Electroni Industries Assn., Sheraton Park Hotel Washington, D.C., May 25-27.

American Rocket Society, Institute of th Aeronautical Sciences, American Insti tute of Electrical Engineers and Th Instrument Society of America, "In vestigation of Space" Conference Brown Palace and Cosmopolitan Hotel Denver, May 25-27.

American Society for Quality Control All-Industry Production and Qualit Control Exposition and Convention Cleveland Public Hall and Hotel Sher aton, Cleveland, May 25-27.

SUBSCRIBER SERVICE
missiles and rockets

For additional information about any product or service advertised mentioned in the editorial pages of this issue of Missiles and ckets:

Use the attached prepaid reply cards. Circle numbers shown on reply card that correspond with numbers appearing beneath items ribed. If no circle number accompanies the article or advertise- ct, give page number (and advertiser's name) on line provided at om of the card.

Your requests for information will be forwarded promptly to the panies concerned.

NEW PRODUCT BRIEFS

RIOPLASTIC POLYMER. The lment of a new acrylic-type thero- ti polymer possessing high heat re- n and an exceptional combination tiness and toughness has been an- ed by the J. T. Baker Co. The i designated by the code #PL-12, heat distortion point of 240°F, ral modulus of 415,000 psi and a th izod impact strength of 1.0 ft. rt. Injection molding and extrusion L2 can be carried out by conven- a acrylic techniques.

lo. 240 on Subscriber Service Card.

G: SWITCH. A magnetic emplifier Es for the first time the relia- y of all-static construction and the it to perform logical switching tns. The small unit serves as an r, or not gate, or as a bi-stable ny device. Designer and manufac- rs Pacific Magnetic Corp. Called MC-785 logic type magnetic am- e the unit is made primarily for il control and check-out applica- s. it replaces three relays in logical cng epplications and is suited for i pressure and temperature detec- nd control infrared detection, ntion, servomechanisms, computer es and in other logic epplications. vstands extremes of shock, vibra- nd temperature, has no moving srequires no servicing, and has un- te shelf and use life. The unit has e input control windings, a bias dg and two gate windings. It op- e from a 70V center-tapped trans- n on a 115V line at 400 cps, has r response, and accepts a minimum signal of only 2 millwatts. Nominal p is 28 VDC at 10 watts. The com- e is fully encapsulated and op- te over a temperature range of 0 to 100°C. Dimensions: 2" x x 1¼". Weight: 10 oz.

lo. 241 on Subscriber Service Card.

NAKE SYNCROS. Luther Manu- ng Co. has announced aveilability h-accuracy pancake synchros and l rs. These synchros end resolvers esigned and manufactured for inertial guidance systems where a pan- cake configuration is necessary for space and weight limitations. These units are available in size 20 to size 27, featuring accuracies down to 5 minutes. Their electrical properties are designed to match standard com- ponents for accuracy, voltage gradient and impedances. They can be obtained with flanges and hubs as an integral part for ease of installation and adjust- ment.

Circle No. 242 on Subscriber Service Card.

CONTROL VALVES. A two-way valve which allows independently-controlled flow in either or both directions is an- nounced by True-Flo Valve Co. Avail- able in standard IPS from ⅛" to ¾", the units are adaptable to hydraulic or pneumatic applications in pressures as high as 5000 psi. The valves are female- threaded to dryseal specifications and ere available in brass, steel, aluminum, stainless, end special alloys. Extreme dependability, lower friction loss, and greater flow at ell temperatures are claimed due to design which eliminates internal gaskets, springs, or hinged parts.

Circle No. 243 on Subscriber Service Card.

TIMING GOVERNOR. A universal tim- ing governor, designed for application to a variety of timing devices, is now being offered by Precision Products Inc. The governor features e patented self- starting movement housed in a stainless steel case with a transparent tamper- proof cover. It is easy to attach to an associated device end easily removed for servicing. A small connecting drive pin mey be used to connect working mechanism to power supply.

Circle No. 244 on Subscriber Service Card.

TITANIUM HOOKS. Titanium anode hooks and baskets, with high corrosion- resistant qualities, have been developed for the plating industry by Mellory- Sharon Metals Corp. Both hooks and baskets are aveilable in standard sizes and shapes. Standard titanium hooks range in size from 3½" to 8", with special sizes on request Fabriceted from pure titanium, the hooks and baskets are said to have an indefinite life in highly corrosive mixtures.

Circle No. 245 on Subscriber Service Card.

NAME_____

TITLE/POSITION_____

COMPANY_____

Product Mfg./Service Offered_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

Card cannot be processed unless all information is given. Please limit requests to ten items.

MISSILES AND ROCKETS

MAY 18, 1959

Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers: _____

POSTAGE WILL BE PAID BY ADDRESSEE

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD

First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

MISSILES and ROCKETS

17 EAST 48th STREET

NEW YORK 17, N.Y.

SUBSCRIBER SERVICE DEPT.

MISSILE LITERATURE

MERCURY SWITCHES. Newly-revised Catalog 90b describes the standard line of Honeywell mercury switches, manufactured by Micro Switch, a Division of Minneapolis-Honeywell Regulator Company. Included are photographs, dimensions, electrical ratings, drawings, application information and complete technical data.

Circle No. 206 on Subscriber Service Card.

MISSILE LEXICON. A new book, Missiles From Concept to Countdown, just published by the Aircraft Industries Association, puts into proper perspective the relationship of the missile to the Nation's arsenal; the complexities of its manufacture; the reasons for its cost; and its potential both in war and for peace. This primer has been prepared in response to thousands of inquiries from throughout the Nation for information concerning this newest form of automatic weaponry manufactured by the United States aircraft industry, and the rapidly expanding developments and achievements in the field of space exploration.

Circle No. 207 on Subscriber Service Card.

MAGNET WIRE. High-temperature ceramic insulated magnet wire for service up to 1000°F. is the subject of a new 8-page brochure just issued by Secon Metals Corporation of White Plains, N.Y. It contains the basic information on the original research performed approximately one year ago as well as the engineering data which was compiled during the past year.

Circle No. 208 on Subscriber Service Card.

BRAZING. A single-page 8½ x 11 two-color engineering data sheet discussing Nicrobrax Vapo-Flux, which produces wetting and flow of brazing alloys in marginal or poor dry hydrogen atmospheres, is now available from Stainless Processing Division, Wall Colmonoy Corp. Included in the engineering data sheet are properties, uses and methods of applying Vapo-Flux to aid in brazing in pure hydrogen or inert atmospheres.

Circle No. 200 on Subscriber Service Card.

LOCKNUTS. Locknuts combing high strength with lightweight for use in missile and related applications at temperatures up to 1200°F are described in a new bulletin offered by Standard Pressed Steel Co. Suitable for use on present MS9033 bolts as well as on stronger fasteners now being developed, the one-piece, all metal featherweight locknuts—designated FN1216 series—are rated at minimum tensile strengths of 160,000 pounds per square inch at room temperature, and more than 140,000 psi at 1200°F. Photos, design drawings and charts supplement text in the four-page illustrated bulletin in pointing up configuration and principal design features. These include overall height than present high-beam type nuts, reduced across-flats dimension of the 12-point wrenching drive and smaller outside dimensions. These permit use of shorter companion bolts and installation of nuts closer to bulkheads, saving space.

Circle No. 201 on Subscriber Service Card.

COMPUTERS. Publication of a new textbook on the basic principles, language and characteristics of electronic puters was announced by the RCA ice Co., a division of Radio Cor America. The 114-page book, en "The Language and Symbology of tal Computer Systems," explains of the basic characteristics of puters. It discusses Boolean algeb practical terms, and contains a reference of logic diagrams and sy used by various computer manufac and a dictionary of computer t nology. "In the digital computer the language is a combination of bols and words which, unfortun vary among different manufacturer users," D. H. Kunsman, President c RCA Service Co. said. "This boo fords a common index of that lan for the many engineering as well as engineering people, who must work or provide services for a com group."

Circle No. 202 on Subscriber Service

SERVO COMPONENTS. A 12 booklet, entitled Nomenclature Rotating Servo Components, has prepared to help engineers who servo components. It covers sta mil type synchors, resolvers, motors and tachometer gener Complete explanations of the sy which identify units are include well as definitions of all impo characteristics of units. It is ava from the Ketay Dept. of the N Div. of the United Aircraft Corp.

Circle No. 203 on Subscriber Service

AUTOMATED CHECKOUT. Severe proaches have recently been deva to solve the problem of maint complex military electronic equipm a state of combat readiness. The nique described by the Checkmate matic Test Equipment Co. in their let "14 Men in a Box," which utili series of portable "black boxes" performing a programmed sequen automatic checkout procedures. initiate a test, the operator s pushes a button on the panel; te sults are shown by green and red no go" lamps. Each black box i signed to test a specific equipmen in the case of large systems, a sp unit. A copy of "14 Men in a Bo available from the Checkmate matic Test Equipment Co.

Circle No. 204 on Subscriber Service

SELSYNS AND SYNCHROS. A 16 bulletin discusses complete line of eral Electric selsyn and synchro tromagnetic devices used for extr accurate transmission of electrical lar data between two or more p Most commonly used models of high-accuracy class for precise r control applications are described. accuracy is from plus or minus 1. plus or minus .3°. Illustrated pu tion discusses selsyn and sy generators, motors control transfor differential generators, differ motors, tandem selsyns, and s operation. Bulletin includes sche and line drawings, figures, tables, and dimensions.

Circle No. 205 on Subscriber Service

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD

First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

MISSILES and ROCKETS

17 EAST 48th STREET

NEW YORK 17, N.Y.

SUBSCRIBER SERVICE DEPT.

POSTAGE WILL BE PAID BY ADDRESSEE

NAME_____

TITLE/POSITION_____

COMPANY_____

Product Mfg./Service Offered_____

ADDRESS_____

CITY_____ ZONE____ STATE____

Card cannot be processed unless all information is given. Please limit requests to ten items.

MISSILES AND ROCKETS

MAY 18, 1959

Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers: _____





INSTANTANEOUS RESPONSE

Grove Regulators... For over twenty years—from the first missile experiments in the Navy Experimental Station at Annapolis to the launching pads at Cape Canaveral—setting the standards for the control of high pressure fluids ...the regulators which served as the critical control on World War II flame throwers and torpedoes...and made missile development work possible...Grove High Pressure Regulators...frequently imitated but never equaled.

Powreactor Dome Regulator—Model GH-408 · 50-6000 psi inlet...5-3000 psi reduced pressure

ROVE VALVE and REGULATOR COMPANY

2 Hollis St., Oakland 8, California • 2559 W. Olympic Blvd., Los Angeles 6, California

s in other principal cities

Subsidiary of Walworth

Circle No. 33 on Subscriber Service Card.

Circle No. 34 on Subscriber Service Card. →

NEW! Electro Instruments totally-transistorized, modular

XY recorders!



NEW ENGINEERING IMPROVEMENTS THROUGHOUT!

- Faster slewing speeds— Pen: 30"/sec.; Carriage: 30"/sec.
- Greater accuracies— Static: 0.1%; Dynamic: 0.2%.
- 0.05% internal calibration.
- High precision internal Zener diode reference.
- New improved vacuum hold-down system.
- Vernier control between ranges.
- Input function modules in rack mountable case can be removed from plotter for remote operation.
- Calibrated scales on both axes.
- Front panel gain control.
- Vacuum release on front panel.
- Visible ink supply.

One basic plotter with input modules available for general-purpose, computer, low level differential, time base, curve following and other specialized functions.

	Model 41D Computer Module	Model 42D General Purpose Module	Model 43D Low Level Differential Module	Model 45D Curve Follower Module	Model 46D Time Base Module
Input	Single Ended	Single-Ended	Differential	Single-Ended	Single-Ended
Ranges	0.1, 1.0, 10v/in, calibrated vernier	16 steps, 1m v/in to 100 v/in, plus vernier	16 steps, 1m v/in to 100 v/in, plus vernier		0.1, 0.2, 0.3, 0.6, 1.0, 2.0 in/sec
Accuracy: Static Dynamic	±0.1% F/s ±0.2% F/s	±0.1% F/s ±0.2% F/s	±0.15% F/s ±0.2% F/s	±0.25% F/s	(time) ±1.0% F/s
Linearity				±0.1% F/s	(sweep) ±0.5% F/s
Input Resistance	2 megs, all ranges	1 meg to 3 megs Depending on range	1 meg to 3 megs Depending on range		
Zero Adjust	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset	Full scale X and Y plus 9" offset		
Reference	Internal Zener diode and external ±100v computer	Internal Zener diode	Internal Zener diode		Internal Zener diode
Calibration	Internal 0.1, 1.0, 10v Accurate to ±0.05%				
Common Mode Rejection			DC, 120 db AC, 100 db at 60 cps		
Max. Common Mode Voltage			50 v dc or peak ac		
Principle of Operation				60 cps magnetic induction	Electronic Integration
Zero Drift				None	

Dimensions All Modules: 8½" W x 3½" H x 7¾" D

Model 400 Plotter

Recording Size: 10" x 15"
Slewing Speed: X, 40"/sec; Y, 30"/sec
Inputs: X and Y inputs, and computer reference
Power: 115 ±10 v, 60 cps
Dimensions: 19" W x 19½" H x 11¾" D
Ambient Temperature Range: 0-55°C
Controls: Power off, standby, operate, pen; vacuum release; curve follower, amplifier; local, remote.

3540 Aero Court
San Diego 11, California

Electro Instruments, Inc.

MAY 25, 1959

MAY 1959
HOUSTON PUBLIC
LIBRARY
Houston, Texas

SEABORNE MISSILE TRACKER



missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

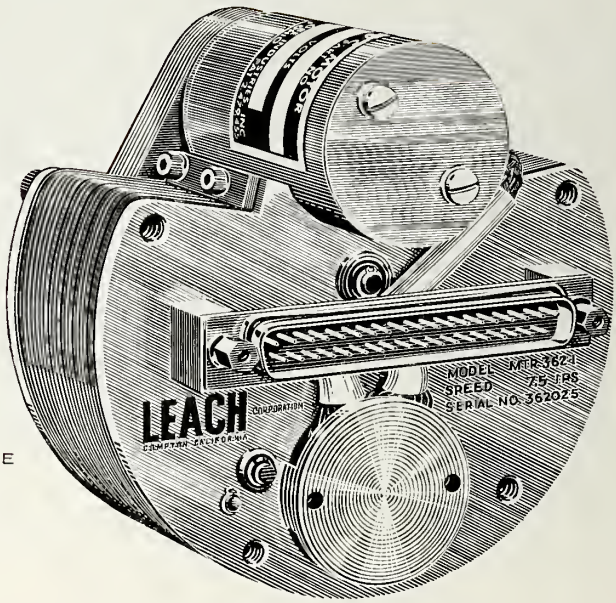
'ssile Financing Pitfalls 17
ıture of Solids in Space 20
ectronic Needs in GSE 25

AN AMERICAN AVIATION PUBLICATION

tells the whole story...with impact!

miniature tape recorder

ACTUAL SIZE



newest new product from Inet!

Testing under severe environments . . . in extremely limited space? Inet's rugged new Miniature Tape Recorder simultaneously records data on 1 to 14 in-line channels, never loses a record because it's built to survive high impacts.

Here are the features to look for: precision in-line recording head; adjustable motor speed and tape tension; molded rubber pressure roller and driver wheels; and precision ball bearings at both ends to support all revolving parts.

Weighs just 24 ounces and operates at tape speeds of from ¼ to 15 inches per second in a temperature range of —50°F. to +200°F. Among its applications: in-flight and static tests; atmospheric, blast, explosion, and wind tunnel studies; and acceleration and actuation tests. *Write today for complete specifications.*

RELIA

LOOK TO LEACH

INET DIVISION . . . LEACH CORPORATIO

18435 SUSANA ROAD, COMPTON, CALIFORNI

DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U. S. AND CANADA • EXPORT: LEACH CORP., INTERNATIONAL DIVISIO

600,000 SQUARE FEET... TO YOUR PRODUCTION CAPACITY...





ENGINEERING
analysis, design, liaison, and process

PROTOTYPE MANUFACTURING
large, modern experimental shop

PRODUCTION ENGINEERING
lofting, reproduction, and producibility

Prime contractors looking for major subcontract capability in missiles, rocket engines, ordnance, or electronics will find it at Rheem. With more than 600,000 square feet at Downey, California, the Rheem Defense and Technical Products Division offers a unique combination of experience and facilities that is unmatched in the West.

If you require unusual skills in critical welding or machining operations, be sure to consult Rheem. Rheem will assume the complete responsibility for system, subsystem, or component production, from engineering through manufacturing . . . whatever best suits your requirements. You will be impressed by the "package contract" capability that is available to you.

For the full details on Rheem availability for subcontract assignment, write to Dept. MR-712-2.



TOOLING
tool design and manufacture



MANUFACTURING
systems, assemblies, and components

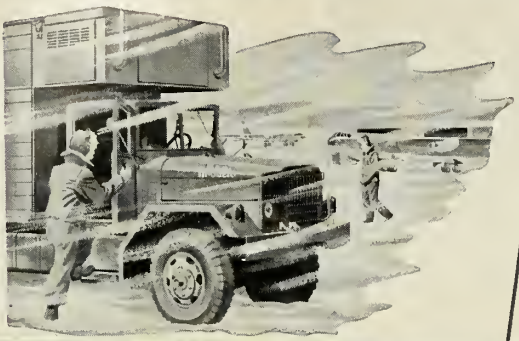
Rheem

RHEEM MANUFACTURING COMPANY
Defense and Technical Products Division

11711 woodruff avenue, downey, california

PROPULSION & MISSILE SYSTEMS • ELECTRONICS • DRONES • ORDNANCE • PRESSURE VESSELS • RESEARCH

HEAT in military applications

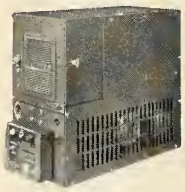




HUNTER SPACE and PERSONNEL HEATERS

for mobile and portable shelters

Hunter Heaters are designed and manufactured in conformity with military specifications for space, equipment and personnel heating in ground support systems for missiles, radar, microwave, monitoring centers, etc. Five basic Hunter models are available currently, some multi-fuel-burning, others which burn any type gasoline, each custom-engineered to specific requirements for the area of end use. Model range is from 15,000 to 60,000 BTU/Hour output, all air-circulating, all thermostatically controlled, all designed for cold starts as low as —65°F. One of the current models is . . .



MODEL UH-68

Produced in conformity with military specification MIL-H 11511B • 60,000 BTU/Hr. output • multi-fuel burning • designated "spec" equipment in Corps of Engineers' Expansible Body Program, AN/GPQ-T1 Air Force Trainer Radar and many other end item projects in the GCA category • also custom-engineered for the Matador Missile System communications shelters.



MODEL DH-73: 50,000 BTU/Hr. • for guided missile ground control equipment.

MODEL UH-73-2: 50,000 BTU/Hr. • used in U.S. Signal Corps AN/MSG-4.

MODEL UH-58-SC-1A: 60,000 BTU/Hr. • used in S-44, CPN/18A, MPS/7, M-109, etc.

MODEL UH-47-4S: 15,000 BTU/Hr. • for use in small and medium size shelters.

Engine heaters, instant lighting torches, refrigeration and air conditioning units are other Hunter products for military applications.

get these brochures TODAY! for complete details

MH-162 "Space Heaters" | MH-166 "Engine Heaters" | MH-167 "Military Torches"

HUNTER MANUFACTURING CO. | HEATING AND REFRIGERATION SYSTEMS

30533 AURORA RD. SOLON, OHIO

Executive Editor .....CLARKE NEWL
Managing Editor ....DONALD E. PE

EDITORIAL STAFF

News Editor .....REED BU
Military & Defense .....BETTY OST
JAMES
Electronics/Support Equipment ..HAL GETT
Electronics Engineering ....CHARLES D. LA
Missile Manufacturing .....WILLIAM E. HO
Missile Business .....ERICA M. F
NASA .....PAUL M
Los Angeles .....FRED HU
RICHARD VAN O
FRANK MCG
London .....G. V. E. THOMP
Paris .....JEAN-MARIE R
Geneva .....ANTHONY VAN
Art Director .....WILLIAM MA
Ass't Art Director .....BACIL GU

CONTRIBUTORS

Propulsion Engineering .....MICHAEL LOR
Industry .....JAMES J. HAGGERTY,
Soviet Affairs .....DR. ALBERT PA
Space Medicine .....DR. HUBERTUS STRUGH
Astrophysics .....DR. I. M. LE
Research .....HEYWARD CANNEY,

ADVISORY BOARD

DR. WERNHER VON BRAUN — ROBERT P. HAVIL
DR. PETER CASTRUCCIO — DR. ARTHUR KANTROW
KRAFFT EHRICKE — DR. EUGEN SAEN
R. F. GOMPERTZ — ALEXANDER SA

BUSINESS STAFF

Assistant Publisher .....E. D. MUHL
Advertising Sales Manager .....W. E. BRO
Circulation Director .....L. L. BRETT
Research Manager .....D. T. FOS
Promotion Manager .....J. E. MUL
Advtg. Service Manager ..MRS. GLADYS BUSS
Production Manager .....J. F. WA
Ass't Production Mgr. .....ELSIE G
New York .....17 East 48 Str
Eastern Advtg. Mgr. .....P. B. KIN
P. N. ANDER
A. B. SCHE
Detroit .....201 Stephenson B
K. J. WE
Chicago .....139 N. Clark
G. E. YO
Los Angeles .....8929 Wilshire B
J. A. CL
C. R. MARTZ,
Miami .....208 Almeria Aven
R. D. HA
Toronto .....12 Richmond St.
ALLIN ASSOCIA
London .....28 Bruton
NORALL & H
Paris .....11 Rue Condor
Geneva .....10 Rue Gren

Missiles and Rockets Volume 5 Number 21

Published each Monday by American Aviati Publications, Inc., 1001 Vermont Ave., N.W. Washington 5, D.C.

WAYNE W. PARRISH .....*President & Publish*
LEONARD A. EISERER ...*Executive Vice Preside & General Manag*
A. H. STACKPOLE .....*Vice Preside*
FRED HUNTER .....*Vice Preside*
ERIC BRAMLEY .....*Vice Preside*
ROBERT R. PARRISH .....*Vice Preside*

Printed at the Telegraph Press, Harrisburg, P Second class postage paid at Washington, D and at additional mailing offices. Copyrig 1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, $8.00; 2 years, $12.00; 3 years, 14.00. Foreign—1 year, $10.00; 2 years, $18.00; 3 years, $26.00. Single copy rate—$.75. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr., m/r, 1001 Vermont Ave., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

MAY 25 HEADLINES

Pitfalls of Missile Business Financing
Special M/R staff report shows that growth can be deadly, but here's advice on where to get capital—while you still can 17

Unit Cools IR Gear to 60°K 32

U.S. Seeks Ways to Close Translation Gap
Electronic translator seen as a dire need to cope with the problem 35

ABMA Receives First *Saturn* Engines
Jupiter test stand being modified to accommodate cluster of eight Rocketdyne H-1 liquid engines 36

British Developing A-Warheads for *Thor* 54

Spacecraft Materials Probed
Lockheed-sponsored symposium brings out techniques being studied including temperature, erosion, sputtering, lubrication and vacuum 56

ASTRONAUTICS ENGINEERING

Solids in Space: Where do We Go?
Bright future seen for deep space probes where more than a simple ballistic trajectory is needed for exact astronavigation ... 20

MISSILE SUPPORT

What's Future for Electronics in GSE?
All indications by EIA point to a doubling of electronics output by 1965 with 75% of the electronics dollar remaining on the ground 25

MISSILE ELECTRONICS

GE Has New Micro-Modular Concept
Company claims eraser-size device called TIMM utilizes heat losses and lends itself to stacking for varied uses 28

THE MISSILE WEEK

Washington Countdown 9

Industry Countdown 15

More About Missile Week 46

DEPARTMENTS

Editorial 7
Letters 37
Contract Awards 39
People 42
Missile Business 50
Propulsion Engineering ... 52
When and Where 60

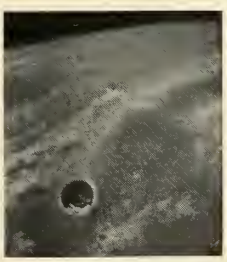


COVER: This large antenna is part of radar network on Army's missile tracking ship SS AMERICAN MARINER.

AND AWAY IT GOES!







125 MILES UP: A special ACR Electronics Corp. 16-millimeter camera snapped these sensational shots as the nose cone of a *Thor* separated over the Atlantic. Camera is of compact design capable of safeguarding film during impact with ocean. Pictures were taken through a quartz window of General Electric Co. recovery capsule located in the cone-shaped afterbody of the *Thor* nose cone. Capsule was ejected from nose cone shortly after it hit the water, 1400 miles from Cape Canaveral.





RUGGED

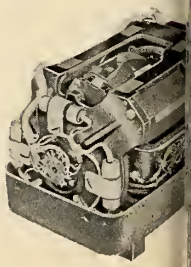
IN THE ROUGHEST, TOUGHEST RIDES, LEAR SERIES 1080 GYROS ASSURE CONTROL

Demanded by extreme vibration in missile environment: a small, rugged, reliable vertical gyro providing maximum performance. *Successfully engineered by Lear:* a compact two-degree-of-freedom vertical gyro with proven high quality at low cost.

SERIES 1080 GYROS WILL MEET YOUR APPLICATION REQUIREMENTS FOR DIRECTIONAL OR FREE GYROS AS WELL AS VERTICAL GYROS.



LEAR 1080 SERIES DISPLACEMENT GYRO







LEAR

GRAND RAPIDS DIVISION

110 IONIA AVE., N.W., GRAND RAPIDS 2, MICHIGAN

The Remarkable City of Huntsville

One of these days the technicians of the Army Ballistic Missile Agency at Huntsville will bolt a circular cluster of H-1 Rocketdyne engines to a modified *Jupiter* test stand and push a button. The act will unleash some million and a half pounds of thrust and the most horrible roar that has ever been heard in Alabama.

ABMA announced this week that it had received the first of the new engines (see page 36) and that the entire system, named *Saturn*, would be flight tested in 1960. Work has already begun on modification of the test stand to accommodate this monster of the Space Age and now it is a matter of forging the eight engines together in the approved configuration. This work cannot be done, incidentally, in the ABMA "fab lab" where other missile construction goes on. The three-story high ceiling is too low to accommodate the cluster.

Huntsville, Alabama, is probably the only town in the country where such a test could be carried out with the consent and approval of its citizens. ABMA will simply inform Huntsville to hold its collective ears, say, between and 9 and 10 a.m., on the designated day and Huntsville will cheerfully, even enthusiastically, run whatever risk to its *tympanum* that may be involved. Anyone who has ever stood a quarter of a mile away during the testing of *one* 150,000-pound-thrust engine can imagine the noise a cluster of eight will make. Yet, Huntsville will probably be both hurt and incensed at any suggestion that the testing should be done elsewhere.

In many ways Huntsville is quite a remarkable place. Settled during the early days of America because a big gushing spring provided ample fresh water, it became important, particularly in Civil War days, because it was the junction of north-south, east-west rail lines. But it was never really anything more than a sleepy Southern village until the Army decided to get into the missile business and chose Huntsville and the Redstone Arsenal there for its operating site.

Huntsville then blossomed and boomed from 15,000 to its present hundred and some thousand, depending on how far into the environs you want to go. It has been a relatively orderly boom with roads, housing developments, schools and law and order keeping pace under a remarkably wise municipal government. (In schools, for instance, the rate of progression has been one classroom a day for the past several months.) A solid local newspaper has helped immeasurably, too.

Chiefly, Huntsville cannot escape being notable for the enthusiasm it constantly displays for its missile and spacecraft building tenants. A new assignment for a new project in the cosmos brings cheers from the town—mayor, merchant and millworker. A cancellation, a setback or an adverse decision from the Pentagon brings corresponding gloom along Main Street. Roles and missions aren't involved. Huntsville is for the home team.

If this is a reflection of Huntsville's economic dependence on the Army's vast complex in the town's back (or front) yard, it is also a reflection of some highly-inspired labors in military-civilian relations with model results. Every military installation in the world could wish for such support.

A great deal of this amicable blending is, of course, traceable to the nature of the military establishment—the U.S. Army Ordnance Missile Command under the leadership of Maj. Gen. John B. Medaris. His organization at Huntsville is divided into two lesser commands—the Army Ballistic Missile Agency under Brig. Gen. John K. Barclay and the Army Rocket and Guided Missile Agency under Brig. Gen. John G. Shinkle. The redoubtable Wernher von Braun is, of course, director of development operations for the former, ABMA. Another occupant of the Huntsville complex, although a tenant, is the Ordnance Guided Missile School.

Obviously, the calibre of both military and civilians working in the three agencies must be and is a cut considerably above the norm in both education and intelligence. The Missile School, for instance, trains both Army and Air Force personnel in the operation of the *Jupiter*. It also trains NATO soldiers and airmen, both as individuals and in operational units, in the operation of Army missiles which have been or will be stationed overseas. (The curriculum is all set for the first Italian teams who will man the *Jupiter* IRBM stations in Italy.)

The 2000-person teaching and administration staff of the school, incidentally, averages (from secretary to commander) two years of college. Twelve months once passed without a court martial among the military personnel. The school introduced for the first time into military usage the TelePrompTer System of visual teaching and later added closed television circuits.

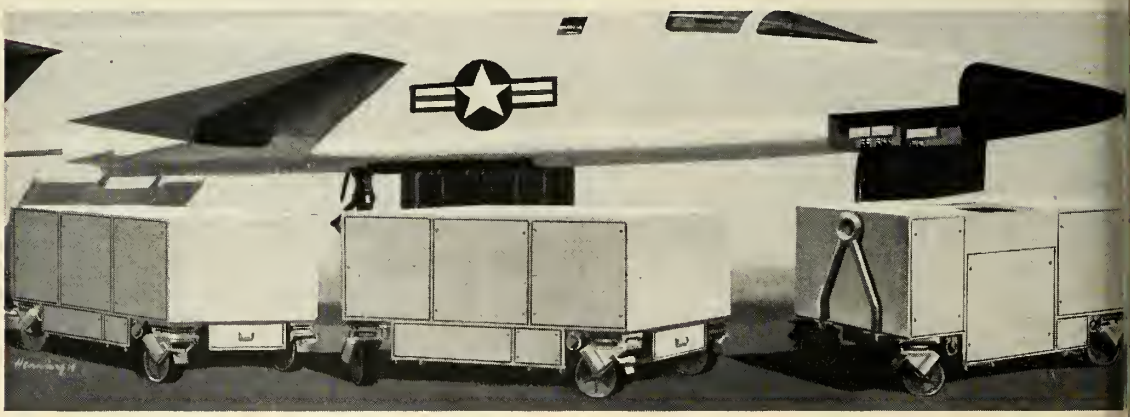
All in all, both Huntsville and the Army can be proud of military command and civilian population. Together they make a good team which, one of these days, will be holding its collective ears against the sound which will signal another step in man's adventuring in space.

Clarke Newlon

HOW TO FIND FAULT



...BEFORE COUNTDOWN



...BEFORE TAKEOFF

Just connect your weapon system, manned or unmanned, to one of Autonetics' two automatic checkout centrals: the GS-1A test console or the C6A BACE low-profile cart.

They render a GO or NO-GO verdict in *minutes* instead of hours. They do their critical job at least 100 times faster than a swarm of skilled technicians with meters and hand probes—and they do it with infinitely greater accuracy.

They meet the needs of the majority of modern weapon systems... accommodate adaptive equipment to test special electronic systems.

They're rugged: no relays, no tubes, fully transistorized. They're very simple to use: just show the operator which button to push. They're reliable: continuously take their own pulse.

Autonetics foresaw the day when the electronic systems inside a weapon would become as important as the frame that enclosed them... decided to automate the whole procedure. These automatic checkout controls—originally developed in cooperation with the Air Force and tested in the NAVAHO program—are now at work for both Air Force and Navy.

They're the heart of today's most *versatile* automatic checkout systems—only *practical* way to keep weapon system reliability at a ready-to-go pitch.

Automatic checkout centrals by Autonetics

A DIVISION OF NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA • REGIONAL OFFICES: WASHINGTON, D. C. AND DAYTON, OHIO
INERTIAL NAVIGATION / ARMAMENT CONTROL / FLIGHT CONTROL / COMPUTERS AND DATA PROCESSING

washington countdown

IN THE PENTAGON

The death of Deputy Defense Secretary Donald A. Quarles can—and probably will—have far-reaching effects on the future of the Pentagon's widespread development set-up. Some of the effects of his death already showing up are . . .

In Dr. Herbert York's new Development & Engineering organization: The powerful centralized organization—a Quarles favorite—was just about to be given final approval by Defense Secretary Neil H. McElroy. Now a serious drive by the services and others is underway to lessen the power of York's office. But his chances of holding most of his own are considered good . . .

In top Pentagon development offices generally: The release of Quarles' strong hand is felt in many places. Once greatly-concentrated authority is flowing back into a more distributed pattern . . .

In Roy Johnson's ARPA: Many have thought that ARPA was headed for fairly rapid extinction. But now that McElroy has decided to stay on "indefinitely," it looks as if Johnson and ARPA will stay on "indefinitely," too.

• • •

The meaning: Control over development tightly held by Quarles could go to York . . . or partly to Johnson . . . or partly to the services. An inner struggle is on.

• • •

However, don't expect any drastic policy changes because of the appointment of Navy Secretary Thomas S. Gates as the new Deputy Defense Secretary. Like Quarles, Gates is known as an Administration man and will not try to alter the existing presidential party line.

• • •

A decision is expected very soon on selection of a prime contractor for *Dyna-Soar*, the boost-glide space missile launching platform. Competition is between Boeing and Martin. As M/R went to press the USAF Air Council had not received an evaluation report from Air Materiel Command but knew it was on the way.

• • •

Alterations on the *Redstones* which will be used to send the astronauts on their first trip into space will be made at Huntsville. The same capsule being developed by McDonnell for later use on the *Atlas* will be fitted to the early Army missile. First flight is expected before the end of 1959.

Watch for more big changes at Air Research and Development Command under new leadership of Lt. Gen. Bernard Schriever. Among those already announced: Maj. Gen. James Ferguson as ARDC vice commander, succeeding Maj. Gen. John Sessums who is expected to retire . . . Maj. Gen. William Canterbury as deputy commander for research, succeeding Maj. Gen. Leighton I. Davis.

ON CAPITOL HILL

One of the most significant moves by the 86th Congress is the attempt to tighten Congressional control over both missiles and space. Earlier this month the Senate Armed Services Committee called for requiring authorization of all missile programs as well as approval of appropriation requests. Now the House has called for authorization of all space programs for the next five years. All-out fights can be expected.

• • •

The Joint Congressional Atomic Research Subcommittee is preparing to crack down on the Administration over delays in development of the nuclear-powered plane—a proposed deliverer of the ALBM. The subcommittee understood a speed-up was planned. Then it was told that this was incorrect. If no speed-up is forthcoming, the subcommittee is all but certain to stage some of the hottest hearings of the year.

AT NASA

NASA is soon to announce the location of a site in North Dakota for one of four polar-orbit tracking and telemetry stations. Selection of the other three sites—in Alaska, Newfoundland, and Europe—is also supposed to be at hand.

• • •

NASA also is speeding up its search for an appropriate site for the proposed $5 million high-energy rocket development and test center. The center was cut from the NASA FY '60 budget by House members because NASA couldn't tell the Congressmen where the center would be located. Ideally, NASA would like to build it near the Lewis Propulsion Laboratories in Cleveland.

AROUND TOWN

The National Aviation Club is going to honor Dr. Theodore von Karman, one of the world's top scientists, as man of the month for May. Von Karman is chairman emeritus of the USAF Scientific Advisory Board.



8497-A

SPECIFICATION: AERONCA BRAZED HONEYCOMB STRUCTURES

DESTINATION: *MACH 3!*

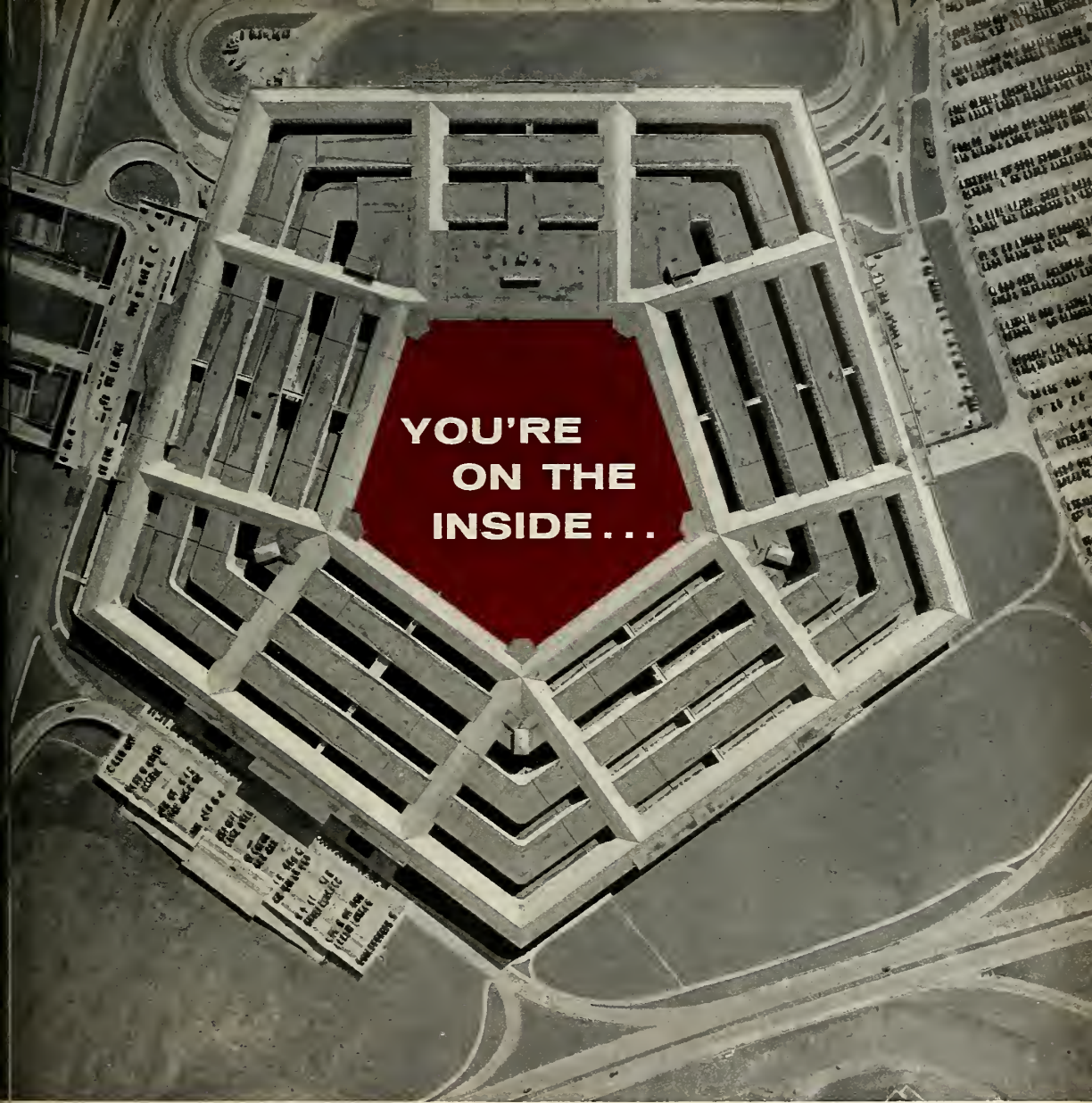
To meet the critical demands of Mach 3 performance, new concepts in air vehicle structures have been evolved. Stainless steel honeycomb sandwiches, for example, are specified as major structural components in current weapons systems designed to operate in high mach environments.

Aeronca, a pioneer in the application of stainless honeycomb to air weapons, has developed advanced production methods and facilities under a proprietary research and development program. As a result, Aeronca is one of the few companies actually producing these high-temperature structures in quantity.

Aeronca is proud that its capabilities have been selected to support the North American B-70 and F-108 Weapons Systems.

AERONCA manufacturing corporation
1716 GERMANTOWN ROAD • MIDDLETOWN, OHIO

Expansion of our operations has created openings for additional senior engineers. Write to L. C. Wolfe, Chief Engine



You're on the inside of the entire $45 Billion Military Market when you advertise in Armed Forces Management—reaching 17,000 top military and civilian personnel in the Department of Defense. Over 4,000 copies go to the Pentagon alone! It reports with authority on military policies, politics, plans . . . editorial material of interest, value and importance to all the military services.

Send for detailed Armed Services Marketing Manual—Armed Forces Management offers you a marketing manual giving complete analysis of the military market. It explains how to reach the top military (major and above) and civilian executives (GS-13 and above) who have the most to say about policy, purchase, specification and procurement of the many thousands of items the armed services buy. Write for your copy.

AF m ARMED FORCES management

AMERICAN AVIATION PUBLICATIONS, INC.
1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

BRAIN POWER



RAMJETS

THE PROBLEM. To realise for civil and military use the staggering potential of the ramjet engine—the jet engine with no moving parts that promises to prove the most efficient method of propulsion inside the earth's atmosphere.

THE ANSWER. Bristol teams designed and developed efficient ramjet engines. They flew many hundreds of supersonic test vehicles, since, of course, ramjets must be tested in the environment in which they are destined to operate.

This work culminated in the Bristol Siddeley Thor, the powerplant for the Bristol/Ferranti Bloodhound Guided Missile. But in producing Thor, Bristol built up Europe's most extensive experience of the ramjet and the most complete facilities for its further development.

And developed it will be. For today, the world's designers are beginning to see in ramjet engines the means of making *civil* supersonic travel a p economic reality.

How well has the brief been fulfilled? The Bloodhound can best answer for the milit plication.

Security forbids publication of the full fac this much can be said. The Bloodhound alre proaches full operational status with the RAF been ordered by Sweden. With the range an imparted by its Bristol Siddeley ramjets, the hound has greater effectiveness than any other to-air guided missile in the western world. An future defence needs dictate even higher speed longer ranges, even heavier armament, these ne be met without major alteration or redesign ramjet-powered missile and its system.

Ramjet power for manned aircraft is the nex

LIGHT POWER



ramous Bristol Siddeley engines :-

E.E—turbojet . . . high subsonic and supersonic speeds
oerplant of the Handley Page Victor bomber.

ES—most powerful jet-prop in airline service . . .
rable mechanical excellence and exceptional reliability
ne Bristol Britannia.

R-turbojet . . . exceptional handling qualities . . .
r the Hunting Jet Provost, RAF's basic jet trainer, and
ilivik pilotless target aircraft.

US—outstanding lightweight medium-thrust turbojet
ady specified for 14 different aircraft in 8 countries.

L MAMBA—jet-prop . . . stressed for naval operations
s deck landing and catapulting . . . installed in the
teamew.

OLUS—turbojet . . . remarkable for great power at high
e and very low fuel consumption . . . powerplant of the
ulcan bomber.

DOUBLE MAMBA—jet-prop . . . virtually twin-engined reliability for long oversea reconnaissance duties . . . powers the Fairey Gannet anti-submarine aircraft.

CENTAURUS AND HERCULES—two radial piston engines, with Bristol-pioneered sleeve-valves . . . renowned for their reliability and long overhaul life.

Bristol

Siddeley

ENGINES LIMITED

RAIN POWER translated into FLIGHT POWER



A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)

industry countdown

STRUCTURES

First nuclear-powered missile cruiser—Long Beach (to be commissioned in FY 1961)—will have two extremely high-speed fire control systems to launch the supersonic surface-to-air *Talos*. Mark XII magazine and mechanized loader being developed by General Electric under $8 million contract will weigh 350 tons—reportedly the largest single piece of ordnance ever ordered by the Navy. It is bigger than the fire control system for a battery of 16-inch guns. Two other nuclear cruisers also are programmed and will be similarly equipped for the Bendix-RCA *Talos*.

• • •

In the 1960 budget, the Navy discloses it is buying enough Raytheon *Sparrow III* air-to-air missiles to "provide slightly more than a month's combat usage." Amount for Martin air-to-surface *Bullpup* will last for "a little less than a month's combat."

• • •

Look for NASA to back off somewhat from its original decision to keep exclusive rights to inventions conceived under its contracts. Permanent regulations upcoming soon are expected to allow contractors to retain proprietary rights—but the final decision as to who gets the patent rights will come after the invention, and not before the contract is signed.

PROPULSION

North American engineers predict the missile-launching B-70 bomber may use 50 to 75 tons of steel products, mostly thin-gauge alloys and stainless sheets and honeycomb sandwiches. Plane will be built like a "flying fuel tank" with the basic load-carrying structure containing the fuel to eliminate internal tanks. Structure may be assembled by fusion welding to meet 400°F to 650°F temperature requirements.

ELECTRONICS

Competing for $12 million NASA contract to construct and manage *Mercury* range are: Thompson Ramo Wooldridge, Reeves Instrument, Aeronautics Systems, Cubic Corp., Austin Corp., IBM, Convair, Vitro Laboratories, Milgo Electronics, Temco Aircraft, Aircraft Armaments, Sylvania, J. G. White Engineering, Nat Harrison Associates, Chance Vought, Ralph M. Parsons Co., ITT Laboratories, Page Communications, Philco, RCA, Space Electronics, Collins Radio, Aerojet-General, Chrysler Corp., Westinghouse, Cook Electric, Western Electric, Brown & Root, Lockheed, Burroughs Corp. and Underwood Corp. Contract will be let July 1.

• • •

The Pentagon is earmarking $118.1 million in the 1960 budget for purchase of ECM (electronic countermeasures) equipment. ECM embraces both defensive countermeasures to help aircraft penetrate enemy defenses and electronic reconnaissance to obtain information on enemy missiles and other weapons.

• • •

Best guess of the Air Force is that it will be sometime in 1963—four years from now—before SAGE (semiautomatic ground environment) combat command system is completely finished. It is now operational from Bangor, Me., to Washington, D.C.

ASTROPHYSICS

Russia is reported to be very actively researching the dynamics of outer space travel, which some day may be scheduled around solar storm activity. Avco's Dr. Arthur Kantrowitz is urging more U.S. research to open up this entirely new field of meteorology.

• • •

Soviet astronomer Nikolai Barabashov refutes the "green cheese" theory about the moon. He says the moon is not one color but many—brown, yellow, blue and red as well as green. Instead of being covered by cosmic dust or volcanic ash, as suggested by other observers, the Russian says the lunar surface is covered by a layer of rock grains.

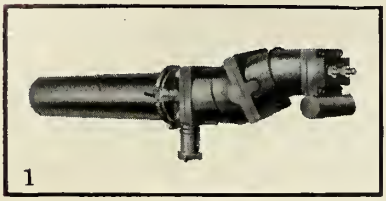
SPACE MEDICINE

Strictly paper combination of medical facilities at Brooks AFB and Lackland AFB in Texas and Gunter AFB, Ala., will be made soon to form the AF Aerospace Medical Center. All facilities will remain at their present locations.

More about the Missile Week on page 46.

EFFICIENT, COMPATIBLE AUXILIARY POWER SYSTEMS...

designed and built by VICKERS

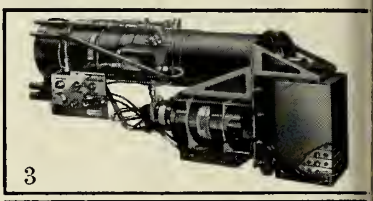

1

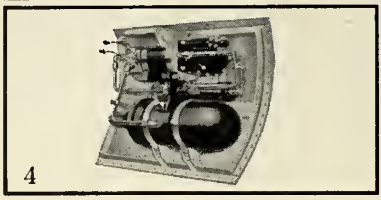
Missile progress demands unquestionable reliability, maximum efficiency and compatibility of the system with the overa vehicle. These rigid standards are being met by Vickers wit *missile industry-tailored* R & D, engineering, production an service capabilities blended with extensive experience gaine from a large number of successful accessory applications o a majority of the current production missiles.

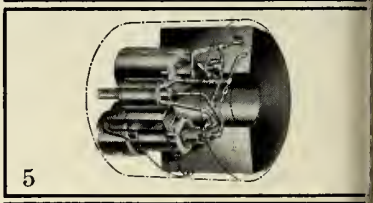
Typical Vickers designed APS's include:

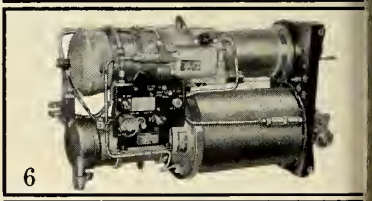
1. Hot Gas Systems
2. Close Frequency Systems
3. Battery Powered Systems
4. Door Mounted Systems
5. Blast Tube Configurations
6. Turbine Powered Systems
7. Flywheel Systems

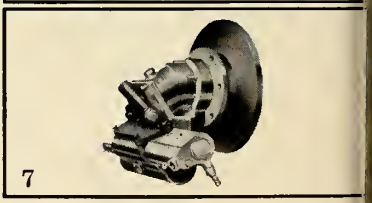

2


3


4


5


6


7

Using proven components as building blocks, Vickers can shorten APS development time and speed delivery . . . all with the assurance of dependability. These advantages are passed on to you whether your specifications call for one or any combination of the following:

- TEMPERATURE TOLERANT SYSTEMS
- MAXIMUM EFFICIENCY
- CLOSE FREQUENCY CONTROL
- HIGH SPECIFIC POWER
- HIGH OR LOW DRIVE SPEEDS
- ACCURATE VOLTAGE REGULATION

For further information contact the nearest Vickers Sales and Service Office or *write for Bulletin No. A-5236.*

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION

Aero Hydraulics Division — Engineering, Sales and Service Offices:

ADMINISTRATIVE and ENGINEERING CENTER
P. O. Box 302 • Detroit 32, Michigan

TORRANCE, CALIFORNIA
3201 Lomita Blvd., P.O. Box 2003 • Torrance, Calif.

Aero Hydraulics Division District Sales and Service Offices:
Albertson, Long Island, N.Y., 882 Willis Ave. • Arlington, Texas, P. O. Box 213 • Seattle 4, Washington, 623 8th Ave. South • Washington 5, D.C., 624-7 Wyatt Bldg.
***Additional Service facilities at:* Miami Springs, Florida, 641 De Soto Drive**
TELEGRAMS: Vickers WUX Detroit • TELETYPE: "ROY" 1149 • CABLE: Videt
8239 OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd.—Great West Road, Brentford, Middx., England

Engineers and Builders of Fluid Power Equipment Since 19

Y 25, 1959—VOL. 5, NO. 21

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Pitfalls of Missile Business Financing

Growth can be deadly. But here's where to get capital —while you still can!

An M/R Staff Report

WASHINGTON—Need money? Final- get that first really big contract only find you can't finance it? Short of ital for expansion, market develop- nt, new business, in-house R&D, ? Got backlogitis (symptom: ched bank account)?

In a word, are you suffering the ncial growing pains of a growth npany in a growth industry? If so, a money doctor—right away. nerwise, lacking time to effect a e, you may end up being embalmed ler the terms of the Federal Bank- tcy Act—for without a diet of bal- ed management and proper finan- nourishment, growth can kill.

More and more companies in the siness are beginning to realize that hnological posers aren't the only idaches plaguing missilery. There are ney problems, too, that can be every as tough as developing a leak-tight prine joint, a 283,000-psi solid rocket tor case, or a continuous space wer source rated at one kilowatt per ice of weight. What many compa- s don't know is that there is a good ker's dozen or more of ways to ward these money troubles.

In 1950 the missile market came to mere $500 million. Today, if you lude missile, space and related sup- rt procurement, it's nudging $9 bil- n. For 1965, half a decade hence, n conservative estimates peg the al at $30 billion a year. It's one of most rapid growth patterns in peace- e history.

And with the growth of the indus- many companies are growing too— ne at a more rapid rate than they afford. Too many—particularly all businesses plunging headlong into business—find this out too late. en they lose an important contract, cause they can't finance it, and thus mage their reputation; are forced to rge with a larger, moneyed com- ny, with loss of identity and too en loss of the creative secret of their success; or, worst of all, are driven into bankruptcy.

The basic financial hazards of growth all add up to too little money to finance: expansion, current business (cost of materials and labor in servicing too big a backlog can be, and often has been fatal), new business, contract termination (other bad times), modernization, research and development, etc. And to these general hazards of growth must be added the numerous specific handicaps of current defense business policies. Here are just a few of these:

• **Tight competition** (sometimes from companies *buying* their way into the missile market) for advertised bid contracts, with resultant skinnier profit margins.

MANAGEMENT TRAPS

A. Poor Financial Planning
1. Inadequate Records
2. Cumulative Losses
3. Neglected Tax Payments
4. Expansion Beyond Resources
5. Excessive Fixed Costs

B. Poor Coordination Between Manufacturing and Selling
6. Lack of Product Development
7. Lack of Diversification
8. Lack of Data on Own Customers
9. Contracted Entire Output to Single Buyer
10. Lack of Market Research
11. Continued Policies of Bankrupt Predecessor
12. Legal Problems

C. Poor Other General Administration
13. Family Factors
14. Lack of Administrative Coordination
15. One-Man Management
16. Lack of Technical Knowledge
17. Absentee Management
18. Internal Conflict

• **Nature of CPFF contracts,** particularly in missilery, where often as not changes in requirements and technological modifications force the cost way, way up with no commensurate increase in the fee which, as the term says, is cost-plus-FIXED-fee. This reduces earning power of both working capital and equity investment.

• **Need to finance 20% of inventory** of certain cost-type contracts. This gets particularly worrisome during the shift from development to production phase when, again, change orders may pile up that inventory perilously high.

• **Contract termination,** sometimes with cancellation coming with the quick brutality of a telegram. This not only means loss of business, but you will have to finance termination costs until the red tape permits final payment.

• **High cost of much missile R & D,** where you may have the best technical qualifications in the world but, lacking evidence of financial ability, you lose the business.

• **Chances of losing the production contract** to someone else, after you made a profitless low bid on the R&D phase just to get into the program—figuring to make your money on the production run.

• **Obsolescence of a technology** in which you were leader, because of development of a newer, better method. Unless you've got the capital as well as the know-how to diversify or improve your own techniques, you're in trouble.

• **High materials costs** relative to processing costs, which could force you to give up a particularly lucrative piece of business. A recent example was a monstrously big, devilishly complex nozzle for a development rocket motor. Use of a so-called "exotic" metal pushed materials cost to over $400,000, compared to only $80,000 in processing costs—just for one nozzle. Business like this takes some heavy financing.

This usually happens because Washington doesn't want to upset its cash expenditure budget system—or, maybe, because (if you're a subcontractor) one of your best customers may be maneuvering for a merger and wanting to make his cash position look as good as possible.

• **Performance bond requirements** on some especially large contracts, such as engineering, manufacture and assembly of, say, a hypersonic wind tunnel—where the bond may run $500,000 or more.

• **Need to finance in-house R&D** if you're going to have any kind of favorable patent position. If developed under contract, patent rights usually belong to the government.

All these add up to increase the dangers of doing business in the missile market, and tend to make financial collapse, when and if it comes, all the more sudden. They also make it pretty obvious that defense business, in itself, does not always provide an easy route to expansion.

But for the company that looks to its financial future in time, there are many roads to relief. This is particularly true of smaller companies, due to Federal small business legislation. They range from going to the public with a stock issue, to a 100% government loan from the Small Business Administration.

Large companies face virtually the same financial problems as small companies—government limitations on earnings from defense business, renegotiation, taxes, hazards of CPFF contracts, etc., versus continuing and expanding needs for both equity and working capital.

Big company management, however, is usually well enough balanced between technological, administrative and financial know-how that it becomes aware of financial troubles at their onset. And, knowing of the impending danger, it is also aware of the various alternative solutions.

Small companies, however, are often built on the technological and/or sales abilities of one or two men who frequently don't recognize the impending danger until it's too late or, if they do, may be aware neither of the various solutions available to them nor of how to go about taking advantage of them.

• **Many sources**—There are many sources of money, both direct and indirect. Direct sources of capital break down between investment and borrowings. Indirect sources evolve from competent corporate management. Here are some of the direct sources open to both big and small companies:

• **Public stock issue**—Even if profit and loss and balance sheets seem to leave something to be desired, so long as you're in the missile business and not obviously bankrupt, your stock should be in good demand.

Look at the prices some missile stocks are bringing, and it's obvious that more often than not the public is buying on romance, rather than statistics. And the newer the "find," such as a missile stock on the market for the first time, the hotter the demand. By "missile company," we mean any company demonstrably connected with the business—not necessarily one of the big prime contractors. Some recent new issues have been over-subscribed tenfold or better.

Going to the public for money doesn't mean you have to give up control. You can usually keep control—and it doesn't require a majority interest. And of course there are many different kinds of stock—preferred without voting rights; common stocks that have a first call on dividends up to a certain point, with limited voting rights and which may be convertible to full voting shares; and many more. One currently successful money-raising technique is the issuing of subordinate debentures with stock warrants enabling holders to buy common stock at a favorable price. If you're interested in these possibilities, consult a recognized expert in the field.

• **Private investment**—This can be done by one of the big financial houses or an individual. Examples of the former are the Lehman Bros.-General Dynamics relationship, which has been very profitable for both, or the Johnston-Lemon-Atlantic Research relationship. This approach usually means participation in the management of your company by the investment house, but at least you'll get top financial advice—which may be just what the doctor ordered.

One problem missile companies may run into in going to, say, a Wall Street financial house, is that people there may not have a ready technical appreciation of just what it is your company is so good at. One financial consultant puts it this way: "You're trying to raise money for a bizarre and unestablished product on a whimsical money market." However, this problem is rapidly disappearing with the mounting business acceptability of missilery and space flight.

Two notable individuals in the business of picking up and backing "golden opportunities" are How Hughes and Laurance Rockefel What kind of deal you can make such an arrangement depends on individual, and individuals vary grea But odds are that one thing they have in common is a desire to fol their money with their control.

• **Long-term borrowings**—This can be from an insurance comp or, again, an individual. Banks are help, since long-term business lo aren't bankable. Long-term lo usually mean issuing first mortg bonds, general mortgage bonds (b of which must be more or less secu or debentures, which are little m than interest-bearing promises to p Usually it's tough for a small c pany to raise capital this way, un it can present a really convincing ture of good management and g prospects.

In any case, make certain you d borrow so much at such an inte rate (on bonds now running ab 5%) that you eat up the meager pr allowance (7-14%) permitted on g ernment business.

• **"V" loans**—These are prima working capital loans whereby the n tary services (and certain other g ernment agencies) with ultimate sponsibility for your defense contr will guarantee up to 90% (excepti up to 100%) of a bank loan amounts limited by an "asset formu but not to exceed 90% of the "t rower's investment in defense prod tion operations."

Maturity dates are set to "confo reasonably to the borrower's financ requirements for defense product contracts on hand at the time of guarantee."

These are available to both la and small business and to both pri and subcontractors. What you're do must be essential to the national fense. The responsible military serv the local Federal Reserve Bank and bank that's going to actually loan the money all participate in appro first, of a certificate of eligibility, a second, of the actual guarantee.

One real advantage of this syst is that it can be arranged as a volving account—moving up or do with your volume of defense busin

• **State and local developmen** These are privately-owned corpor entities set up in states and local c munities for the double purpose bringing new business to the area fostering the growth of companies ready there.

These are eligible for long-te loans from SBA up to the amount their borrowings from other sour This money they can use, in turn, provide equity capital and long-te

is to small business. However, un- their charters they can also help business in other ways—provision low-rent plant space, for example. re are over 2000 such development panies in the U.S.

• **Agreements with larger firms**—e the larger company supplies both king capital and back-up produc- capacity. You may ask: But why uld a big company make such an ement? Why don't they go out and the business themselves?

The answer will usually be: Be- se they can't. They don't know their around the missile business yet don't have a technical familiarity its problems and requirements. ur company, on the other hand, may e an intimate knowledge of all these gs. If so, you probably pass up e sales opportunities than you go r—because you haven't the physical t and cold cash. So, you trade iness and know-how for cash and acity.

It's a good deal—if it works. But will work out over a profitable pe- of time only if there's a rare meet- of minds and temperaments. Real- also that the larger company may k with you only long enough to the necessary know-how and then ll of a sudden he's no longer bene- or, but competitor.

Nevertheless, it may give you the athing spell you need. Should you er into such an arrangement, be pared to demonstrate both joint individual responsibility to your tomers.

• **Special financial aids**—The gov- ment usually defines a small manu- uring business as a company with 250 employes or less, but with numer- ous exceptions up to 1000. Small serv- ices companies are those that gross $5 million or less—again with some ex- ceptions. As a result of various acts of Congress there are now a number of special financial aids to small busi- ness—nearly all administered directly or indirectly through the Small Busi- ness Administration. Here are some of the aids it offers:

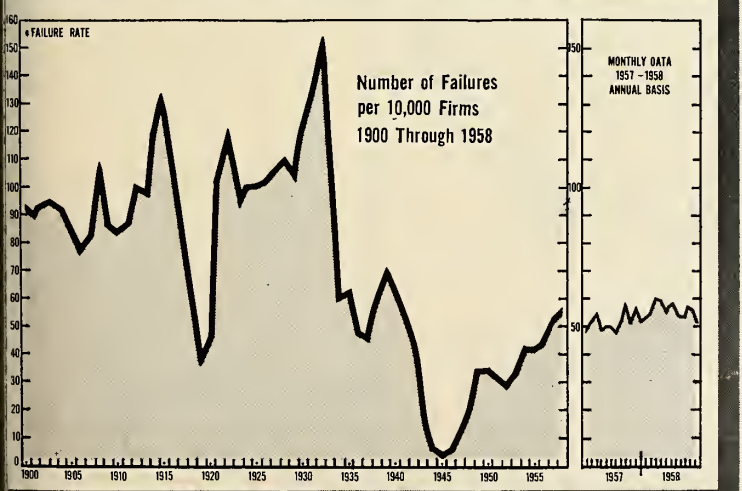
• **Participating loans**—In this case SBA goes in with a bank in loaning you long-term money (up to 10 years at 5½% interest) for working capi- tal, expansion, research and develop- ment, modernization, consolidation of accounts payable, etc. In these SBA will supply up to 90% of the joint loan, up to $350,000 as its share.

• **Direct loans**—In this case, SBA supplies all the money. Maximum ma- turity is still 10 years; interest, 5½%. The top limit of an SBA direct loan is also $350,000. Actually just over three- quarters of the loan applications com- ing into SBA are for amounts under $50,000. During the July-December, 1958, period, 262 loans over $100,000 were approved, including 21 over $250,000.

However, few were missile com- panies. In March, of over 1000 loan applications coming into SBA, fewer than 10 could even be remotely con- nected with the missiles and space flight effort. Of this situation, SBA says:

"With exceptions, it is the opinion of the study team that the prime con- tractors were not familiar with SBA nor have they sought the assistance of SBA."

RATES OF BUSINESS FAILURES



1958, there were 56 failures per 10,000 firms compared with 52 in 1957, but the of failures was 55 in the second half compared to 57 in the first half of 1958.

For an idea of how small business in general avails itself of SBA's loans, in the last six months of calendar 1958, 34.2% of the approved business loans were for working capital; 19.2% for facilities; 36.7% for consolidating ob- ligations, and 9.9% for equipment.

Kinds of companies to whom loans go include: chemicals and allied pro- ducts, fabricated metal products, ma- chinery, electrical machinery, etc., as well as a wide variety of wholesaling, retailing and servicing companies.

• **Equity capital investment**—This is possible by one of the new Small Business Investment Corporations auth- orized last year by Congress and just now being set up. Seven have been established. Sixty applications are pend- ing, of which 30 have tentative ap- proval. Albeit indirectly, this puts gov- ernment into equity financing for the first time.

SBIC's are authorized to supply equity capital in return for common stock not exceeding 20% of the SBIC's own capitalization, or to make loans in return for debentures that may be later convertible into common stock at the sound book value as of the day of the loan. SIBC's also make long-term loans secured against assets. On some of the money it lends, an SBIC may get between 8 and 12% interest— which may or may not be any bargain, depending on your need.

To be eligible for help from an SBIC, a company must be privately owned; not dominant in its field; not have over $5 million total assets; and must not have had annual earnings after taxes in the past three years in ex- cess of $150,000. If its stock is traded or it has had a public stock issue of $50,000 or more, the company is not eligible.

Exceptions to all these regulations are possible through application to SBA, which has close control over the SBIC's due to the fact that (a) it licenses them, and (b), it puts up part of their capital.

To get this kind of aid, no change in Securities & Exchange Commission registration is needed, and you must buy stock in the SIBC up to 2% of the loan or $50,000, whichever is less. The investment company will not ac- quire control of your company unless your management turns out to be in- adequate or its investment is jeopard- ized.

• **Dollars not answer**—For all these many ways to raise money, dollars alone won't assure a healthy maturity for the growth company. If its man- agement isn't good, more money only means a more expensive funeral—if not today, then tomorrow.

Up to a point, sound management

(Continued on page 47)

Solid Rockets in Space: Where Do We Go?



Bright future seen for deep space probes where more than a simple ballistic trajectory is needed for exact astronavigation

by Paul Means

WASHINGTON—A strong argument for the suitability of solid rockets for space missions—even with the advent of some of the more exotic propulsion systems—has been made by Ben F. Wilkes, an applications engineer with Astrodyne. Speaking before the national aeronautical meeting of the Society of Automotive Engineers in New York, Wilkes said the basic advantage of solids in space work is their reliability, and the fact that solid propellants and motors can be designed to handle specific jobs during the various phases of a space vehicle's flight.

Whether solids will be used as a primary propulsion system in space vehicles 10 years hence depends on many undeterminable factors, principally on the relative progress made by other types of rocket motors. If ion, fusion, plasma, or nuclear rockets approach operational status within this period, they could be used for the upper stages, and conceivably for the boosters. Without them, rocket makers will have to rely on the more advanced liquid and solid chemical rockets.

Along with development of other propulsion systems, Wilkes believes following factors will help decide fate of solids as a prime propellant space vehicles:

• The upsetting of the space roc development timetable due to spe problems not now known—such as unexpected radiation levels encoun ed by the *Explorer* satellites.

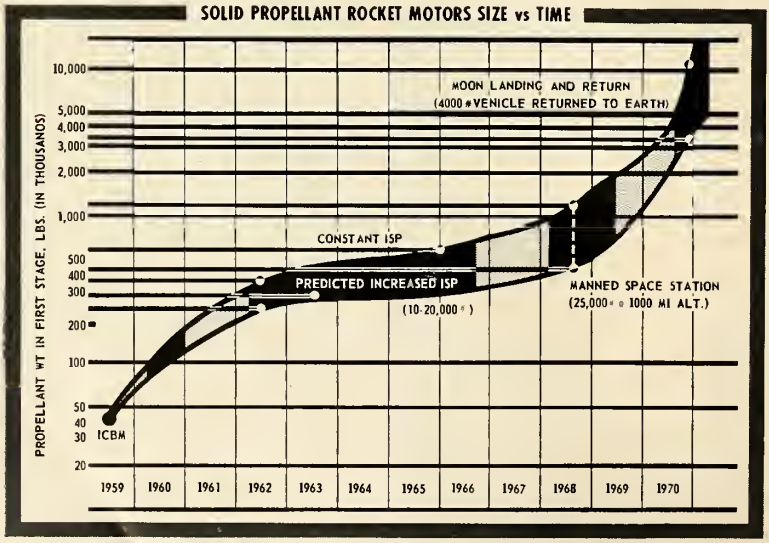
• Changes in national and in national politics (and space resea budgets) which could accelerate slow down developments.

• Changes in military objectives plans versus, or in conjunction w commercial uses which could a types of propulsion systems to be u as well as time scales.

• **Upping energy**—As a space hicle launcher, solid propellants h the disadvantage of being at the end of the energy spectrum of prim energy sources (see table). Some provement can be expected. Wilkes lieves, in the ability to convert a sol reaction energy to kinetic energy

He is supported in this conclus by H. W. Ritchey, vice president the Thiokol Chemical Corp. In article in the House Astronautics Space Committee's staff report on *Next Ten Years in Space,* Ritc stated: "Although a 1 million-pou thrust liquid combuster may be fe ble, solid engines developing thr 10 to 100 times this figure present straightforward engineering proble

• **Strong points**—Solids also n be considered as space vehicle laun ers, Wilkes feels, because of their liability, simplicity, quick response start, and the ease with which they be staged. Using five or six solid st



VERSATILE SOLIDS for space vehicles can grow in the next decade. Top curve assumes no change in available energy; bottom assumes increase.

a space vehicle launcher, he re-
ds, allows increases in the payload
h less going to gross load.

The other advantage in using a
lti-stage solid space vehicle launch-
according to Wilkes, is that "if the
rational and environmental require-
nts for these motors are carefully
sidered beforehand and one motor
ot expected to be everything, then
pellants and motors will be found
handle specific jobs. For example,
notor that is to operate in space
uld not be required to meet the
le handling and storage require-
nts that an everyday rocket motor
artillery use must meet."

The various stages, Wilkes believes,
ld be designed to optimize perform-
e, i.e., "propellants with different
and burning characteristics, propel-
weight ratios, nozzle designs,
mber pressures, throat area ratios,
t"

Low motor weights could be util-
in the final launching stages, after
rocket has reached an altitude
re there are near-zero drag losses,
ause the vehicle at that point could
accelerated to theoretical maximum
city independent of thrust.

Problems yet to be solved before
ds become effective space vehicle
chers, Wilkes believes, are those of
ieving close dimensional and weight
rances of hardware and propellant
rge, and possible close tolerances
ballistic parameters and thrust ter-
nation.

• **For moon trips**—An area in
ch solids have an advantage over
greater-specific-impulse liquid pro-
ants is in proposed manned, unpow-
d, round trips to the moon. High
jection velocity, Wilkes points out,
uld not allow the space vehicle to
the moon's field as a source of sub-
tial trajectory shaping. The idea is
keep initial velocity low so that the
owered vehicle will travel behind
moon and then be deflected around
its return trip to earth.

Low projection velocity, and its
lting increase in payload, would
be advantageous for missions need-
great increases in payload weight,
h as missions requiring the expendi-
e of large amounts of electrical
rgy in flight, or manned flights
re the demands of nutrition and a
ble environment increase with flight
ation.

Low projection velocity solid rock-
t would also give the "marked sensi-
tivity of flight duration to small errors in this velocity," Wilkes asserts. The close scheduling needed for an unpowered flight into deep space and return to earth would "require very close control of projection velocity simply to prevent variation in flight time," and solid motors could be used "to give the minute corrections."

One area in which solids may have a promising future, according to Wilkes, is in deep space probes to planets or space stations where more than a simple ballistic trajectory is needed to allow the space vehicle to arrive at the exact point in space at the exact point in time.

• **Disturbing forces**—Besides the minute exactness of burnout velocity and position necessary for a space vehicle to start on its way into space, Wilkes lists 16 forces at work in the universe for which the rocket will need counteraction or thrust correction.

These are:

(a) The last-minute aerodynamic forces escaping from any atmosphere;

(b) Errors in burnout velocity and position of the vehicle—any residual propellant or unnecessary weight could affect the whole trajectory;

(c) The geomagnetic field of the earth, sun, planets, asteroids, etc.;

(d) Electrical forces, both known and unknown, and even the magnetic fields generated by induced currents in conducting parts of the vehicle itself;

(e) Radiation forces from the sun;

(f) Cosmic rays;

(g) Radio noise from the sun and other space objects;

(h) Temperature changes;

(i) Meteor impacts;

(j & k) Einstein Mechanics and Newton's Laws—will they hold true in space?

(l & m) Navigating in space, and the refraction and abberation of the instruments used for navigation;

(n) Bulge perturbations in the gravitational forces in the planets, sun, etc., and their effects on the space vehicle;

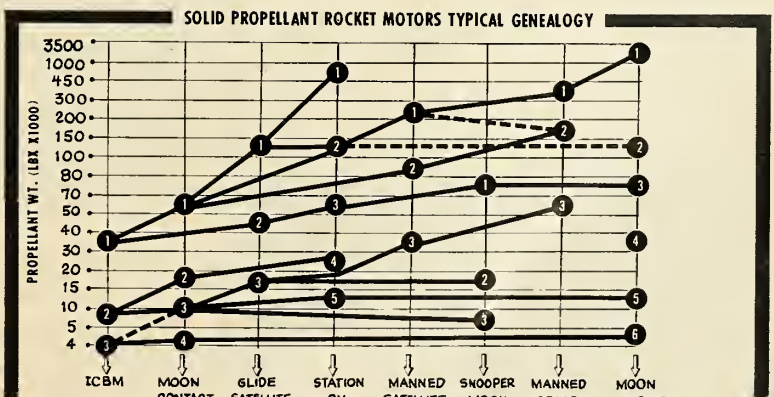
(o) Errors in earthly calculations and observations of mass and gravity of space vehicles;

(p) And the motions of the internal masses of the space vehicle.

Thrust correction and counteractions by solid-propellant rockets, Wilkes believes, could compensate for, and even eliminate, the effect of some of the forces. Others, he believes, could even be used to stabilize and orient the vehicle. Other forces, such as the effect of radio noises on guidance control from earth, would need man in the vehicle itself to correct.

• **Mars and back**—Wilkes describes how simple, reliable, solid-propellant rocket motors could provide the necessary guidance control for a space vehicle travelling from earth to Mars and back:

After arriving at an earth satellite space station, the vehicle would then make 377 revolutions about the earth until it arrived at the point where its



HERE'S HOW solids will grow in size and number of stages during the next 10 years of rocketry advancement in space exploration.

total energy would be equal to that of a body falling to infinity from that point.

Shortly after this point is reached, after 108 days of flight, the trajectory would start its hyperbolic path as the vehicle accelerated.

The problem now is to put the vehicle into a trajectory which will allow it to arrive at Mars. If thrust is shut off before reaching the escape point from the earth's pull, the rocket would continue its eliptical orbit around the earth. If thrust is shut off after the escape point is reached, the rocket would go into orbit around the sun.

But by cutting off thrust slowly, the rocket's trajectory can be changed from a spiral to a circular one. As soon as the correct position is reached, thrust is switched on and the vehicle continues on a spiral path about the sun towards Mars.

The advantage of using solid rockets for thrust corrections during heliocentric departure, according to Wilkes, is to counteract the possible errors due to (1) technical cutoff errors in the escape hyperbola; (2) uncertainty in knowledge of the combined mass of Earth-Moon-Sun System; and (3) the uncertainty with which the mean Sun-Earth distance is known, which is detrimental to the accuracy of the transfer orbit because of its sensitivity to inaccuracies in tangential velocity.

• **Bending trajectory**—Guidance, which could be provided by small solid rockets motors, is needed during midcourse, and at the end of 194 days of flight, when thrust direction is reversed 180 degrees and the rocket decelerates.

Solid-Propellant Rocket Motors
Typical Advanced Propulsion Sys. Family

Series	Type	Wt. Pr plnt. Lbs	Thrust Lbs.	Dia. In.	Length Feet	Duration Sec.	Isp Lb. Sec./Sec.	Propellant Fraction
1	General Application	4K-10K	10K-100K	38-54	4-13	40-90	> 225	>.89
2	Single Unit Lg. Total Impulse	120K 200K	500K 4500K	72-96	20 60	10-90	> 245	>.90
3	(1) Clustered Series 1 or 2	100K 1000K	1000K 5000K	(1)	(1)	10 90	> 245	>.90
4	Specialized Hi Perfmce Might Be Used For Series 1 or 2	.1K 10K	2K 50K	10 48	2 10	6 60	> 255	>.90
5	Accessory Power	0 < 1K	.5 50	Small	Short	2 Sec. 3 Hrs.	100 to > 245	High

NOTES:
Reliability desired = 100%.
Operating temperatures always reaching for greater spans = <—65 to > 160°F.

FIVE DIFFERENT families of solids could handle most of a space vehicle's propulsion needs. Ultimately envisioned is 4.5 million pounds of thrust.

After 275 days, thrust is again reversed and the ensuing acceleration bends the trajectory toward the Martian ellipse. Wilkes estimates that correction impulses of only 200 to 400 fps will be sufficient to generate encounter distances of about 10,000 nautical miles.

Correction thrust is used again if the vehicle heads for the Martian ellipse too early or too late. If too early, according to Wilkes, it directs thrust first rearward then slowly toward the sun to compensate for the sun's attractive force. If it arrives too late, it reverses this process.

Solid rockets could also be used on the final approach, when the rocket needs some thrust to force it closer to Mars, and some side thrust to create a spiral so that it will not fall straig into Mars. The solids also would ideal as the retros and/or verni which decelerate the rocket into circular orbit around Mars.

An analysis of this projected t to Mars, according to Wilkes, "ad up to the need for guidance contr Simple, reliable, solid-propellant roc motors used all along the way w make sure the desired terminal or is reached . . ."

• **Solid versatility**—Wilkes adm that liquid propellants probably will ways be ahead of solids in the ava able propellant energy or specific i pulse, and that for this reason liqu will probably be the primary prop lant used for a large space vehi booster's first stage. But because their instant readiness and reliabili he thinks that solids will be used m and more for the rest of the stag And their great advantage is that t can be used in all areas of space flig

The accompanying tables indic how solid rocket motors will grow d ing the next decade to propel some the space vehicles now in the pl ning stage. Still to be overcome large solid rocket engine design are problems of making the propellant tain its shape and reliability throu out burning.

Wilkes forsees solid rocket mot developed up to a scale where t would be 200,000 lbs. in weight, 500,000 lbs. in thrust, 60 ft. in leng 96 inches in diameter, 90 seconds duration, and a .90 propellant (to t weight) fraction.

Clustering rockets of this size, smaller ones, according to Wilkes, go on ad infinitum, until structu material can't withstand the strain

Solid-Propellant Rocket Motors
Place In Energy Spectrum

Energy Source	Theor. Max. Isp Lbs. Sec./Lb.	Relative Energy Release (Ergs./Gm.)	Fraction of Annihilation Energy
1. Chem. (Solid or Liquid) 2. Super Chemical ($H_2 + O_2$)	225 to 300 364	1.0×10^{10} 1.3×10^{11}	1.1×10^{-11} 1.5×10^{-10}
3. Free Radical Chemical ($H + H \rightarrow H_2$) . .	2140	2.2×10^{12}	2.5×10^{-9}
4. Nuclear Fission	200 to 1×10^6	7.1×10^{17}	8×10^{-4}
5. Thermonuclear	5×10^5 -3×10^6	3.6×10^{18}	4×10^{-3}
6. Matter Annihilation	∞	9×10^{20}	1.0
7. Solar	1000 to 3×10^7	3.3×10^2 Calories/Sq. Cm./Sec.	

INDICATION OF low energy of solids compared to other primary energy sources. However, this can be overcome by staging and clustering.

Space Technology Laboratories is responsible for the over-all systems engineering, technical direction and related research for the Air Force Intercontinental and Intermediate Range Ballistic Missile Programs and for the highly successful Thor-Able series of ICBM range re-entry launches. ■ In addition, STL carries out special experimental projects for such agencies as the National Aeronautics and Space Administration and the Advanced Research Projects Agency. On behalf of these agencies and in conjunction with the Air Force Ballistic Missile Division, STL designed and produced the Pioneer I payload, one of the most sophisticated fact-finding devices ever launched into space. In addition, STL provided systems engineering and technical direction for the Air Force satellite, the Atlas SCORE. ■ In support of these and future requirements, STL's activities provide a medium through which scientists and engineers are able to direct their interests and abilities towards the solution of complex space age problems. STL invites inquiries regarding staff openings in any of the five major areas of the company's activities.

Electronics Laboratory
...provides technical direction for, and conducts studies leading to, design and specifications of advanced guidance, control, and communication systems; also packaging, environmental testing and over-all checkout.





Physical Research Laboratory
...conducts basic research including analytical and experimental investigations in magnetohydrodynamics, thermonuclear power, plasma physics, and low temperature solid state physics.

Astrovehicles Laboratory
...conceives, evaluates, designs, develops, and tests space vehicle systems; provides technical direction of propulsion, nose cone, and airframe subsystems; explores new propulsion, airframe, re-entry, and ground handling techniques.



Computation & Data Reduction Center
...provides a centralized mathematical and computing facility and engages in advanced research in data systems, information theory, computation systems and automatic programming, systems and hardware simulation, and applied mathematics.



Systems Engineering Division
...has the over-all responsibility for the system integration of the Atlas, Titan, Thor, and Minuteman weapons systems, in addition to responsibility for technical direction of the airframe, sub-system, assembly and test, and ground support activities; evaluates proposed future weapons and space systems.



STL

Space Technology Laboratories, Inc., P.O. Box 95004, Los Angeles 45, California



...NEWS IS HAPPENING AT NORTHROP

Now being produced and delivered to the U.S. Army Signal Corps, the Radioplane SD-1 gives greater battlefield surveillance flexibility to combat units than ever before. (This photo of terrain was actually taken from an SD-1 at 1,000 feet.)

RADIOPLANE PRODUCES FIRST COMBAT-READY SURVEILLANCE DRONE

Meeting tough Army Signal Corps requirements and being produced in operational quantities, the SD-1 is proved and ready to fly unmanned photo reconnaissance missions for tactical troops.

Highly mobile, the camera-carrying SD-1 may be zero-length launched in rough terrain from a camouflaged position. It is flown by remote control over enemy installations on surveillance missions without risking a pilot's life or man-carrying aircraft. Within minutes after the SD-1 returns from its mission, photographs are delivered to the requesting unit.

Other specialized sensory equipment may be carried by the SD-1 depending on particular mission requirements.

This Army-Radioplane achievement exemplifies Radioplane teamwork with all of the U.S. Armed Forces. Radioplane provides a complete drone family spanning medium speeds through supersonic performances.

RADIOPLANE

Van Nuys, California, and El Paso, Texas
A Division of
NORTHROP CORPORATION

What's the future for electronics in GSE?

Electronic Output to Double by 1965

by William E. Howard

WASHINGTON—Plotted on a graph, fortunes of the Nation's electronic ustry resemble the upward arc of ICBM's trajectory. For the next ade the outlook is for the industry keep on expanding at an even dizzier e.

Propelling the industry on its head- g flight are demands to produce re and more complex missile systems d in with a growing and extremely ricate "decision-making" alarm net- rk to give the U.S. a capability for tant response to Soviet attack.

And as missiles become operational, industry is being pressed to manu- cture in greater and greater quanti- s the equipment to back them up on ground. Seventy-five percent of *an's* guidance and control system is the ground; *Minuteman's* is ex- cted to be in a 90-10 ratio.

Taking a looking into the future s week, Electronic Industries Asso- tion President David R. Hull told R that the Nation's electronic out- t must double by 1965. This will an at least 50% increase in existing nt capacity, he said.

He sees the government spending total of $30 billion on missiles be- en now and 1965—with more than lf that amount going into missile ctronics.

The EIA estimates for the elec- nic share of the missile budget for 1960 fiscal year is $2 billion. This more than half of the $3.922 billion al EIA expects the armed forces spend on missiles.

For the period through 1970, the ociation says "a total of over $100 lion" will be available for electronics enditures from this source alone. y the end of the period," it adds, 0-25% of the defense dollar will be marked for electronics."

• **Space funding**—General increases procurement by the government for ctronic equipment, for commercial ation and space activities are also ected to boost the industry's output. A believes ARPA's appropriations will fall off from $455 million in 1959 to about $170 million in 1964. But, says the association:

"NASA will probably finish fiscal 1959 with authorizations of about half a billion dollars, and will triple this by 1964. By 1970 space programs are expected to be operating at a level over $3 billion.

"FAA (Federal Aviation Agency) is expected to nearly double its 1959 fund level, reaching $1.2 billion by 1964. Increasing air activity will maintain this trend. By 1970 authorizations may exceed $2 billion."

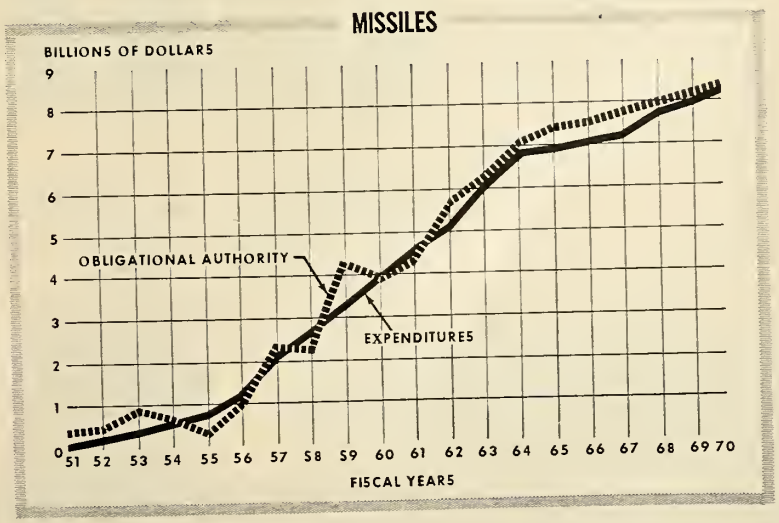
EIA experts are inclined to discount suggestions that the defense budget will be enlarged abruptly by Congress short of an emergency. The current defense budget of close to $41 billion, they point out, along with the non-defense budget of about $36 billion is already pushing Federal credits to the limit.

Accordingly, these experts believe actual defense spending will rise slowly over the next 10 years—in step with the gross national product—to a top of about $57 billion.

• **Ready to grow**—Individual electronic companies, Hull says, already are planning ways of coping with the expected expansion. He said a number have considerable reserve facilities and the government has some backup plants.

Estimated DOD Authorizations For Electronics
(Fiscal Years in Billions of Dollars)

	59	60	61	62	63	64	65	66	67	68	69	70
Operations & Maintenance												
Dollars Authorized	9.4	9.6	9.8	10.0	10.3	10.6	10.9	11.1	11.3	11.5	11.8	12.1
Percent for Electronics	9	9	10.5	11	11.5	12	12	12	13	14	15	16.
Dollars for Electronics	.85	.86	1.03	1.10	1.18	1.27	1.31	1.33	1.47	1.61	1.77	1.94
Major Production & Procurement												
Dollars Authorized	14.3	15.3	16.0	16.7	17.8	18.2	18.7	19.2	19.7	20.0	20.3	20.6
Percent for Electronics	29	30	31	32	32.7	33.2	33.8	34.5	35.0	35.8	36.4	37
Dollars for Electronics	4.15	4.59	4.96	5.34	5.82	5.86	6.32	6.62	6.90	7.16	7.39	7.62
Research & Development												
Dollars Authorized	2.6	2.7	2.8	3.0	3.8	4.6	5.4	5.9	6.2	6.5	7.0	7.5
Percent for Electronics	19	21	24	27	29	31	32	33	34	35	36	37
Dollars for Electronics	.49	.56	.67	.81	1.10	1.43	1.73	1.95	2.11	2.28	2.52	2.78
TOTAL DOLLARS FOR ELECTRONICS IN ABOVE CLASSES	5.49	6.02	6.66	7.25	8.11	8.56	9.36	9.90	10.48	11.05	11.68	12.34



Third of a series on Missile Support

THE GRAND CENTRAL REPORT

Tennessee Gas Transmission Company and Food Machinery and Chemical Corporation, the parent companies of Grand Central Rocket, have extensive investments in the energy field. In addition to their interest in Grand Central, TGT is in the oil, gas, and petrochemical fields, while FMC has three other divisions in dimazine, peroxygen chemical and boron propellants as well as other fuel and related products.

It is the long-range plan of both parent companies to build a strong position in the energy field. Grand Central Rocket Co., as a developer and producer of solid propellants and solid rocket motors, is a vital part of this plan.

It is our goal to make Grand Central Rocket, under new and aggressive management and with the addition of major facilities, one of the strongest and most capable solid propellant rocket organizations in the country.

J. J. King

JOE J. KING
Chairman of the Board
Grand Central Rocket Co.

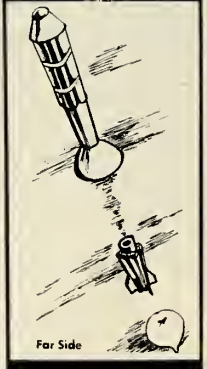
(If you have the qualifications that a fast-moving space propulsion team needs, contact our Director, Personnel. Openings now for chemists and engineers.)

Grand Central Rocket Co.
P. O. Box 111
REDLANDS, CALIFORNIA


Mercury


The Dart


Explorer III and IV


Far Side


Vanguard


Nike-Zeus


Test Sled

Most firms presently are operatin one shift and a step-up to two and thr shifts a day alone might boost outp by over 100%. However, Hull sa training personnel looms as a maj problem and it has been industry experience that second and third shi operations are not as effective produ tionwise as the primary day shift.

To finance required additional f cilities, Hull said the industry woul be able to lay out the capital for bric and mortar, but "we may have to ca on the government for special toolin and test facilities."

Hull feels any future expansio will follow the present pattern. Ne companies will be formed by "breal off" of personnel. "They will merg and re-amalgamate."

"There are amazingly few failures said Hull, pointing out that most ne companies are founded on know-ho in a specialized area of electronic He said he does not anticipate ar "radical expansion in any one area; a vancement of tubes and semi-co ductors probably will be balanced."

• **Ratio climbing**—The electron industry currently is devoting 52% its energies to military requirement In 1958 this translated into facto sales of $4.1 billion for military pro ucts and $3.8 billion in industrial ar consumer goods.

Increasing demands from the mi tary, EIA believes, will shift the rat to 60-40 by 1965, with missiles a counting for most of the difference.

Pentagon procurement officials s their figures bear out the fact that ele tronics companies are getting a bigg and bigger share of the defense budg dollar. At present, 11 cents of eve DOD dollar is spent on some electron component or service, and out of eve "hard goods" dollar, 28 to 29 cen goes into electronic equipment.

In addition to missiles, this expen ture covers everything from walki talkie to wholly-transistorized compu ers for SAGE supercombat centers a giant radar dishes for BMEWS.

The actual number of componen produced by the industry for miss systems alone is staggering. It runs in the hundreds of thousands—from 35 ton *Talos* fire control systems to mini ture components so small that 600,0 may be crammed into a density of o cubic foot.

• **Challenges**—Hand in hand wi the exploding technology and expa sion of the industry is the creation new opportunities in both the milita and civilian markets. Missiles offer t greatest challenge.

Right now Hull says there is a ne for the industry to come up wi smaller, more complex and more re able test devices for system checko

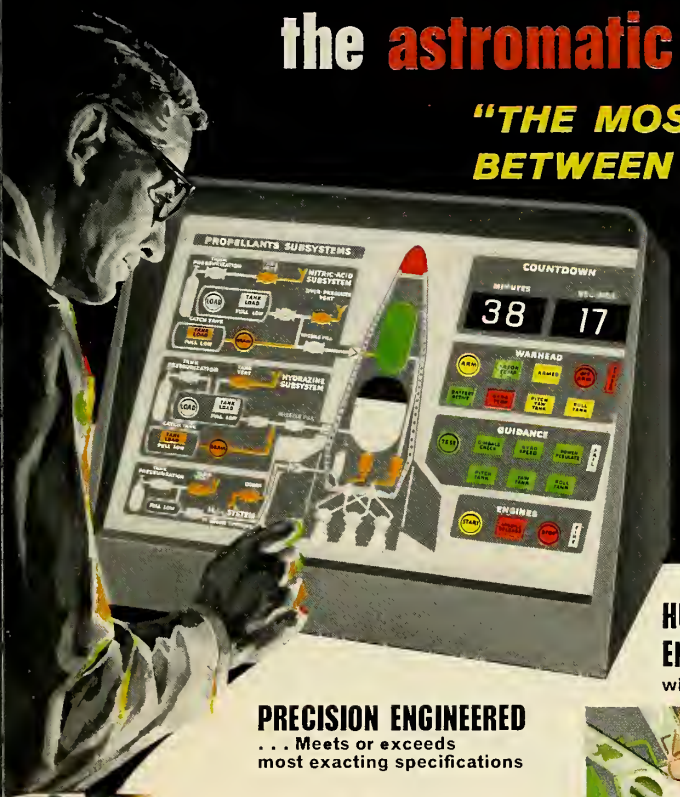
ELECTRO SNAP

Creators of over 6,000 Precision Switches and Controls

presents . . . A new panel concept that promises to revolutionize monitoring or control of Missiles and Rockets

the astromatic panel concept

"THE MOST EFFICIENT LINK BETWEEN MAN AND MACHINES"



Consider These Obvious Advantages in Your Designing

- OFFERS INSTANT VISUAL CONTROL WITH EXTREME ACCURACY
- REDUCES HUMAN ERROR TO AN IMPROBABILITY
- PROVIDES SIMPLIFICATION OF THE MOST COMPLEX OPERATION
- ALLOWS REMARKABLE CONSERVATION OF VITAL SPACE
- WITHSTANDS EXTREME LIMITS OF TESTING SPECIFICATIONS
- APPLICATION POSSIBILITIES AS UNLIMITED AS THE IMAGINATION

HUMAN FACTOR ENGINEERED for highest efficiency with extreme accuracy



100% FLUSH PANEL . . . Eliminates protruding hardware . . . unless specified by human engineering requirements. Switching functions may be recessed, flush, or overflush.



TRI-COLOR LIGHTS . . . Each light module contains separate bulbs and circuits to permit three distinct color indications.



VERSATILE SWITCHING . . . Momentary, positive feel and alternate action switching is available.

LIMITLESS COLOR COMBINATIONS . . . Versatile TRILITES plus multi-color photo printing of panel allows unlimited color guidance.

SCHEMATIC DIAGRAMMING . . . Eliminates the written word. Increases speed and efficiency of operators and recognition of indications.

PRECISION ENGINEERED . . . Meets or exceeds most exacting specifications



SHOCK AND ABUSE TOLERANT . . . Laminated Fiberglas and aluminum eggcrate construction of front panel very rugged.



LASTING LEGIBILITY . . . Vivid colors actually photoprinted. Legend and diagrams will not chip or scratch off . . . meets all requirements of MIL-P-7788.

EASY TO ALTER . . . Legend and diagramming can be changed to visualize any new findings.

QUICK LAMP REPLACEMENT . . . Panel hinged for access to subpanel components permitting 10-sec. lamp change.



CONCENTRATED GROUPING OF CONTROLS . . . Multiple function of TRILITE controls saves two to four times space required by ordinary panel.

VERSATILITY OF DESIGN . . . The module concept of construction makes the Astromatic panel technique extremely versatile. WHATEVER ACTION YOU DESIRE TO VISUALIZE, ASTROMATIC CAN SUBMIT A PANEL DESIGN TO SURPASS YOUR EXPECTATIONS.

RITE FOR ADDITIONAL TECHNICAL INFORMATION OR PHONE ROBERT PROVART, ECHNICAL DIRECTOR "COLLECT" . . . VAN BUREN 6-3100

ASTROMATIC DIVISION
Electrosnap Corporation
4220 W. Lake Street, Chicago 24, Illinois
VAn Buren 6-3100, TWX CG-1400

GE Offers New Micro-Modular Concept

Company claims eraser-size device named TIMM utilizes heat losses and lends itself to stacking for varied uses

PHILADELPHIA—A different concept of building several radio tubes and their circuits in one tiny, ceramic, stacked module for space electronics has been announced by General Electric Research Laboratory.

The laboratory has produced new devices called TIMM's, for "thermionic integrated micromodules." Instead of trying to eliminate the heat in tightly-packed electronic equipment, GE scientists have confined this heat and put it to work operating vacuum devices.

A complete circuit, such as an amplifier or multivibrator, occupies a space no larger than that of a pencil eraser, said GE. Operating at nearly red-hot temperatures, it takes full advantage of the high-frequency and reliability features of thermionic electron tubes.

• **New twists**—The design and operation approach embodied in TIMM's differs chiefly from other micro-modular concepts in that (1) tiny heaterless electron tubes are used instead of transistors, and (2) auxiliary cooling is reduced or eliminated and the heat losses generated within an equipment are utilized.

This serves the purpose of increasing the overall efficiency of operation and contributes to the extended life and reliability of the equipment. The TIMM's can be stacked, like building blocks, to provide a variety of electron circuit functions.

Resistors built into the ceramic modules consist of a resistive film on the inside of evacuated and sealed ceramic insulators. Laboratory reports indicate resistances of 5K per square are possible, and resistors made in this fashion of from 1 ohm to 500K have operated stably at 700°C.

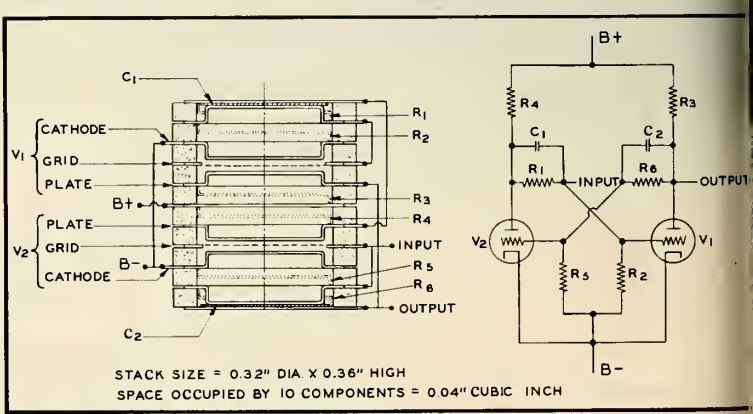
The preliminary data have shown changes of less than 3% in resistance in an operating temperature of 550°C, and similar stability in operation within a nuclear pile.

Built-in microminiature capacitors, with synthetic mica as the dielectric, in operation have shown a change of less than 5% over a temperature variation ranging from zero to 700°C.

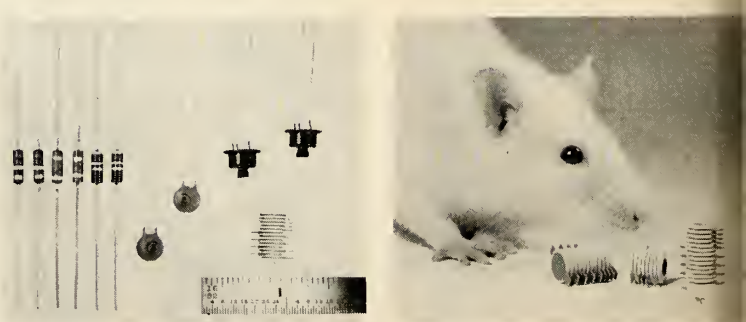
The heaterless electron tubes built into the stacks have a self-biasing characteristic—no grid current flows until the grid is at least two volts positive with respect to the cathode—thus eliminating the necessity for an external bias battery or a cathode-bias resistor and capacitor.

• **Component density**—A typic circuit module 1/3 inch in diamet and 2.6 inches in length can contain 1 diodes, 14 triodes, 14 resistors, and capacitors. This total of 44 compo nents yields an operating circuit den sity of 250,000 components per cubi foot. With different operating requir ments, densities of 1,000,000 compo nents per cubic foot are possible, sai the company.

A circuit function capable of 1(megacycle operation, selected as a



CROSS-SECTION and schematic diagram of a typical GE TIMM.



TINY CERAMIC micromodule (just above rule in photo at left and investigated b mouse at right) is less than 1/3 inch in diameter, can be stacked several inches. I comprises equivalent of conventional units shown in the left-hand photo.



suit-ability

FROM PHILOSOPHY — TO FEASIBILITY STUDY — TO DESIGN AND PRODUCTION

GENERAL ELECTRIC'S GROUND-BASED GUIDANCE SYSTEM FOR THE ATLAS MISSILE REQUIRED A COMPLETE MAINTENANCE TRAINING METHOD FOR MILITARY PERSONNEL WHO WOULD BE ENTRUSTED WITH THE UPKEEP OF THIS MODERN WEAPON. ERCO WAS SELECTED FOR THIS CRITICAL TASK.

ERCO TRAINING...TO FILL THE SUITS...TO SERVICE THE WEAPON

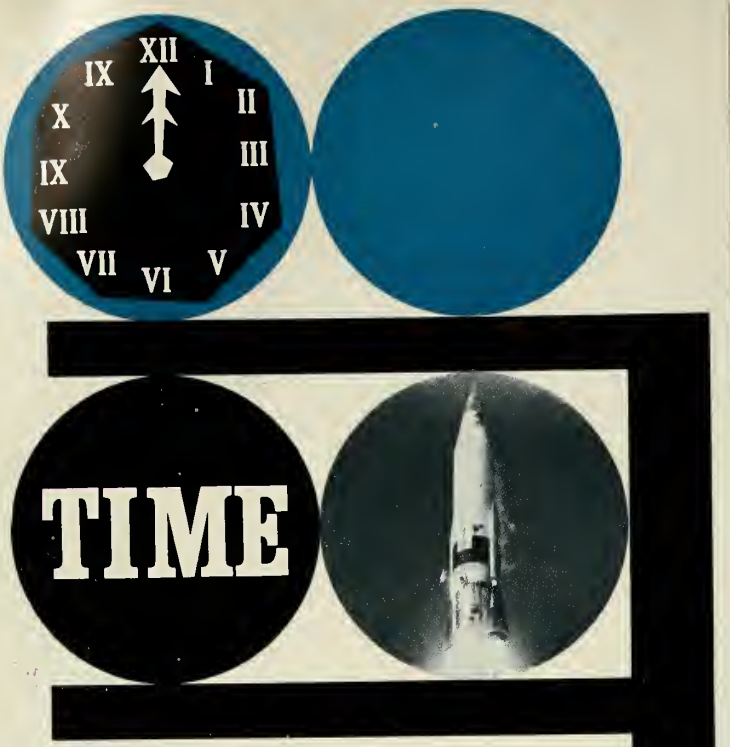
The requirements imposed by this intricate electronic problem were satisfied through unusually close engineering liaison, with appreciable economy and compressed schedules.

ERCO

NUCLEAR PRODUCTS—ERCO, DIVISION OF

acf INDUSTRIES, INC., RIVERDALE, MARYLAND

AMERICAN CAR AND FOUNDRY • AVION • CARTER CARBURETOR • SHIPPERS CAR LINE • W-K-M



Time waits for no missile. At Cape Canaveral, where we assist the Air Force in management, operation and maintenance of the 5000-mile Atlantic Missile Range, time is our most demanding dimension. Countdowns must be completed, missile test schedules must be met, orbital interceptions must occur.

Everyday each member of our technical staff works against time to play an intimate, vital role in the nation's missile test and space exploration activities. Yet each man thrives, and in fact succeeds, by defying the time dimension — for nothing furthers an individual's career so much as meeting and successfully conquering crucial deadlines.

Certainly other ambitious engineers and scientists will find no more unique challenge for professional achievement than through an early appointment in the space age with Pan Am. If you are one such man, we invite you to investigate our career opportunities by addressing a brief resume to Mr. J. B. Appledorn, Director of Technical Employment, Pan American World Airways, Inc., Dept. B-8, Patrick Air Force Base, Florida.

PAN AM

Guided Missiles Range Division
Patrick Air Force Base, Florida

...missile electronics

example only, includes a pair of triple input "and" gates, a bistable multivibrator, and dual cathode follower outputs. It contains 30 parts and represents a circuit density of 250,000 components per cubic foot.

The circuit generates its own operating ambient temperature of 580 and requires less than ¾ of a watt of power from an external source. A comparable epoxy-encapsulated semiconductor version of the same circuit, capable of 5-mc operation and built by present methods, would contain 3 parts and with a circuit density of only 33,000 components per cubic foot would be limited in operation to a temperature range of minus 55 to plus 71°C.

• **Advantages**—GE believes the ceramic micro-modules make possible circuits which are smaller, lighter and generally require fewer components than their conventional encapsulated semiconductor counterparts.

Also, they seem to offer fewer temperature problems, higher reliability, longer life, greater ruggedness, resistance to nuclear radiation and higher operating speeds without sacrificing the signal power levels of their printed board or encapsulated predecessors.

In systems applications, their compactness should lead to improved electrical performance and greater efficiency through the useful application of circuit power dissipation, said a company spokesman. It also tends to reduce both weight and volume in systems where elevated temperature ambients are encountered.

The GE Receiving Tube Dept. in Owensboro, Ky., has announced that it already is planning the necessary applied research, development and production engineering procedures to make the devices, and engineering samples could be developed in a relatively short time. Production in quantity may be possible after another year, depending on the requirements of particular applications.

NCR to Research Photochromic Memory

HAWTHORNE, CALIF.—A one-year $90,000 contract from the Wright Air Development Center Aeronautical Research Laboratory for photochromic memory research has been awarded to the National Cash Register Company's Electronics Division.

Photochromic memory techniques and devices leading to possible future application in an ultra-high-density memory will be investigated theoretically and experimentally.

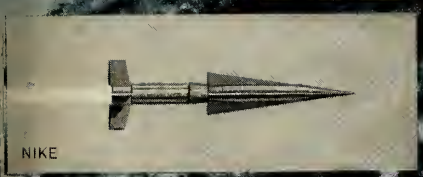
Studies will be based on the encap

WESTERN GEAR MISSILE ASSISTS

- TURBO-PUMP DRIVES
- THRUST CHAMBERS (SOLID)
- JETAVATOR ACTUATORS AND RINGS
- MOTORS, FANS AND BLOWERS
- WARNING DEVICES
- SERVOS AND SERVO AMPLIFIERS
- HIGH PRECISION FINE PITCH GEARING
- GROUND SERVICE EQUIPMENT
- TEST FACILITY DRIVES





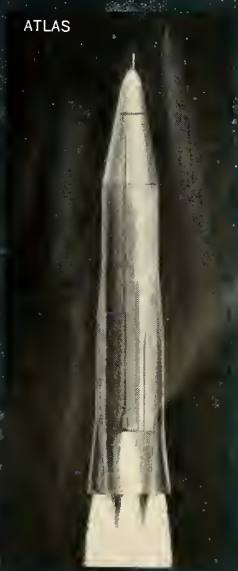


Why not take advantage of the complete engineering and manufacturing facilities offered by Western Gear for an expeditious thoroughly reliable answer to your missile requirements in the electro-mechanical field?

Let us know your needs . . . Write

Precision Products Division,
Western Gear Corporation,
P.O. Box 192, Lynwood, California.

No obligation.



WG PRECISION PRODUCTS DIVISION

WESTERN GEAR CORPORATION

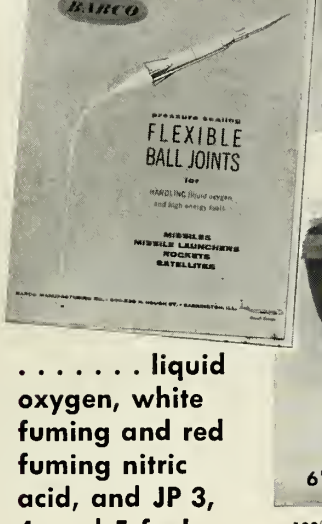


The earth [illegible] miles up, taken by Navy camera, shows [illegible] miles of U. S. and Mexico.

5912

BARCO FLEXIBLE JOINTS

For Handling High Energy Fuels . . . .





4" speciol stoinless steel Borco Flexible Boll Joint for hondling liquid oxygen.

. . . . . liquid oxygen, white fuming and red fuming nitric acid, and JP 3, 4, and 5 fuel



180° flonged 6" Borco Boll Joint for use in looding ond unlooding line hondling liquid propellont.

-special designs for LOX and other Missile Fuels

Extensive design and manufacturing experience is yours to call upon at Barco for the handling of special liquid fuels in the aircraft, rocket, and missile industries:

- —Flexible Ball Joints for metal loading lines handling corrosive fluids.
- —Special flexible joints with leakproof seals for conveying fluids at low temperatures down to −300°F. Also high temperature designs up to +1000°F.
- —Special designs resistant to nuclear energy radiation.

Barco joints provide flexibility *unlimited* for piping and tubing. Our engineers will be glad to work with you on special problems and assist with recommendations.

ASK FOR NEW BULLETIN No. 233-A

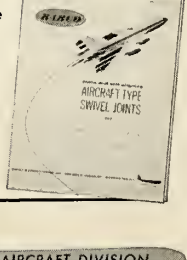
Flexible Hydraulic Lines for Missiles, Aircraft



MISSILE LAUNCHER HYDRAULIC ASSEMBLY

Borco produces high pressure self-oligning swivel joint ond tubing ossemblies for hydrou-lic pressures to 4,000 psi, ond higher. Also o wide se-lection of stondord ond spe-ciol swivel joints ond os-semblies for lounching ond flight geor. Sizes ¼" to1".

ASK FOR NEW CATALOG 269-A.



BARCO *Serving Industry Since 1908*
MANUFACTURING CO., 566 Hough St., Barrington, Ill.

AIRCRAFT DIVISION

sulation technique developed by N research laboratories in Dayton, O in which a light-sensitive liquid dy stored in a gelatin capsule only millionths of a meter in diameter. cause the fluid has the necessary stable states for switching, the mic scopic chemical memory cell can st or give up information instantaneo in response to a beam of light. small size of the cells points computer memories of unpreceden density for airborne and spacebo applications, said NCR. It is belie possible to coat a square inch of with 1,000,000 of the capsules.

Eventual application of the resea findings will be in automatic cen control and data systems for high-a tude vehicles. The immediate goal i obtain all necessary data for a deta preliminary design of a feasibi model having optimum photochro memory. The program will be c cerned with simplicity of design, creased reliability, minimum rand access time, high storage density, weight, low power consumption, sensitivity to severe environmental c ditions, and low cost.

Unit Cools IR Gear to As Low As 60° K

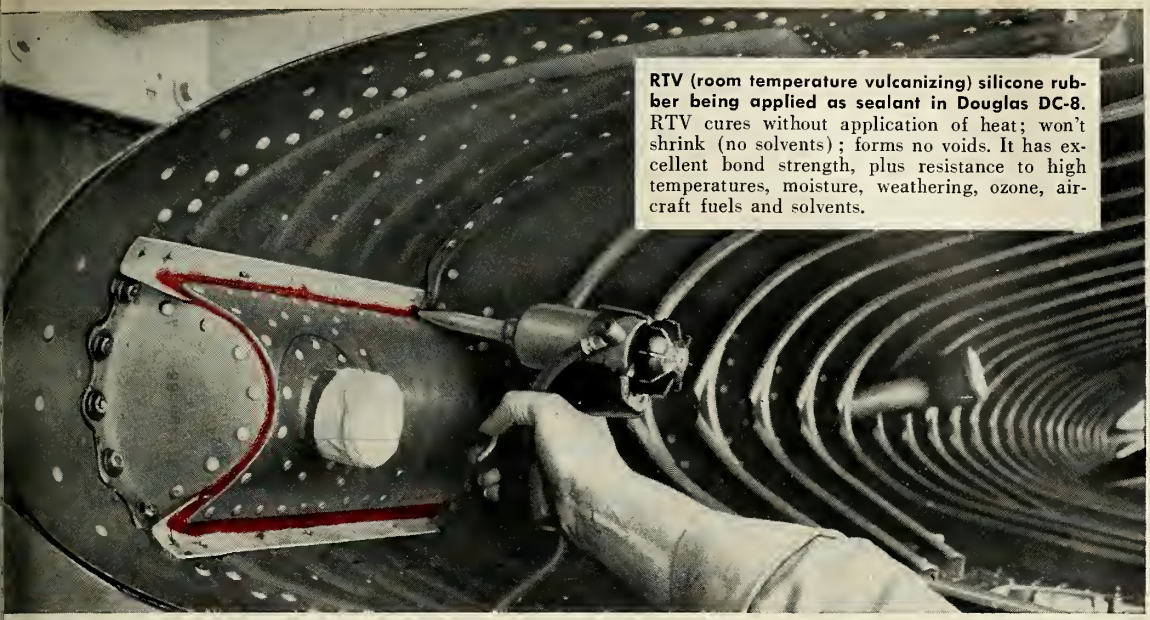
CAMBRIDGE, MASS.—A tiny coo device which super-chills infrared tection (IR) equipment to 60°K b new refrigerating technique has b developed by Arthur D. Little, I Cambridge research and enginee company.

The 8-ounce unit is the result the company's two-year research ject into extreme low-tempera equipment. Known as the min cooler, it will be shown at the Nati Missile Industry Conference (May 28) in Washington.

Believed to be suitable for airb operation in missiles or airplanes, current closed-cycle IR detection tem is designed to weigh less than pounds. Further development with new device is expected to reduce weight to less than 10 pounds, ADL.

In operation, helium gas expa from 300 psi in a ¼-inch-diam cylinder, 2 inches long. A tiny pl piston is the only moving part b room temperature. The cold end of tube refrigerates an IR cell to 6

Cooling IR detectors to extrem low temperatures increases their s tivity and makes them responsive a wider range of wavelengths. makes it possible to detect small ra tion differences between the "tar and its background.

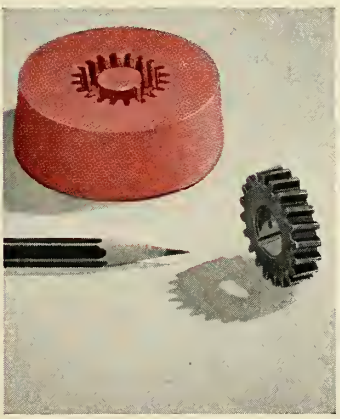


RTV (room temperature vulcanizing) silicone rubber being applied as sealant in Douglas DC-8. RTV cures without application of heat; won't shrink (no solvents); forms no voids. It has excellent bond strength, plus resistance to high temperatures, moisture, weathering, ozone, aircraft fuels and solvents.

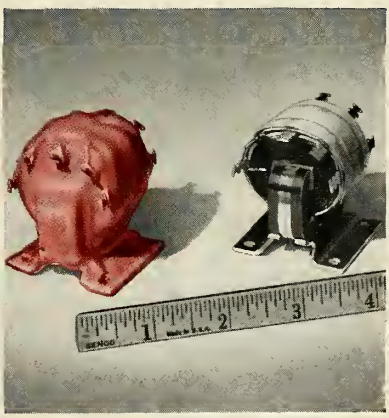
G-E RTV silicone rubber—a superior material for tooling, encapsulating and sealing



rototype jet engine nose cone (right) cast n RTV mold. Epoxy parts cast in flexible TV molds have a bright, glossy surface and eproduce extremely fine detail. No parting gent is required for even the most complex arts. High tensile and tear strength is reained even after prolonged heat aging.



Close-tolerance, non-standard helix gear cast complete in low-cost, one-piece RTV mold. Previously such replacement parts had to be machined by hand. Now they can be quickly and inexpensively replaced by using the broken part as a master.

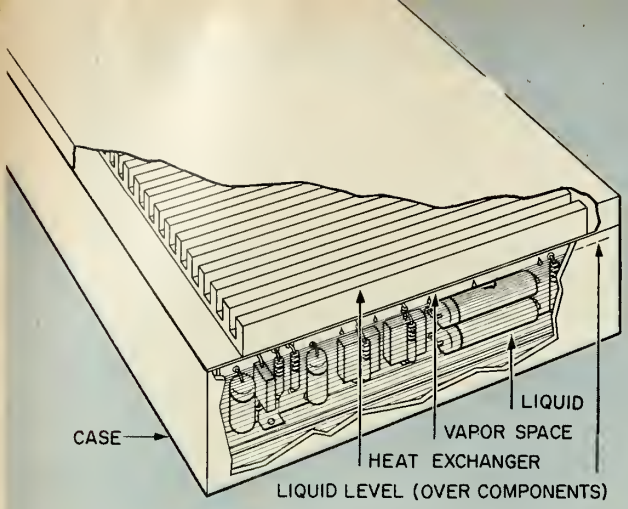


Potting and encapsulating of electrical components, such as this aircraft transformer, are easy with RTV. It can be poured, sprayed, painted or applied by dipping. Temperature resistant from −60°F to +600°F; excellent resistance to high altitude arc-over and corona. Comes in wide viscosity range.

For application data and samples of General Electric RTV silicone rubber, write to General Electric Company, Silicone Products Department, Section 052, Waterford, N. Y.

GENERAL ELECTRIC

Silicone Products Dept., Waterford, N. Y.



In Raytheon's "EV-GRAV" system, liquid refrigerant boils off the surfaces of the individual electronic components, rises as vapor, condenses on the heat exchanger, and drops as liquid to repeat the cycle.

"EV-GRAV" COOLING

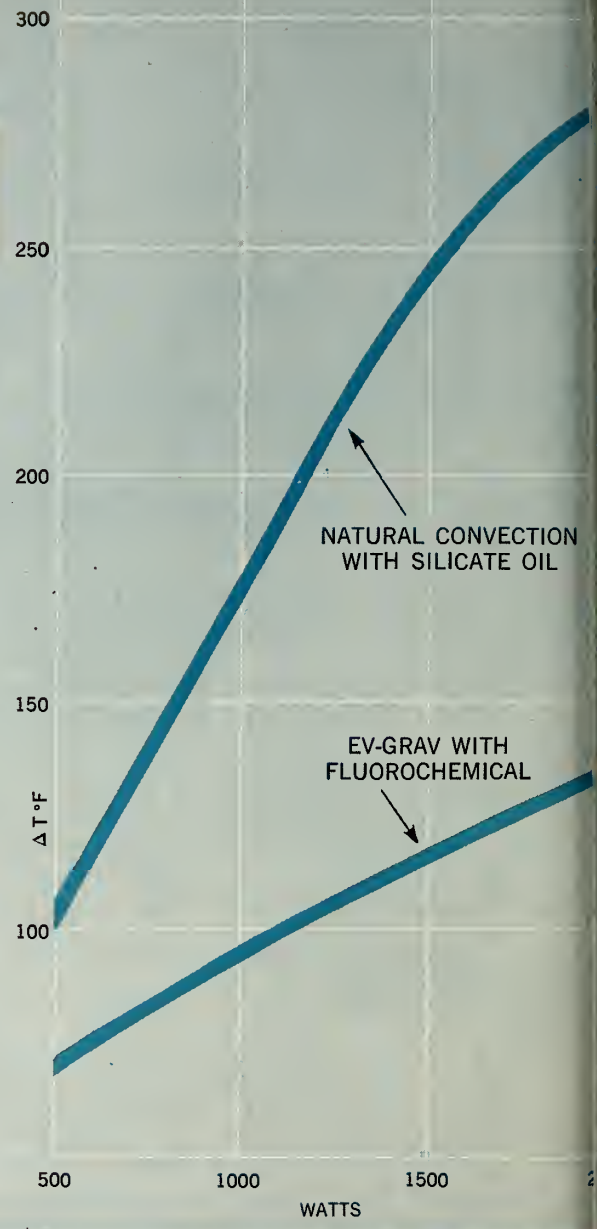
IN THE DESIGN OF HIGH HEAT-DENSITY ELECTRONIC EQUIPMENT

Performance requirements for electronic equipment in supersonic aircraft and missiles place particular emphasis on the need for more efficient heat transfer techniques.

The use of fluorochemical refrigerants in an "evaporative-gravity" cooling system is a novel method of removing heat from electronic components. The refrigerant boils at the surfaces of submerged heat-dissipating components and condenses on the surface of a heat exchanger at the top of the package.

This technique has proved more efficient than free convection in oil dielectrics or forced convection with gas dielectrics. The high dielectric strength of the fluorochemicals permits the achievement of higher density packaging.

Contributions such as this are typical of the Heat Transfer Group in Raytheon's Government Equipment Division . . . assisting design engineers in developing the complex weapons systems of tomorrow.



PROFESSIONAL ASSOCIATION WITH A FUTURE

Qualified engineers and physical scientists with BS or advanced degrees interested in systems, development, design or manufacturing engineering of complex electronic equipments are invited to write Donald H. Sweet, Government Equipment Division, Raytheon Manufacturing Company, Wayland, Massachusetts.

Engineering Laboratories: *Wayland, Maynard, Sudbury, Mass.; Santa Barbara, Calif.*
Manufacturing Facilities: *Waltham, North Dighton, Mass.*

RAYTHEON

Excellence in Electronics

GOVERNMENT EQUIPMENT DIVISION

LAND SEA AEROSPACE

U.S. Seeks Ways to Close Translation Gap

by James Baar

WASHINGTON—Hundreds—possibly thousands—of scientists working on U.S. space and missile programs are wasting their time. Much or part of the work they are doing already has been done by Russians . . . or Czechs . . . or Red Chinese . . . or other Iron Curtain scientists.

Moreover, the Iron Curtain scientists have published papers on their work. But their American counterparts may never know about it. The papers may never be translated. Or, if they are, the Americans may never see them until too late—if at all.

The solution to the problem may be a new Spage Age weapon: The electronic translator.

Or it may be a far broader coordinating and distribution system for what already is being translated. Or it may be a long-range Russian language training program. Any one of these would cost millions but America's missile industry can provide the ingenuity.

The House Space Committee within the coming weeks will hold a series of hearings to determine the scope of the problem and what ought to be done. Most experts will tell the committee that the problem is very great. But, they disagree as to the solution.

• **Soviet lead**—The Russians began a mass attack on the problem of translating foreign scientific literature in 1952 with establishment of the All Union Institute for Scientific and Technical Translation (VINITI).

It has a full-time staff of 2300 editors, publishers and assorted experts who screen the world's published scientific output. They draw on some 2,000 Russian scientists to translate and abstract scientific papers and books.

VINITI publishes the vast *Referativnyi Zhurnal* which provides Russian scientists each year with almost a half-million abstracts of scientific works—2% from outside the Soviet Bloc. The sections of the *Referativnyi* divided according to field are distributed throughout Russia. Full translations are provided by VINITI on request.

Besides VINITI, Russia also has three other types of organizations abstracting, translating and distributing foreign scientific material. However, VINITI acts as a centralizing point for most of the other abstracting services.

The speed with which the Russians translate and distribute foreign scientific papers varies greatly.

U.S. experts say many Russian scientists complain that sometimes they don't see a translation until more than a year after publication of the original article.

However, the Russians also provide an extremely rapid express service for articles and books considered to be of top importance. Such an article may be translated and put in the hands of a Russian scientist in Moscow one or two weeks after its original publication in New York.

• **Steps taken**—The United States within the last year has made two major steps toward improving the translation, coordination and distribution of scientific literature of Russia and other Soviet Bloc nations.

The National Science Foundation in December established the Science Information Service to help make foreign scientific literature more readily available to Americans through a variety of programs.

One of the main roles of the Foundation in carrying out the program is the subsidization through grants of more than 20 societies and universities for cover-to-cover translation of 35 of the most significant Russian scientific journals.

Meantime, the U.S. Office of Technical Services has undertaken a broad program of selling translations of Russian scientific work made by all government agencies. These include translations of the Soviet *Referativnyi.*

Among other OTS offerings are:

• Bi-monthly lists of translations of Russian scientific material available from government agencies or private translating firms.

• Abstracts of about 140 Russian journals.

OTS expects to provide abstracts of more than 170 Russian journals by the end of the year. It also expects to provide abstracts of about 30 Red Chinese journals.

At present, OTS is spending about a half-million dollars a year on its program. National Science Foundation is spending more than a million.

Finally, considerable quantities of Russian translating are being carried on throughout the country by private industry. Much of this is never distributed beyond the firm doing the work in order to avoid tipping off competitors as to what the firm is working on.

In all, Science Information Service officials estimate that the United States is doing about as much translating as Russia. Also, they say about the fastest translating jobs being done in the United States take about five months—although as in Russia there are exceptions.

"Where we're behind," one expert said, "is in distribution. It's harder for the average scientific working staff to find and get the stuff in the United States."

Moreover, the United States is behind in another vital area: reducing the need for translations.

More and more Russians today speak English. They begin studying a foreign language in the first years of school. The language they most often choose is English.

On the other hand, only about 2 per cent of U.S. scientists read Russian.

• **Electronic help**—One of the most hopeful immediate solutions is the possibility of developing electronic translators out of huge computers. Study programs at a half-dozen American universities have shown that the idea is promising. And the Machine Translation Research Project at Georgetown University already has claimed a reasonable degree of success with an IBM 704 computer.

Georgetown research workers have been able to translate both French and Russian texts at a rate of three words a second. They expect far better results with the much faster IBM 709 and 7090.

However, they say the principal drawback in computer translation today is the cost of having the foreign text punched on cards, making the entire operation more expensive than human translating.

"What we need to develop is an electronic scanner or reading machine," one said. "Then we'd have something."

Some officials say the best approach to the whole translating problem probably would be twofold: perfection of the electronic translator plus a Russian language training program.

They say this would solve both the problem both for the present and the future. And they stress that the problem must be solved as quickly as possible.

As one Russian-speaking expert put it pointedly: "Rossiya dumayut! (Russia is thinking!)."

ABMA Receives First of *Saturn* Engines

Jupiter test stand being modified to accommodate cluster of Rocketdyne H-1 liquid engines

HUNTSVILLE, ALA.—The Army Ballistic Missile Agency has received the first of eight Rocketdyne H-1 liquid engines which will be clustered to produce 1.3 million pounds of thrust and has already begun modifying a *Jupiter* test stand for static tests here.

The entire project, dubbed *Saturn*, is on schedule, project officers say. But they have yet to name a date for first tests. Since *Saturn* is due to be flight-tested at Cape Canaveral in 1960 it is entirely possible that the first static tests may be made sometime this fall.

The H-1 engine is a refinement of the device now powering both the *Thor* and the *Jupiter* IRBM's, somewhat more compact and probably slightly smaller. Components were repackaged to achieve better grouping and the turbopump is slung "side-saddle" on the thrust chamber in contrast to its former position on top of the chamber.

Each of the eight clustered engines, will, of course, have its own turbine. LOX and RP-1 will be supplied from a common fuel tank, a combination of present *Redstone* and *Jupiter* frames.

• **Departures**—Contrary to previous speculations, the engines will be clustered in a circle, with each engine gimballed separately and possibly in staggered depth. Provision is made for jettisoning the booster engines—with recovery by parachute a later development.

The engines are hypergolically ignited. Safety devices which will be built into *Saturn* include a provision that all eight engines must be functioning normally before the missile can be released, and compensating factors to keep the missile on course should one or even two of the engines fail during flight.

It is believed that the more compact H-1 engine will also produce a greater thrust, probably from 180,000 to 190,000 pounds, producing a combined total of the 1.3 million pounds desired. The big booster is intended to lift into satellite orbit loads of some 20,000 pounds. Under its present design, the cluster will be so high that it cannot be assembled in ABMA's "fab lab" where such work is normally done. It would almost touch the ceiling cranes necessary to move it.

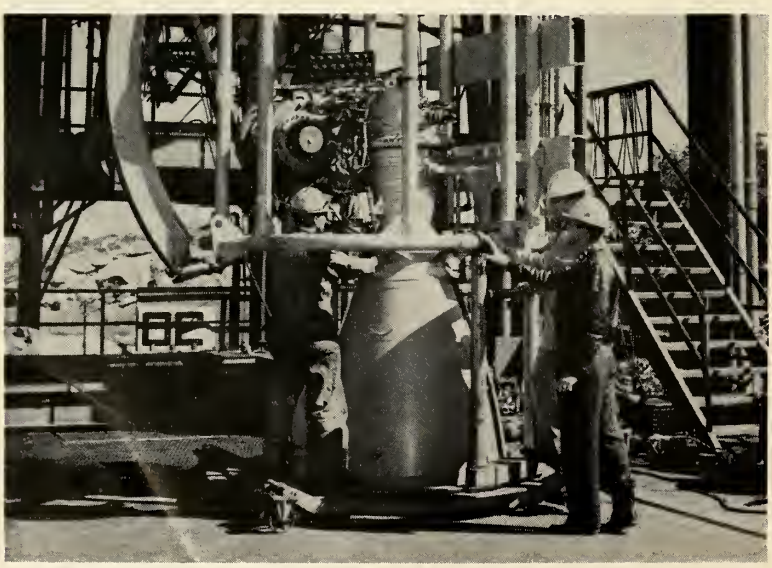
In September ABMA was authorized by the Advanced Research Projects Agency to develop the super booster. During the same month, Rocketdyne received the contract from the Army Ballistic Missile Agency to develop the basic engine. ARPA said that the cluster concept has been uti… because of the proven "extreme … ability of the Rocketdyne engine."

The entire *Saturn* system, wh… enters flight test in 1960, will an… the nation's urgent demand for q… relatively inexpensive, reliable del… of an extremely high-thrust bo… capable of lifting into satellite orb… outward to space journeys, a mul… load of instrumentation. The thrust … be nearly four times that of the nat… currently most powerful flight-te… propulsion system, the *Atlas* IC… cluster of engines.

No details of the overall config… tion of the *Saturn* space vehicle … been released, but in other multi-s… rocket powered vehicles the boost… jettisoned after operating for the … grammed duration, permitting the … per stages and instrumentation to … tinue on the space journey. Parac… recovery of the booster is under st…

The start sequence is the sim… yet provided in the family of Roc… dyne engines. Safety devices have … built in; one of the safety factors is … assurance that all eight engines … function normally before the mi… can be released.

Hypergolic ignition (self-ignit… will further increase the reliability … the H-1. Combustion within the th… chamber occurs above 500°F.



THE FIRST of eight H-1 Rocketdyne engines arrives at the Army Ballistic Missile Agency for clustering into Project *Saturn*.

Army Redesigning Air Supply Tank for *Corpora*…

LOS ANGELES—The Army will … a redesigned internal air supply t… for the *Corporal* and other miss… which eliminates multi-cell struct… characteristics.

The tank, developed by the F… stone Tire and Rubber Co. guided … sile division here, is called a "… cell." It is comprised of two half-sh… joined longitudinally and welded … 30-inch-diameter hemispherical dra… heads.

Fabrication costs of the steel … cell are estimated at about 50% … multi-cell construction. Weight will … reduced by about 50 pounds.

In redesigning the tank, Firest… says it considered increased safety … operating personnel, cost reducti… improved reliability and higher prod… tion rate.

letters

(ptik' or 'Vel'?

the Editor:

I have read Maj. W. C. Mannix's ar- ie on the "optik" (M/R, April 27) h considerable interest and applause. I solicitation for comment prompts me uggest a velocity unit based upon the pe velocity which, for earth consider- ns, approximates 7 miles per second. monosyllabic term "vel" could be l to denote this equivalence.

Unlike the optik, the vel does not have advantage of being absolute. How- , the vel would seem to have a flex- ty and convenience not shared by optik. For example, the Mach unit proven to be useful since it is asso- ed with and automatically defines cer- aerodynamic phenomena. By the e token, the vel would automatically ne certain astronautical characteristics. earth considerations, this table depicts relationship between a space vehicle's rt, orbital velocity at perigee (in vel s), and orbital eccentricity:

Units	Eccentricity	Orbit
ut 0.7	0	Circular
veen 0.7	less than 1	Elliptical
1		
1	1	Parabolic
ter than 1	greater than 1	Hyperbolic

As a matter of interest and informa- , the following equivalences are slide approximations:

	miles/ hour	feet/ sec	einsteins (roemers)	optiks
illivel	25.2			
l	25.2×10^{3}*	37.0×10^{3}	3.76×10^{-6}	37.3
lovel	25.2×10^{6}			

(*By coincidence, this figure yields a nor convenience in that it approxi- es the earth's circumference in miles.)

Reuben B. Moody
Lt. Col., USAF
622 Upchurch Circle
Montgomery, Ala.

the Editor:

lease accept this note as representing approval for Maj. William C. Man- is efforts to introduce the "Optik" sys- e related to measurements of speed velocity in the missile era.

His article on this subject in the April issue of Missiles and Rockets was a t concise presentation of the problem; should be commended on the clarity of ight which he set forth.

Ray Okonski
Director of Sales
Dynamic Filters Inc.
Detroit

ec Writers Defended

the Editor:

After reading your editorial "Six Lines o the V-2" in the March 23 issue, I e that it could not be let pass without ie comment on my part, specifically because I have a background in both industry and government.

The editorial unfortunately conveys the impression that:

a. Government specifications are written arbitrarily by people not as "realistic" as industry engineers.

b. A manufacturer will provide an optimum piece of equipment on a government contract regardless of availability of previous tooling, availability of components, engineering time etc.

Having observed and operated on both sides of the fence, I have found that both of these are dangerous generalizations. In most cases, military equipment specifications are written by an engineer who has considerable background on the equipment for which the specification is being written. He also has a reasonably good background on the applicability of the various new types of components. Many engineering reports on research contracts are available to him to help him keep his specifications realistic. These reports are seldom immediately available to industry.

In my opinion, the engineer writing military specifications is probably closer to the equipments than most of the contractors who bid to manufacture the equipment. He must consider having to "live" with the equipment for many years and must be "realistic" in both his specification and the design for which he must give final approval. Because of these facts, I believe the government engineer must be at least as realistic as his industrial brother.

As to point b., it is quite obvious that a manufacturer is not in business as a philanthropic organization—he must make a profit. He is required by contract to meet only the minimum requirements of the specification. He would be a poor businessman indeed to discard previously developed tooling, engineering and components if they could be used on a new equipment with a minimum of change. This approach, while good business, does not lead to improvement of equipment by application of new techniques, ideas and components.

I would suggest that you investigate the difference between a research and development contract, an applications engineering contract and a production contract. I believe that you would find that spec. writers are as flexible as the situation allows insofar as the use of components, new designs, etc., is concerned in both R&D and applications engineering. In production there is very little allowance for flexibility . . .

John F. Hyland
914 Timber Lane
Vienna, Va.

Miscredit

To the Editor:

I am writing in regard to the article: "Story Behind The Death of a Missile" which appeared in your May 4, 1959, issue.

I note that the photograph facing the first page of the article is credited, by implication, to your photographer, Mr. Cornell Capa. This photo illustrates the actual explosion of the Convair missile in the test stand at Edwards Air Force Base.

I wish to state that I am the photographer who took the picture at great personal risk and I feel that crediting this photo to another photographer, by implication or any other means, is a gross violation of existing ethics.

Allen D. Rice
1209 W. Milling St.
Lancaster, Calif.

Our apologies to the Air Force, which released the picture, and to Photographer Rice. Cornell Capa was, of course, taking pictures in the blockhouse at the time of the explosion.

Suggestion Box?

To the Editor:

Your editorial of May 4th and the statement by Dr. Walter Dornberger on page 30 touch on two aspects of one idea. The editorial points out that since every *Minuteman* missile will need a hole in the ground 100 feet deep, the military is looking for a more efficient and economical way to do it than by present methods. You quote a Pentagon official predicting that if a solution is found it will probably come from "a little guy with an idea."

In the profile on Dr. Dornberger, he is quoted as speaking up for a financial slice for the scientists who come up with ideas: "Creative thinking and imaginative engineering should be paid for . . . the government should guarantee a share in the profit of later production for the original creative mind."

Occasionally some obscure "little guy's" idea does get used, but the lack of a channel for submitting ideas is still a major problem. Why not marry the two concepts above with a missile problems program based on the breakfast food contest idea? They set out a problem, state their rules, tell where to submit, when it will be judged and the reward.

It seems to me that Missiles and Rockets is in a position to arrange such a plan on missile problems. You are in closer contact with military leaders—which is the first obstacle for the "little guy." You might even be able to act as receiving and forwarding agency for submitted problem solutions suggested. The military agency could be contest judge.

What do you think?

H. E. Manning
Value Analyst
Convair Division
General Dynamics Corp.
San Diego

We're not sure.

VEST POCKET POWER

From vest-pocket nuclear generators for ocean, arctic and wilderness stations—or satellites and space systems—to portable power reactor systems meeting the large-scale requirements of military installations, the products of Martin's five-year nuclear development program are now making news... Developed under the direction of the AEC, the pint-sized 4-pound Martin SNAP III thermo-electric generator was recently singled out for commendation by the scientific community. Meanwhile, Martin is at work on a portable nuclear power plant, designed for transport by air, to provide power and heat for an Air Force installation at Sundance, Wyoming.



MARTIN

BALTIMORE·DENVER·ORLANDO

The Nuclear Division is one of the seven divisions of The Martin Company

contract awards

AIR FORCE

$29,300,000—**General Electric Corp.,** for further development of the J93 jet engine. (This is in addition to the $8,300,000 contract previously announced.)

$510,000—**United Enterprises, Inc.,** New Orleans, for construction of an assembly hangar at Cape Canaveral for the *Mace* tactical missile.

$350,000—**Burroughs Corp.,** Detroit, for coordinating data on transmitting set compatibility to Montgomery sector radars.

$326,500—**General Electric Corp., Defense Electronics Dept.,** Syracuse, N.Y., for miscellaneous telemetric components.

$170,700—**Douglas Aircraft Co., Inc.,** for technical services.

$151,300—**General Motors Corp., AC Spark Plug Div.,** Milwaukee, for technical services.

$131,500—**North American Aviation, Inc., Rocketdyne Div.,** for technical services.

$83,093—**Hallamore Electronics Co., Div. of Siegler Corp.,** Anaheim, Calif., for data insertion converter rack.

$64,815—**Bendix Aviation Corp., Freiz Instrument Div.,** Towson, Md., for miscellaneous replacement parts for airborne weather equipment, radiosonde receptor and radiosonde dispensing sets.

ARMY

$6,462,384—**Independent Contractors & Engineers,** Dallas, for construction at the *Atlas* site, Forbes AFB, Topeka, Kan.

$3,370,000—**Douglas Aircraft Co.,** Santa Monica, Calif., for launching equipment for the *Nike-Hercules.*

$1,442,315—**Industrial Metal Fabricating, Inc.,** Wayne, N.J., for 500 prefabricated buildings.

$1,375,010—**General Electric Co.,** for generators.

$777,886—**Douglas Aircraft Co., Inc.,** Santa Monica, Calif., for launching items (four contracts).

$510,618—**Rheem Mfg. Co.,** Downey, Calif., for fuzing system for warheads (two contracts).

$450,000—**Firestone Tire & Rubber Co.,** Los Angeles, for modification of guided missiles.

$180,499—**Harvey Aluminum,** Torrance, Calif., for study of weapon systems.

. . . contract awards

$169,512—**Data Instruments Division, Telecomputing Corp.,** for fixed camera reader.

$74,886—**Gilfillan Bros., Inc.,** Los Angeles, for repair parts.

$56,419—**Ordnance Engineering Associates, Inc.,** Chicago, for testing including thruster XM-11 PMTS, cartridge and load assembly.

$46,651—**Hufford Corp.,** El Segundo, Calif., for spherical heads.

$46,047—**Librascope, Inc.,** Glendale, Calif., for tape cartridge memory system.

$38,205—**Airtemp Div., Chrysler Corp.,** Dayton, Ohio, for engineering orders applicable to ballistic missiles.

$30,000—**University of Utah,** for investigation of chemical reactions.

NASA

$175,000—**Callery Chemical Co.,** Pittsburgh, for evaluation of a new classified solid-liquid rocket propellant.

$135,480—**Consolidated Electrodynamics Corp., Datalab Div.,** Pasadena, Calif., for design and development of airborne magnetic-tape recorders to monitor the first manned orbital space flight under Project *Mercury* (a subcontract from McDonnell Aircraft Corp.).

(The instrumentation will record physiological reaction of the pilot and monitor environmental conditions of the McDonnell space capsule.)

(Because of military applications, NASA scientists said only that the propellant was of a new non-cryogenic type that would permit substantial increase in payload weight. Callery is expected to explore feasibility of the new concept, which has both liquid and solid applications, and report its findings to NASA in about eight months. A major subcontractor in the evaluation is **Reaction Motors Inc.,** of New Jersey, a division of **Thiokol Chemical Co.**)

$46,000—**Space Electronics Corp.,** Glendale, Calif., for a study of requirements for the proposed Project *Mercury* control center.

(The center will serve as the basic decision-making facility of the project's world-wide range of tracking, telemetry and computation centers. A scale model of the center will be developed under the contract, and requirements and specifications for the center's equipment will be assessed.)

Fellow Engineers and Scientists:

My company has asked me to tell you of the unusual opportunities in operations research at System Development Corporation. These range from positions for engineers and scientists who would like to develop their skills working in a team under an experienced leader to opportunitie for those who are looking for positions of leadership. I hope that the following account of our work will lead you to inquire for further informat

Briefly, SDC's business is automated decision-making systems. More fully, we develop large scale, computer-based information processing systems in which the computer is used as an on-line, centralized control element for a system operating in real-time. At this stage of the art these systems are semi-automatic, the man-machine type in which man shares the repetitive control function with the computer. Our work is concept-oriented, rather than hardware-oriented, and deals with problems of over system design, data processing development, and man-machine system training.

The most fully developed large-scale semi-automatic system is the SAGE (Semi-Automatic Ground Environment) Air Defense System. We have a major responsibility in the development of SAGE. Our experience and unique team skills have led to diversification of our activities; we no have important contracts for other major military and government system vital to our country. The demand for our services is reflected in our grow from 70 to more than 2,700 employees since 1955, and the intriguing possibilities of automated decision-making are only beginning to be reali

In this brief message, I can only suggest the variety of operations research problems at SDC. Perhaps the most important point is that this variety is limited only by the imagination and initiative of our scientists.

Some examples of areas of work are: (1) allocation of decision-making functions between man and machine for optimal system performance; (2) measures of system capacity and system performance; (3) explorati and evaluation of design changes by operational gaming; (4) quality cont and testing of operational computer programs; (5) allocation of compute capacity among several system functions; (6) scheduling and costing of production of operational computer programs; (7) optimal assignment of mixed weapons to targets.

SDC recognizes the importance of a well planned research program fo the vitality and future of the company, and we are carefully organized to carry out such a program. The following are some areas our operations research people are involved in: (1) simulation and operational gaming techniques in problems of control systems; (2) information retrieval and theory of information processing; (3) medical data processing; (4) univer language for computer programming; (5) logistics. We have unusual facilities for research at SDC—these include one of the largest compute facilities in the world and outstanding simulation laboratories.

We have given considerable thought to organizing the activities at SD provide for professional development and self-expression. Operations research professionals are carefully assigned so that their individual talents are matched with company needs. These assignments are review regularly to make sure that developing talents are directed into new company opportunities. We regard the publication of research articles a participation in professional societies as activities important to the company. We encourage new ideas and provide the time and means to explore them.

SDC is one of the leaders in a field which will have a remarkable technological and scientific development. It is a new and vigorous comp with a bright future. I encourage you to join us.

Please write Mr. R. W. Frost at the address below if you wish to purs this invitation.

William Lamb

11-105A

SDC



William Karush
Assistant Director for Research
Operations and Management Research
System Development Corporation

YSTEM DEVELOPMENT CORPORATION



QUARTERBACKING THE EAGLE PROJECT

Bendix Aviation Corporation will be prime contractor for the Eagle missile—and Bendix Systems Division will quarterback the project.

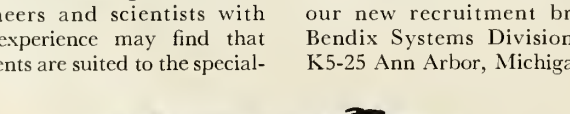
Latest in a series of important defense projects to be assigned Bendix Systems, the Eagle will be a long-range, air-to-air missile designed for fleet air defense and interception missions.

Responsible for systems management and engineering in connection with the project, Bendix Systems Division will also direct the development of the Eagle missile, electronic guidance, and fire control equipment in the launching aircraft.

Engineers and scientists with missile experience may find that their talents are suited to the specialized work involved in the Eagle project and other important system programs at Bendix Systems Division.

Located adjacent to the Engineering campus of the University of Michigan, Bendix Systems Division offers the better man an outstanding opportunity to join an organization with full facilities for encouraging his finest work. Ann Arbor is a wonderful place to live and raise a family, a town which combines life in a college community with the nearby advantages of a large city.

If you are interested and qualified in weapons system planning, research and development, write today for our new recruitment brochure. Bendix Systems Division, Dept. K5-25 Ann Arbor, Michigan.



Bendix Systems Division

ANN ARBOR, MICHIGAN

Bendix AVIATION CORPORATION

people

President Eisenhower has nomin **Joseph V. Charyk**, chief Air Force s tist, to be an assistant secretary of Air Force succeeding **Richard E. Ho** now Associate NASA Director. Ch formerly was with the Jet Propul Laboratory at Cal Tech.

A. C. DeAngelis has been ele vice president of Dynamics Corp. America. He is president of D communications sidiary, Radio gineering Labor ries, Inc. Be joining DCA 1950, DeAngelis president of Gen Armature and M ufacturing Co.



DeANGELIS

General K. Nichols, former Atomic Energy Com sion general manager, and **Dr. Jerry Afee**, vice-president-engineering in Oil Corp's manufacturing departm have been elected to Callery Chem Co.'s board of directors.

Gordon S. Burroughs has been pointed vice p dent of CBS La atories in charg the newly-expan Military and In trial Electronic tems Departm and will direct s projects as mili application of vision, high-res tion reconnaissa and surveillance systems. Formerly p dent of Burroughs Engineering, assets which were acquired by CBS Laborato Burroughs previously served as Head the Electronic Systems Department Olympic Development Co.



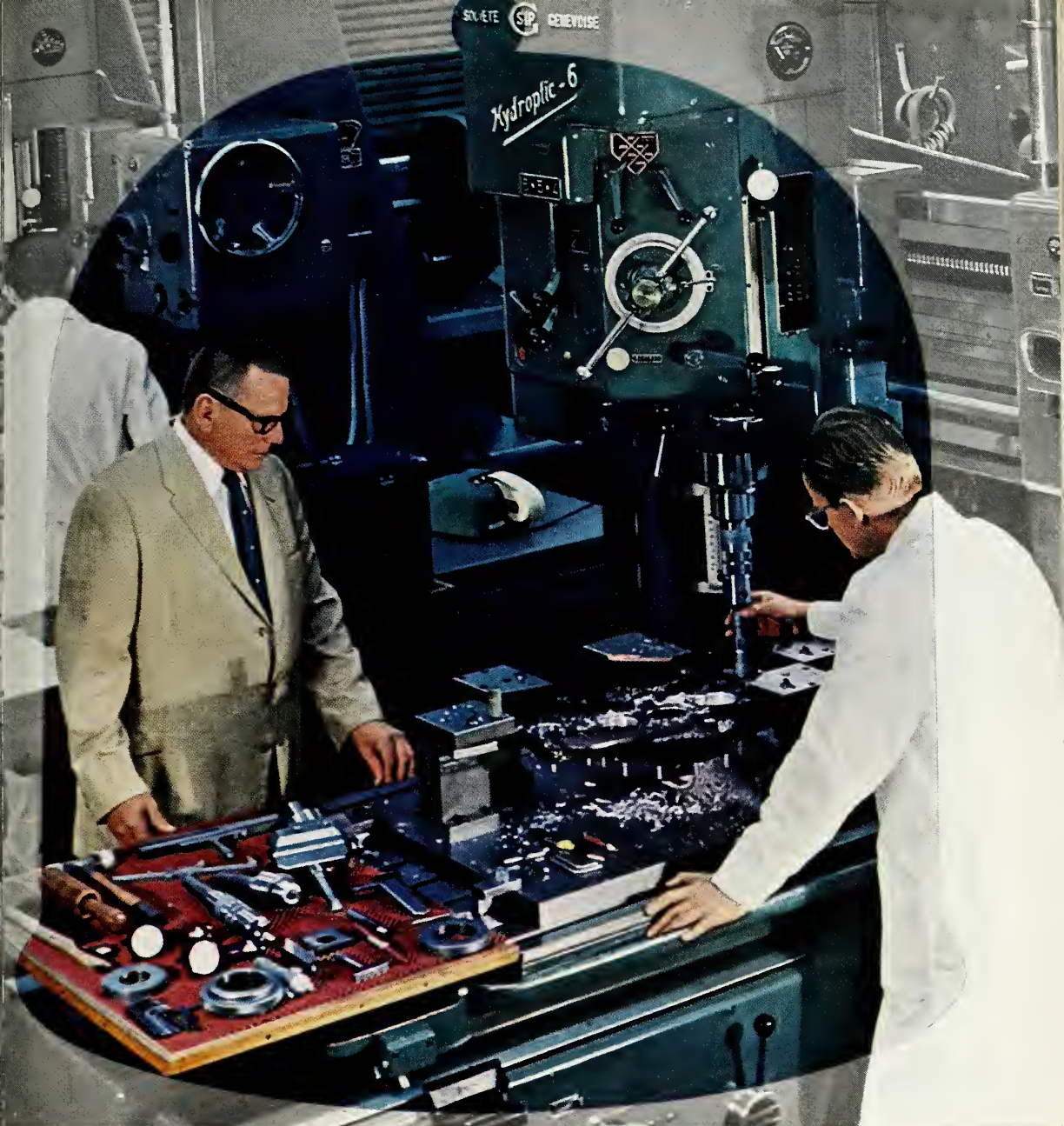
BURROUGHS

John F. Kauwling is the new gen manager of Electronics Divis of Elgin Natic Watch Co. joined Elgin in 1 as operations m ager of the E tronics Division prior to that plant manager Standard Coil Inc.



KAUWLING

Hughes Aircraft Co. has tap **Thomas D. Hanscome**, former U.S. N Research Laboratory scientists, and **Walter G. Wadey**, former Yale Univers research physicist, for its nuclear el tronics department. Hanscome, as ch scientist for the Chesapeake Bay an of the Naval Research Lab, prepared fi experiments for several nuclear tests Nevada and the Pacific and was proj officer on weapons tests for nuclear rad tion measurements. Wadey worked Yale on design and development of hi current linear electron accelerators, n



Like in a huge bell jar, temperature and humidity are controlled to exacting standards in I. G. W.'s precision jig bore room.

Precision is our only product!

Indiana Gear, precision goes far beyond the usual cus-ner requirements. Precision is a part of order coordinating, gineering, production, inspection . . . a part of *every* Indiana ar operation. Precision is a way of thinking at Indiana ar . . . a method of always working beyond the fringe of state of the art.

IGW

INDIANA GEAR WORKS, INC.
INDIANAPOLIS 7, INDIANA

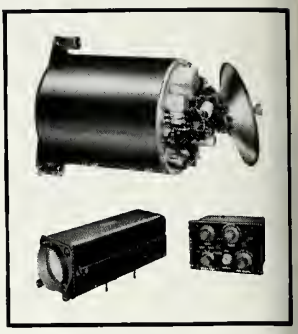
napolis, Ind., ME 8-2331, TWX IP-174-U • Redondo Beach, Cal., FR 5-7597, TWX 7856-U • Westport, Conn., CA 7-0262, TWX 486-U

AIRBORNE RADAR...

The APS-67 Airborne Radar . . . designed and developed by *The Magnavox Company* in conjunction with the Navy Department, gives eyes that see by both day and night to the Crusader.

The APS-67 delivers the utmost in performance and reliability for this Navy Fighter . . . clearly demonstrating *The Magnavox Company's* ability to produce and work as prime contractor on a complex electronics project.

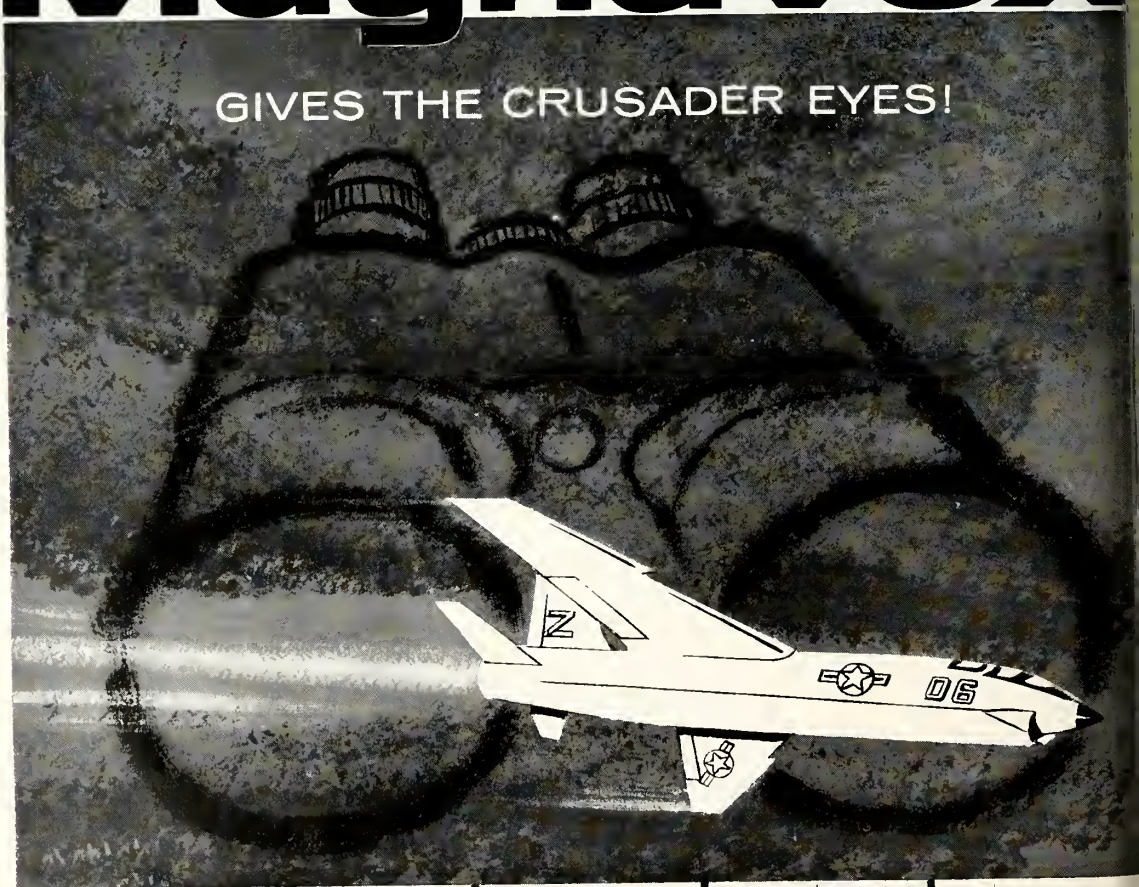
MAGNAVOX capabilities are in The Fields Of Airborne Radar, ASW, Communications, Navigation Equipments, Fusing and Data Handling . . . your inquiries are invited.



PRODUCTS
THAT SEE BY
THEMSELVES

Magnavox

GIVES THE CRUSADER EYES!



COMMUNICATIONS | RADAR | DATA HANDLING | ASW | MISSILES

THE MAGNAVOX CO. • DEPT. 68 • *Government and Industrial Division* • FORT WAYNE, IND

and gamma ray spectroscopy and arch laboratory design. **Dr. Roger** man has joined Hughes as head of physics department of the materials arch laboratory, semiconductor di- on. He was formerly with General tric's research labs.

Barnet R. Adelman and **Herbert R. Lawrence** have been elected vice presidents of United Research Corp., subsidiary of United Aircraft Corp. Both scientists have been active in the missile propulsion field and have worked on development of the engines for the *Atlas, Titan, Thor* and *Minuteman* missiles. American Rocket Society's 1958 C. Hickman award for outstanding contributions to solid-propellant rocketry awarded to Adelman. Lawrence ed a leading role in the development the first shock wave engine and the pulse jet capable of operating at -sonic speeds.



ADELMAN

Dr. Koto Matsudaira, Japan's ambassador to the United States, was elected rman of the 18-nation committee on peaceful uses of outer space. **Dr. rio Amadeo** of Argentina was chosen chairman.

Recent changes at Space Technology oratories: **Dr. Richard D. De Lauer** ed director and **Harold Hirsch,** assoe director of the Vehicle Development oratory, Research and Development ision; **Dr. Robert Bromberg** appointed ctor and **Arthur F. Grant,** assistant dior of the Propulsion Laboratory, Rech and Development Division.

Robert E. Root, former manager of Rheem Manufacturing Co.'s Military Research and Development Laboratories, has been appointed division manager of the Electro-Mechanical Division of American Electronics, Inc. At one time, Root worked in the Ordce Division of Northrop Aircraft.



ROOT

Appointment of **Wilhelm F. Juptner** and **Gilbert Heavin** to executive engineering and production posts, respectively, has been announced by Babcock Relays, Inc. Juptner has been promoted from chief engineer to engineering vice president and chief engineer, and Hea-, who recently joined the company, es over the duties of production man- r. Before joining Babcock, Juptner was h the Electronics Division of Elgin tional Watch Co. Heavin was formerly h the production department at Hallare Electronics, Inc.



JUPTNER

HADLEY

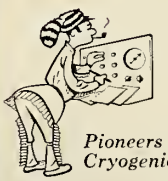
missile valves & controls



Leakage problems?

If your enthusiasm is somewhat dampened by leakage trouble, why not let Hadley design engineers help you with your system problems. In addition to sound engineering, Hadley laboratories are equipped for all types of environmental testing. Supported by precision manufacturing and rigid quality control, Hadley is able to deliver the quality product on schedule.

For more information write,
J. T. Reilly, Director of Marketing



Pioneers in Cryogenic Valves

- **ENGINEERS: Inquire about attractive project & design career opportunities.**

B. H. HADLEY INC.*

POMONA, CALIFORNIA

*Wholly owned subsidiary of Central Hadley Corporation — listed American Stock Exchange.

The House has passed (294-128) and sent to the Senate a $480 million authorization bill for NASA. The measure does not carry any appropriation.

High-strength steel sheets from .005 to .100 inches thick and up to 125 x 240 inches in size are being evaluated at request of Air Materiel Command by 16 propulsion and missile/aircraft manufacturers. Aerojet-General and National Northern will apply series of explosive forming techniques to determine if sheets can be deep drawn for missile applications.

NASA contracts for April amounted to $27.6 million—the largest $24 million to Douglas Aircraft Corp., for three stage launching vehicle *Delta*. Other contracts went to: MIT, $50,000, for the development of a cesium vapor atomic clock, and gamma ray detection instruments; University of Maryland, $60,000, to investigate the forces between atoms, molecules, and ions; Itex Corp., $170,000, for development of upper-atmosphere sounding rocket instruments; New York University, $100,000, to instrument two *Aerobee-Hi* rockets for neutron intensity measurements; AOMC, $150,000, radiation satellite payloads; Univ. of Chicago, $300,000, to build cosmic ray measuring instruments; General Mills, $60,000, for nine 100-foot diameter plastic balloons for communications satellite tests; RCA, $60,000 for *Mercury* ground tracking and instrumentation studies; American Potash & Chemical Co., $50,000, for 161,000 pounds of ammonium perchlorate for solid research; rensselaer Polytechnic Institute, $80,000, for mathematical investigation of control systems; and Rice Institute, $150,000 for wind tunnel studies and research into physics of solid materials at high temperatures.

Lockheed Aircraft is moving into the missile electronics field with the acquisition of Stavid Engineering Inc., Plainfield, N.J. Terms are 2½ shares of Lockheed stock for every share of Stavid. No changes in management or policies of the smaller firm, which has 1000 employes and 1958 sales of $11.2 million, are contemplated. Stavid co tracts have covered scale model launc ing, silo instrumentation for *Minu man*, airborne radar beacons for t *X-15* and guidance and controls f several other weapon systems.

Labor troubles have hit the miss ranges. An *Atlas* shoot at Vandenbe AFB was delayed by a May 18 wal out of machinists protesting Conv living allowances. On the same d there was a double failure of an *Ati* and a *Polaris* during a work stoppa by carpenters at Cape Canaveral.

Test stand at Martin's Denver pla was severely damaged May 15 explosion of *Titan* first stage. No pe sonnel injuries were reported and t missile's second stage, only 10 fe away at the time, also escaped u scathed.

Air Force is now investigating Ra theon's proposed "sky station"—dis shaped structure to be kept aloft b beaming high-powered microwave e ergy to run mechanical rotor. Key ite is amplitron microwave tube whi eliminates need for bulky reflectors a power converters. Potential early app cations are missile and aircraft dete tion, skypath link for long-range, larg capacity communications and meteo ological observation.

Space Recovery Systems Inc. is b ing formed by the Columbia Broa casting System jointly with Steinthal Co. Inc., a parachute R&D and man facturing concern. The new ventu will specialize in equipment to trac locate and recover missile and spa vehicle components and payloads.

Name changes: Yielding to th Space Age, Aircraft Industries Assoc ation has switched to Aerospace Indu tries Association. Henceforth CD Control Services Inc., Hatboro, Pa manufacturer of advanced compute integrated electronic controls, wish to be known as the CompuDyne Cor And stockholders of Mid-Century In strumatic Corp., New York City, ha voted a change to Computer Systen Inc.

What makes plastics crack? Th Wright Air Development Center h awarded a $28,000 contract to Brool lyn Polytechnic Institute to find out particularly on plastics subjected space flight conditions.

check valves with superior sealing for surge flows, high flow rates and opening blasts



P200 Series Check Valves

specifically designed by Circle Seal for perfect performance in high pressure gas or liquid service. For 0-3000 psi or 0-5000 psi.

Write today for free engineering data!

2181 East Foothill Boulevard/Pasadena, California

Circle Seal

James, Pond & Clark, Inc.

. FINANCING

(Continued from page 19)

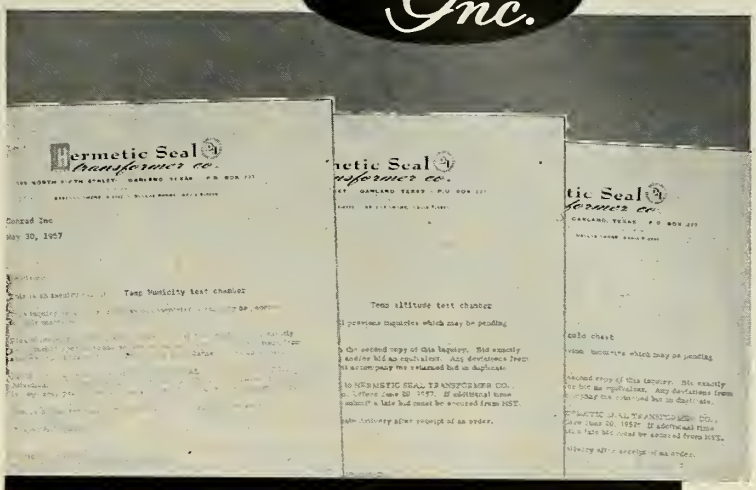
arry-forward, carry-back tax pro-
ns; whether or not to take quick
rtization (where there's a choice—
fast write-off certificates for vital
ıse facilities); general manage-
: of capitalization techniques; etc.
)ther aspects of good management
de knowing and calculating capi-
leeds against growth and planning
d to meet them; building of a
hced management—between ad-
stration, finance, sales, production
technology. Perhaps the most pre-
ous corporate structure is the one-
company. Odds are he's not as
as he should be in all the basic
agement areas. Even if he is, it's
ally certain there aren't enough
s in the week for him to give
er attention to all of the areas that
and it. And what if he's suddenly
available (as in illness or death)?
The year 1958 saw two records
e. There were 150,268 new busi-
incorporations, an all-time high—
pared to 136,697 in 1957. And
were 14,964 business failures—the
est since the end of World War II
mpared to 13,739 in 1957. How
y of these companies were among
50,000-odd now calculated to be
cipating in missiles, spaceflight and
orting activities the figures don't
y.

However, you need only to look
the continuing rash of mergers
attempted mergers to know that no
l number are running into financial
ations on their growth. More often
not this is the basic reason for at
half of the mergers—though
y we've seen cases of companies
ring for a merger, that looked like
thought the other had money!

n the theory that no one is too old
earn, SBA has developed a num-
of programs to provide manage-
t know-how. They include a series
regular publications, a series of
agement courses and other serv-
The agency has 14 regional and
field offices around the country. A
k with SBA may be worth the time
effort.

The basic point is: If you've reach-
he point where you're having to
musical chairs with your creditors'
ırs, you'd better start thinking
ıt remedies. There are many dif-
nt approaches, most of them out-
l above. Almost all of them take
e time—SBA and "V" loans, for
nple, take from three weeks up. A
stock issue takes even longer to
organized and cleared through SEC.
, of course, the development of a
l management team—the most ele-
tary of all—sometimes takes years.

ENVIRONMENTAL TEST CHAMBERS FROM THE CONRAD Inc. FILE

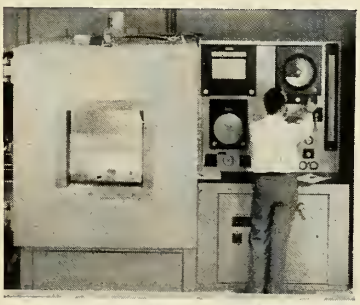


THE INQUIRY FROM THE CUSTOMER

Sometimes we build chombers to our own design, sometimes to customers' specifications. Here's o case of the latter. Hermetic Seol Tronsformer Co. sent us their stondard inquiry forms and specificotions for three chambers — temperoture-humidity, temperoture-oltitude, and temperoture. Conrod's engineering ond estimoting deportments took over, without obligating Hermetic in ony way.

THE RESULT FROM CONRAD, INC.

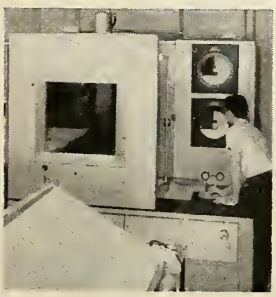
Conrod's product, performance, ond pricing looked right to Hermetic. These three chombers are now key units in Hermetic's up-to-the-minute environmental test loboratory, enabling them to mointain o complete check on prototype ond production models of their products. These focilities ore olso avoiloble for testing products of other manufacturers.



FH 36-5-5 TEMP.-ALT. — Temperature range —100°F. to +500°F., altitudes to 200,000 ft. (from atmospheric to 150,000 ft. in 11 minutes).



CB 8-2-2 TEMP — Electrical units may be operated within this chamber at temperatures from —100° to +250°F.



FO-36-2 TEMP.-HUMIDITY — From —35°F. to +250°F., up to 98% relative humidity. Temperatures stabilized within 2°F.

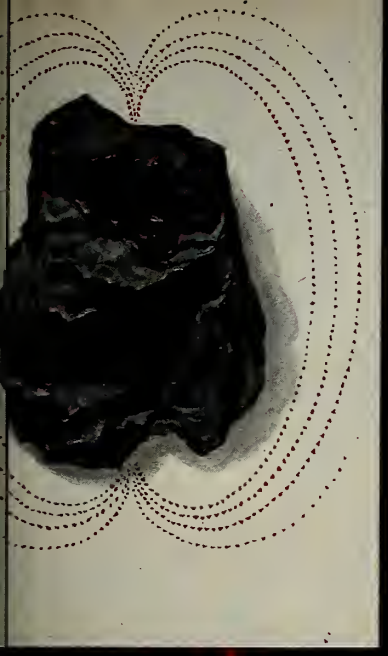
For Complete Service In Planning and Building Environmental Test Chambers, Write

CONRAD Inc.

HOLLAND · MICHIGAN

Subsidiary, Crampton Mfg. Co.


MAGNETOHYDRODYNAMICS
EXPANDING THE FRONTIERS OF SP



MAGNETOHYDRODYNAMICS: Lockheed's 3rd Annual Symposium* on this important new field—which deals with the behavior of conducting fluids in magnetic fields—attracted physicists from all over the world. As portrayed by the artist, man's earliest experiments with magnetic forces involved the use of the ancient lodestone. Solar prominences are a dramatic example of such forces under investigation today.

Lockheed Missiles and Space Division has complete capabilities in more than 40 areas of science and technology—from concept to operation. Headquarters are at Sunnyvale, California, on the San Francisco Peninsula, with research and development facilities located in the Stanford Industrial Park in nearby Palo Alto and at Van Nuys in the San Fernando Valley of Los Angeles. A 4,000 acre, company-owned test base, 40 miles from Sunnyvale, conducts all phases of static field testing. In addition, complete flight testing is conducted at Cape Canaveral, Fla., Alamogordo, N.M., and Vandenberg AFB, Calif. as an integral part of every stage of missile and space programs at Lockheed.

The Division's advanced research and development programs now under intensive study provide a fascinating challenge to creative engineering. These programs include: man in space; space communications; electronics; ionic, nuclear and solar propulsion; magnetohydrodynamics; oceanography; computer research and development; operations research and analysis; human engineering; electromagnetic wave propagation and radiation; materials and processes and others.

HNOLOGY

Lockheed's programs reach far into the future and deal with unknown environments. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research Development Staff, Dept. E3-29, 962 W. El Camino Real, Sunnyvale, California. U.S. Citizenship required.

"The organization that contributed most in the past year to the advancement of the art of missiles and astronautics."
NATIONAL MISSILE INDUSTRY CONFERENCE AWARD.

Lockheed / **MISSILES AND SPACE DIVISION**

Weapons Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA · ALAMOGORDO, NEW MEXICO · HAWAII

*Copies of the proceedings of the first two symposiums were published by the Stanford University Press, Palo Alto, Calif. and are available in book form. Results of this year's symposium will be published shortly by the same house.

missile business

by William E. Howard

Anemia, insofar as the Defense Department is concerned, apparently is no cause for alarm. Missile makers must show acute starvation before the Pentagon will even consider changing the policy line it adopted toward profits in 1957 and still does today.

Precisely what the profit factor should be when doing business with the government is one of those questions not easily resolved. As matters stand now, the government holds virtually complete control. And its decision is to keep profits as low as possible, regardless of the fact that the economic health of its suppliers is critically important to the defense effort.

In essence this is the DOD position set forth for a House Appropriations subcommittee recently by Perkins McGuire, Assistant Defense Secretary for supply and logistics. The aircraft industry early last year asked for a higher profit factor. It said the money was needed to expand industry's research and development facilities for defense. "The Department gave this recommendation considerable study," McGuire said, "which resulted in our conclusion that our profit objective for the industry as a whole was not too low considering all of the factors under which the industry operates."

The assistant secretary's statement left unanswered in the text the question of whether the R&D effort might be too low. Industry spokesmen have long claimed that R&D—particularly basic research—is underfunded. Many companies admit they are skimping their stockholders to put all the money they can into R&D now, and it still isn't enough.

Interestingly, McGuire's statement was accompanied by some figures from the Air Force graphically indicating the profit-shrinking trend. The Air Force compiled published financial statements of Boeing, Douglas, Lockheed, Martin, McDonnell, North American, Northrop and Republic. It found the profit ratio on sales before taxes had slipped from 4.9% in 1957 to 4.1% in 1958 and after taxes the ratio was 2.45% in 1957 and 2.02% in 1958. The Air Force estimates the 1959 profit ratios will be the same as last year.

Reporting on another industry recommendation to increase the return on DOD R&D cost-plus-fixed-fee contracts, McGuire told the lawmakers that a study showed these fees: Army—4 to 9% with most less than 7%; Navy—token fee of $1 to a high of 10% with the average about 6.5%; ARDC—4 to 10% range with the average 6.1%; Air Materiel Command—4 to 7% range, average on small business contracts 6.25%.

"On the basis of these fee ranges, coupled with the fact that the payment of these fee levels did not hamper efforts to obtain research and development or adversely affect expeditious performance and quality of research and development work, the conclusion was that no general increase in the DOD fee objective was indicated," McGuire said. "Accordingly," he added, "there has not been any general increase in our profit objectives in 1957, 1958 and 1959, and, although the final pricing results are not generally available, we do not believe that the final negotiated prices showed an increase. With respect to the fees allowed, our studies definitely establish the fact that there has been no general increase."

What's ahead for 1960? The defense official doesn't say. But several airframe manufacturers aren't waiting for an increase from the government. They are in the process of diversifying to broaden their profit base, which may make the DOD happy. But unfortunately diversification takes money, too—money that otherwise might go into research vital to winning the technological race against Russia.



VOUGHT DESIGNS QUARTE
FOR SPACE EXPLORERS

Chance Vought's qualifications ha
directed the company into one of t
most challenging areas of space explo
tion: the control compartments
manned space vehicles.

Responsible is Vought's reputation
"human factors" – the pilot conside
tions that must be designed into
vanced aircraft. Vought showed an ea
appreciation for human factors, e
ploying biochemists, psychologists a
human engineering specialists in dev
opments such as that of the *Crusa*
fighter.

In spacecraft, these factors are ev
more important. They affect the desi
of the entire vehicle. They bring i
focus the tremendously hostile envir
ment of space, and a completely n
regime of aeromedical problems.

In preparation, Chance Vought h
marshalled space age research and
sign aids. A "hot-shot" wind tunnel
example – capable of duplicating t
rific re-entry heats; and high-spe
computers to calculate trajectories a
orbits for solar system flight.

Vought is a member of the Boei
Airplane Company team in the Air For
competition to produce the highly a
vanced *Dyna-Soar* boost-glide vehic

At the same time, additional intensi
company research programs are und
way for putting man into space.

*Astronautics is just one in the bro
spectrum of Chance Vought fields
activity. Other areas include: design a
production of high performance aircra
electronics, advanced weapons, an
submarine warfare, range systems ma
agement, commercial process cont
systems.*

CHANCE VOUGHT
DALLAS, TEXAS



NEW THEATER OF AIR FORCE ACHIEVEMENT

The first astronauts have been chosen by the National Aeronautics and Space Administration, and Air Force pilots are among them. These men will blaze a trail into space. The first step will be soon — a boost into orbit, a capsule parachute journey back to earth. Next will come very high flights with controlled, glider-like landings. Then, one day, astronauts will pilot space cruisers throughout our solar system. Air Force, Navy and Marine pilots are taking the first step toward use of space in the NASA program, bringing the military pilot a giant stride forward in the evolution to spaceman.

ADVANCED WEAPONS | ASTRONAUTICS | ASW | ELECTRONICS | MISSILES AIRCRAFT | G | RANGE SYSTEMS

CHANCE VOUGHT
DALLAS, TEXAS

DATA PROCESSING SYSTEMS SPECIALISTS

The Techniques of High Speed Data Processing Offer A Big Future For You!

A missile comes "of age"—reaches operational status—as a result of many influences. Vital among these influences is the rapid incorporation in the test vehicle of modifications required by evaluation of flight performances. The faster these modifications are made, tested, and become incorporated in the design, the faster the vehicle is declared operational.

The completion of this cycle is dependent too upon the speed with which vast amounts of test data can be reduced, analyzed, evaluated, and reported to the military and to the cognizant weapon systems contractors.

So, with the advent of missiles has come a revolution in data processing techniques—a revolution in which the Engineering Services Division of Telecomputing Corporation has been highly successful in greatly reducing the elapsed time for complete processing of missile flight test data.

This is an invitation to join the data processing specialists who comprise the Engineering Services staff—a staff which establishes the state-of-the-art in data processing techniques and methods as we go about our job of computing the performance of missiles under test at the White Sands Missile Range.

Join us and work with high speed digital computers and other modern data processing squipment in reducing the test data from scientific data measuring systems such as, cinetheodolites, electronic measuring systems, precision optics, and telemetering systems.

Join us—and grow with us—as our advanced processing techniques are employed in this fascinating field of missile flight testing so important to our national defense effort.

Make your home in New Mexico's Land of Enchantment* Mountain skiing and resorts just 30 minutes away* Attractive salaries with area bonus* Profit Sharing* Relocation Pay* Group Insurance. Send your resume today to the Director of Technical Personnel

Engineering Services Division
Telecomputing Corporation

Box 447, Holloman Air Force Base, New Mexico

propulsion engineering

Binders of future solid propellants may be oxidizers instead fuels. At least that is the line of thought opened up in the chem industry by the recent announcement that the Army Rocket Guided Missile Agency's $750,000, one-year study contract on s propellants went to Allied Chemical's General Chemical Divis The division makes fluorine, chlorine trifluoride, and bromine pe fluoride—all under study, or in development, as super oxidizers. present, binders are fuels that hold together such oxidizers ammonium perchlorate or ammonium nitrate.

Talk that the roles of fuels and oxidizers in solids may rev has been heard several times in recent years. Allied's entry propellants in a big way (it has been in the business "through back door" for several years as a supplier of fluorine and o chemicals) almost certainly means that at least one solid prope will feature a fluorine-based oxidizer-binder holding an unspec fuel. The result could be a fluoro-plastic oxidizer-binder homogen with a rubber or urethane fuel-binder. Allied will conduct the v in its General Chemical research laboratory, Morristown, N.J.

Look for a major research effort to push chlorine into mis possibly as an ingredient in a synthetic structural material, mayb a propellant system. Reason for the chemical industry push: C capacity. The industry was caught in a bad squeeze when n ethylene glycol manufacturers switched from a chlorine process r over to the ethylene oxide route of producing the glycol.

Further overtures to missile business by the chemical industry seen in several of the newest chemical plants now in produc or under construction. Examples: Air Reduction's new oxygen nitrogen facility has started production at Denver; National Cyli Gas Division of Chemetron Corporation has put its new $1,750. 35 ton/day liquid oxygen, nitrogen, and argon plant on strea Los Angeles; Texas Alkyls, Inc., has begun a new $1 million minum alkyls plant at Houston.

The Texas Alkyls plant is a joint venture of Stauffer Chem and Hercules Powder, both already in the missile supply busi making mostly fuels and oxidizers. The aluminum alkyls will two major uses in the missile industry: They will be highly effe catalysts in vital chemical process operations; and they will be as, or in, self-igniting hypergolic propellants for upper rocket st Initial production will exceed 1 million lbs./year, beginning late year or early next.

Foote Mineral Company still is chafing under the Atomic En Commission's order ending purchases of lithium hydrides, but exp to make a major comeback almost immediately. Foote chem under research director Dr. E. M. Kipp, have developed a new lit hydride—or type of hydride—that is a much more reactive redu agent than present commercial lithium hydrides. Foote says not about the missile applications, but in a propellant system the oxi is complemented by the reducer as a fuel.

Lithium nowadays almost always gets into fuel conversat wherever missilemen meet. Foote is part owner of HEF, Inc., w is gearing up for a major role in propellants. However, Foote it will be several years yet before HEF contributes substantiall Foote's income. In the meantime, Kipp and his associates have c up with two more items of missile interest: A new series of hi reactive and very uniform lithium dispersions (metallic); an cheap, controllable process for turning out lithium butyl as cat for several reactions.



But if you want to try, do this:

- Spend 20 years applying advanced metallurgy to production.
- Shake down 35 high-temperature alloys in the laboratory.
- Fabricate these super-alloys into critical hot-part components for prototype power plants.
- Swing into volume production of proved designs.
- Prove, over and over again, that you know what you're doing—with jet, propjet and piston engine components and afterburners, ramjets and rocket motors.
- Make your name a byword for high-temperature research and development... for precision-made components and complete power packages.

Better still—take a 20-year stride by putting Ryan to work on your heat problems.

RYAN BUILDS BETTER

AIRCRAFT · POWER PLANTS · ELECTRONICS

Ryan Aeronautical Company, San Diego, Calif.



Engineers and Scientists enjoy

EXCITING ASSIGNMENTS
and
VACATIONLAND LIVING
with
RCA in FLORIDA

RCA is right there where the *big* birds take off, at Cape Canaveral . . . and RCA engineers and scientists enjoy today's most advanced assignments in missile testing, tracking and data processing. The work is challenging, the professional advancement is rapid, and the living is magnificent!

If *your* field is Operations Analysis . . . Mathematical & Statistical Techniques . . . Astronomy . . . Computer Applications . . . or Computer Programming . . . and if you're looking for the ultimate in a *professional* position . . . you belong with RCA in Florida! You can make the move *right now*, by contacting:

Mr. D. A. Schindler
Professional Placement Representative
RCA Service Company, Dept. N 33F
Atlantic Missile Range
Mail Unit 114
Patrick Air Force Base, Florida

EQUAL JOB OPPORTUNITY For All Qualified Applicants

RCA SERVICE COMPANY
A DIVISION OF
RADIO CORPORATION OF AMERICA

British Astronautics

U.K. is Develop
A-Warheads for T

by G. V. E. Thompson

LONDON—At present the only listic missile in Britain capable of ing fired is the *Thor*, supplied f America with its atomic warhead that Britain can be completely i pendent in the manufacture and of atomic weapons, British warh are being developed.

In addition to those for the A artillery and for bombs, there wil H- and A-bombs warheads for *Blue Streak* ballistic missile, the tol/Ferranti surface-to-air *Bloodho* and the English Electric surface-t *Thunderbird*.

• **Upper atmosphere densities**-G. King-Hele of the Royal Air Establishment, Farnborough, has lysed the orbits of artificial earth s lites to estimate the mean density the amosphere at heights between and 400 km. The chief difficulty in analysis is the evaluation of the qu tity SC_d, (in which S is the mean cr section of the satellite perpendic to the direction of motion, and C the drag coefficient). Its value depe on the shape of the satellite, the n ner in which it is rotating, and way in which the air molecules are flected from its surface.

It is particularly difficult to mate for cylindrical satellites (*plorers 1, 3, 4* and *Atlas*). King-H thinks that these, and the rockets the Russian satellites, have rot about their axis of maximum mon of inertia—that is, about an axis pendicular to their length. The a between this axis and the directio rotation has varied—the extreme c are motion like a propeller and tur ing end-over-end. The following va for mean density were obtained:

Height, km.	Air density/-sea level density	Mean de (g./cm.
200	3.4×10^{-10}	4.1 x 1
220	2.0×10^{-10}	2.5 x 1
240	1.2×10^{-10}	1.5 x 1
260	7.6×10^{-11}	9.3 x 1
280	4.6×10^{-11}	5.6 x 1
300	2.9×10^{-11}	3.6 x 1
320	2.0×10^{-11}	2.4 x 1
340	1.4×10^{-11}	1.7 x 1
360	9.7×10^{-12}	1.2 x 1
380	7.1×10^{-12}	8.7 x 1
400	5.3×10^{-12}	6.5 x 1

The actual density naturally varies f day to day. The factor of error for

figures is not greater than 1.5.

Missile secrets plane lost—A ered Avro Tudor plane carrying missiles (believed to be the *Fire-*) and secret documents to the nera rocket range was recently re- d missing in Eastern Turkey. It t first feared that the plane might been captured by the Russians, flight path lay close to the Soviet r, but its wreckage was later ed on a snow-capped plateau 1000 low the crater of the extinct vol- 14,434 ft. Mount Subhan. The F. mountain rescue team sent to te were impeded by snow, difficult ing conditions, bears and wolves; eaching the wreckage they found all twelve occupants were dead. t material was removed and the ish army has been asked to ex- the missiles.

n enquiry into the accident will ld, and in future such flights will bly be routed via Africa to avoid ng too near Russian territory.

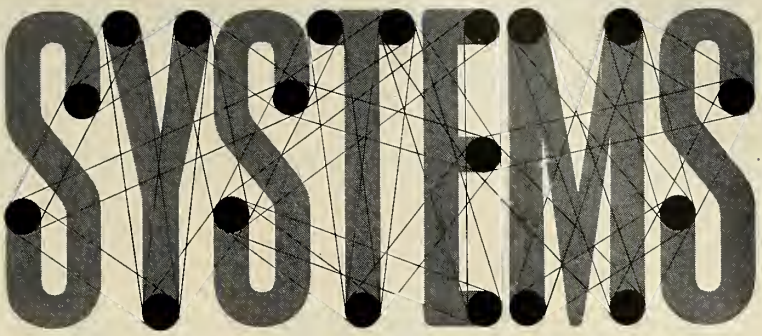
Underwater escape tests—Since five-sevenths of the earth's sur- is covered with water, the possi- of a manned satellite vehicle des- ng in the ocean is quite high. A of experiments made by the U.K. iralty Hydro-Ballistic Research lishment is of interest in this con- on.

tandard aircraft ejection seat ment was fired under water and urements were made continuously e acceleration of the seat and of mmy it contained; the pressures e gun, at various points close to e the gun separates, and at the and abdomen of the dummy.

he maximum velocity of the seat determined by using it to move a permanent magnet over equally- d coils fitted to the fixed frame- . The dummy was ejected satis- rily under water, but the pressures ed may be too high for a pilot. gun pressure dropped from 2000 o 1000 psi. at discharge; an en- d bubble then formed and water ance maintained the pressure for ger period than in air. Near the ny, the pressure varied from 0 to si.

To meet numerous requests m readers, M/R has made ilable reprints of the recent ies of articles by Dr. S. Fred ger on the meaning of Project gus. Copies of the combined ies may be obtained by writing the magazine. The rate is 50¢ a single order (bulk rates on uest).

Explore new areas at IBM in



Electronic systems engineering covers the full spectrum of applied research and development at IBM. Currently, engineers and scientists concerned with broad systems problems in business, science, and government are working toward self-optimizing computers that may some day program themselves and arrive at the one best solution to a problem. Progress is being made in advanced studies for radically different data systems for terrestrial and stellar navigational problems. For problems like these, and many others, IBM needs people who want to convert challenges into careers.

You will enjoy unusual professional freedom, comprehensive education programs, the assistance of specialists of diverse disciplines, and a wealth of systems know-how. Working independently or as a member of a small team, your individual contributions are quickly recognized and rewarded.

CAREERS AVAILABLE IN THESE AREAS . . .

Applied mathematics & statistics
Circuit design & development
Component engineering
Computer analysis
Cryogenics
Flight test analysis
Human factors
Inertial guidance
Information theory
Logical design
Operations research
Programming
Radar circuitry
Theoretical physics
Transistor device design

Qualifications: B.S., M.S., or Ph.D. in Electrical or Mechanical Engineering, Physics, or Mathematics —and proven ability to assume a high degree of technical responsibility in your sphere of interest.

For Details, write, outlining background and interest, to:

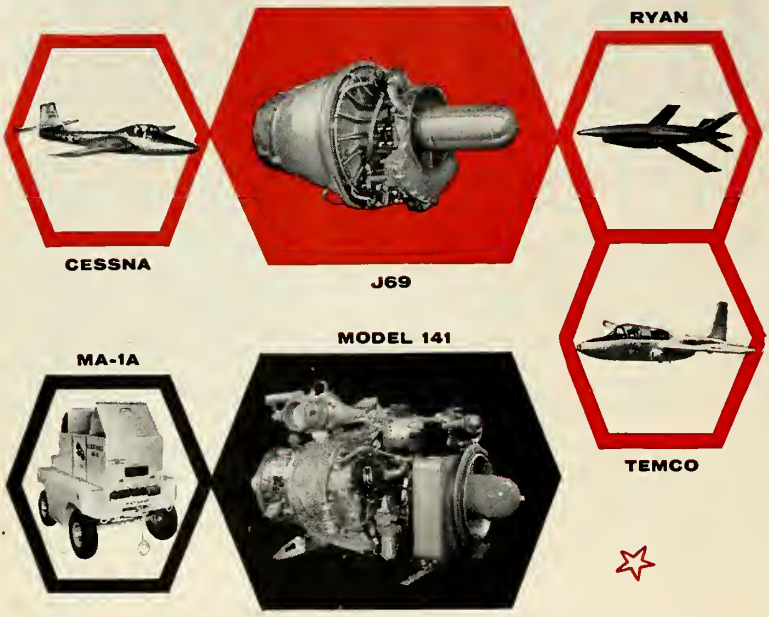
Mr. R. E. Rodgers, Dept. 604E4
International Business Machines Corp.
590 Madison Avenue, New York 22, N. Y.

IBM®

INTERNATIONAL BUSINESS MACHINES CORPORATION

CAE
• RESEARCH
• DEVELOPMENT
• PRODUCTION

Building Tomorrow's Power



Continental Aviation & Engineering Corporation has more than 10 years' experience with small gas turbine engines.... Four versions of the J69 turbojet—delivering 920 to 1700 lbs. thrust—are in operation today. . . . The Model 141 turbine air compressor engine is widely used in jet aircraft ground support equipment. . . . Research and development programs are continuously in process on uprated turbines, new turbine configurations, solid fuel propellents, and solid fuel ramjet vehicles.

CONTINENTAL AVIATION & ENGINEERING CORPORATION
12700 KERCHEVAL AVENUE, DETROIT 15, MICHIGAN
SUBSIDIARY OF CONTINENTAL MOTORS CORPORATION

Spacecraft Materials Probed by Symposium

by Frank G. McGuire

PALO ALTO, CALIF.—Technical pects of temperature, erosion, spu ing, lubrication and vacuum effects materials were thoroughly discusse the first Symposium on Surface Eff on Spacecraft Materials, co-sponsc by Lockheed and ARDC. Over hundred scientists from throughout country attended the meeting, the of its kind to deal with thermal de and surface effects exclusively.

• **Vacuum effects**—Dr. M. R. A ter of the Naval Research Laborat reported on research involving changed characteristics of mate under high vacuum conditions. creep strength of some metals goes when in a vacuum, Dr. Achter s but with high temperatures they r actually be weaker in space than earth. This reversal will have to be c sidered in designs of future spacecr

Changing many of the parame of testing could completely reverse results of a test, according to Ach The loading of the sample, as wel great changes in temperature, cc substantially alter the end result i creep-strength or fatigue test.

Other researchers, discussing sublimation of materials under l vacuum, stressed the need for l vapor-point materials in the consti tion of spacecraft, because vacuum fects them less than other mater As one extreme example, it is poss for a spacecraft to vanish due to "ev oration" of the metal, and resul changes in the bulk properties.

Experiments on plastics and cer metals have been conducted to st this effect at various temperatures. far, these experiments have shown portant changes in materials follow prolonged exposure to vacuum. M subtle effects due to absence of surf gas layers include changes in the efficient of friction, fatigue and cre rupture characteristics.

• **Lubrication**—It probably will necessary to use solid-film lubricant space, but graphite has virtually b ruled out due to the necessity of hav water vapor in the environment s rounding the lubricant. Dr. Bruce D iel, Midwest Research Institute, the symposium that the best solid-l lubricants found so far are molybden disulfide and tungsten disulfide, but they are not as efficient as desi under high-temperature conditions.

Work is under way at Midwest search Institute to determine the act mechanics of friction by use of gra ite whiskers. These hard-to-prod



ANOTHER **MARMAN** FIRST!

Quick, Off-the-Shelf Delivery of Quality Clamps, Couplings, Joints

FROM OUR NEW WAREHOUSE



than 450 different parts are now avail- from stock in the new Marman warehouse.

With the completion of a new warehouse, Marman has initiated a unique inventory program for off-the-shelf delivery of many types of Marman Products.

Now, oircraft/missile engineers and buyers can select high quality Marman Clamps, Couplings and Joints from standardized styles . . . for immediate delivery!

BETTER SERVICE

This new inventory program is designed to provide better service to all of our customers. By ordering standardized products for fastening and joining, wherever possible, manufacturers can eliminate the extensive lead time normally needed for tooling and production.

WIDE SELECTION OF STYLES AND SIZES

At present, 10 basic Marman Products (shown above) fit into this inventory program. These clamps, couplings and joints are now available in a wide range of stock sizes, styles and materials that include 458 separate part numbers. As other products adapt to standardization, they will be added to this list.

IMPORTANT COST SAVINGS

Another very important customer advantage is the reduction of unit costs of inventoried items. This is possible because special production dies, inspection gauges, etc. are not required; optimum production runs can be scheduled; better volume purchases of manufacturing materials can be made. All of these savings are reflected in the new off-the-shelf prices.

Full information on this inventory program including parts specifications, sizes, materials, and prices is now available.

CONOSEAL is on Aeroquip trademark

Mail this coupon for full details.

MR-5

Marman Division, Aeroquip Corporation
11214 W. Exposition Blvd., Los Angeles 64, Calif.

Please send me full details on the new Marman inventory program.
I am interested in ☐ design ☐ procurement

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

MARMAN DIVISION
Aeroquip Corporation

11214 EXPOSITION BLVD. LOS ANGELES CALIFORNIA
IN CANADA: AEROQUIP (CANADA) LTD. TORONTO 19, ONTARIO
Marman Products are Covered by U.S. and Foreign Patents and Other Patents Pending

CUBIC

The Difference is in the Quality

Four and Five-Digit Transistorized

DC VOLTAGE INSTRUMENTATION

For Rapid, Precise Voltage Measurement

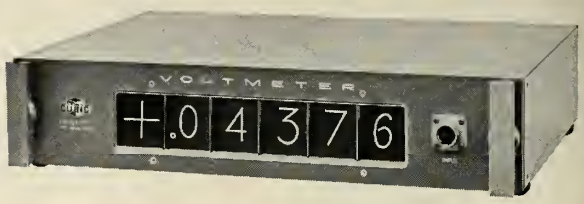
Designed for Versatility
Engineered for Reliability
Precision Built, yet Rugged
Easy to Use, Easy to Maintain

NOT JUST A 'VOLTMETER' . . .

. . . this superior Cubic instrument can measure with great accuracy every phenomenon of science which can be converted to a usable DC voltage level . . . pressure, temperature, depth, volume, salinity, etc. Great economy can be effected through use of the Digital Voltmeter in applications which require precise, legible readings to the unskilled worker without danger of costly operator error. Outstanding engineering and design talents have been combined to produce this fine DC Voltmeter, the most reliable Digital instrumentation available today.

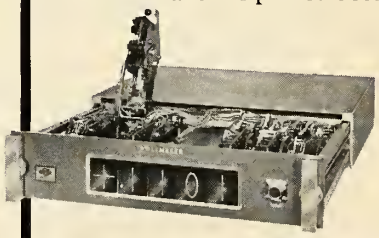
SPECIFICATIONS

Available with 4 digit (Model V-41) or 5 digit (Model V-51) display, the Digital Voltmeter is powered by Control Unit Model C-1, which includes a power supply, precision reference and differential amplifier, and which, separately housed, supplies power to as many units as are required in a Digital System. The Cubic Voltmeter provides an accuracy of .01% plus or minus 1 digit, between ±.0001V and ±999.9V (Model V-41) and ±0.0001V and ±999.99V (Model V-51). Low level voltages ±10 microvolts may be measured by the addition of the Preamplifier unit, Model PA-1.



THE SUPERIOR DIGITAL INSTRUMENT

Space Age know-how that goes into Cubic Corporation's missile tracking systems is also an important engineering and production component of Cubic DC Voltage instrumentation. The 4-digit and 5-digit Voltmeters, powered by the Cubic Control Unit, offer such quality features as unit plug-in construction, a precise two-part filter that eliminates the effect of AC ripple on DC readings, shock-mounted stepping switches with "controlled drive," in which the switch turns off the drive circuit part way through its cycle, ending overdrive and eliminating impact wear. Clear visual display is provided by an ultra-brilliant, edge-lighted read-out containing in-line numerals one inch high. Transistorization ends warm-up time, lengthens instrument life. Cubic's attention to fine detail increases the precision, reliability and functional capability of each instrument and at the same time provides such outstanding features of standardization as printed circuit boards that are interchangeable and stepping switches that swing up and out for ease of routine maintenance. Cubic quality is your guarantee of truly fine instrumentation.



Unit construction of the Cubic Voltmeter and other Digital instruments provides maximum flexibility in creating "systems that design themselves." Inter-*case* wiring and standard-size plug-in units make every Cubic System a customized system using standard units. "Building Block" units which can be added easily to increase systems capabilities are the DC Preamplifier, AC-DC Converter, Digital Ohmmeter, Ratiometer, Master and Auxiliary Scanners and Printer Control Units. Write today for further information.

CUBIC CORPORATION
5575 Kearny Villa Road, San Diego 11, Calif.

CUBIC
ELECTRONIC ENGINEERING WITH A DIMENSION FOR THE FUTURE



FREE
416-PAGE CATALOG

Lists over 8,000 Precision Instruments, Parts and Components.

From stock! Complete with Drawings, Full Specifications and Prices.



FREE
14-Piece
"DESIGN-AID" TEMPLATE KIT
14 actual size templates, created to assist you in the design and development of specific mechanicol systems.

Send for FREE Catalog and "Design Aid" Today.

PIC DESIGN CORP.
Subsidiary of **BENRUS WATCH COMPANY, Inc.**
477 Atlantic Avenue
East Rockaway, L. I., N. Y.

AN YOU USE

TEEL
ABRICATING
LANT
n
OS ANGELES AREA
?

nique opportunity to acquire l or part of this old established ompany. Facilities for all code ork. Experienced employees. wner can lease, sell, or accept ock. Brokers invited.

Write or Wire BEN SAMPSON
450 East Colorado St.,
Pasadena, California

strands of graphite are used as specimens for tensile-strength tests, and for examination into the crystalline structure.

The crystalline structure of graphite is similar to that of molybdenum disulfide and tungsten disulfide, but where graphite needs water vapor in its environment in order to act as an efficient lubricant, the other two use sulphur.

• **Erosion**—The action of particles of varying sizes in space on the surface of a spacecraft was looked at from a number of angles: micrometeorites, dust, and individual atoms and molecules. (Results of a collision with a full-scale meteor were so obvious as to eliminate need for discussion.)

Erosion by interplanetary dust, reported Dr. David B. Beard of the University of California, probably will amount to negligible damage to a satellite. The actual amount is calculated to be 10^{-5} to 10^{-6} particles larger than 4 microns impacting cm^2/sec. (i.e. 30 to 300 impacts/cm^2/year).

Calculating the origins of comets within the solar system has indicated they are "balls of fluff" generally found in the cold regions of space until a passing body sets them in motion. When these comets pass near the sun, dust is thrown off and gradually populates the solar system. The dust, which also comes from other sources, is the cause of the "Zodiacal light" observed at night, since it reflects the light of the sun to the dark side of earth in minute quantities, leaving a milky haze over the sky.

To remain in the solar system, these particles must be at least 3 microns in size—a smaller particle would be forced out of the system by radiation pressure. Density of this dust is greater near the earth due to gravity, where it reaches about 10^{-12} particles per cubic centimeter, as compared with an average density of 10^{-14} or 10^{-15} per cubic centimeter throughout the solar system in general. A particle of 4 microns or larger, therefore, is needed to register appreciable damage on a surface.

A particle having a mass of 10^{-13} grams (low mass but high velocity) would immediately vaporize upon striking a satellite surface. However a greatly prolonged exposure might show appreciable damage, and in some cases could surpass that inflected by larger, but less frequent, particles.

To gain more knowledge of this dust, consideration is being given to exposing a sheet of sticky mylar film on a rocket or recoverable satellite to capture some and bring it back for analysis.

JUST PUBLISHED!

PICTORIAL ENCYCLOPEDIA OF THE WORLD'S ROCKET KNOWLEDGE



ROCKET ENCYCLOPEDIA ILLUSTRATED

John W. Herrick, Chief Editor
Member of Technical Staff, Space Technology Laboratories, Inc., subsidiary of Thompson Ramo Wooldridge, Inc.

Eric Burgess, Associate Editor
Member of Technical Staff, Telecomputing Corp., and internationally known author.

Foreword by
Dr. Theodore von Karman
International authority on rockets and missiles.

—Large 600 Page Book!—

Authentic Definitions of rocket technology . . . research, engineering, production, testing.
Complete Explanations of each term in basic, easy-to-understand language . . . **very profusely illustroted.**

Details of the illustrations are identified by captions, and are cross-referenced in the text by **bold-face** type.

450 Photos & Drawings
Many never published before!

Principles, Developments & Operations. Rocket power, propulsion applications, propellants, engines, assemblies, components, accessories, systems engineering . . . including missiles, processing and production methods, test and ground equipment, Military and industry facilities.

Abbreviations, symbols, engineering data, history of outstanding events, biographies.

Large 7½ x 10¾ size. Only $12.50.

FREE EXAMINATION!

Aero Publishers, Inc., Dept. MR525
2162 Sunset, L. A. 26, Calif.

Rush me the new Rocket Encyclopedia for 10 days free examination. Within that time I will either remit $12.50 plus postage, or return the book with no further obligation.

☐ Bill me ☐ Bill my company.

☐ Send Free 1959 Aviation Book catalog.

Name .....

Firm .....

Address .....

City ..... Zone .....

State .....

☐ **SAVE!** I am enclosing my check or money order for $12.50. I understand Aero Publishers will pay delivery postage, and that I have the same return privilege.

AERO PUBLISHERS, INC.
Aviation Books since 1939

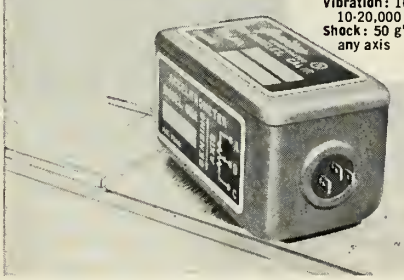
NEW GENISCO MINIATURE ACCELEROMETER

Weighs only 3 ounces; measures just 1 1/16" x 1" x 1 1/8"!

The new Model GMA Accelerometer is a fluid damped, potentiometer output instrument, particularly suited for flight and fire control and telemetering applications. Now in production.

Brief Specifications

Range: ±0.5 g to ±100 g's
Natural Frequency: 12 cps to 75 cps
Linearity: ±1% of full scale
Damping: Nominally 0.7 of critical at ±75°F.
Temperature: Operates to specifications between −20°F and +185°F.
Vibration: 10 g's, 10-20,000 cps, any axis
Shock: 50 g's for 7 ms, any axis



MODEL GMA

Send for complete specifications to the Instrument Division:

Genisco INCORPORATED

2233 Federal Avenue, Los Angeles 64, California

when and where

JUNE

Institute of Radio Engineers' Professional Group on Microw Theory & Techniques, National Symposium, Harvard U versity, Cambridge, Mass., June 1-3.

Armed Forces Communications and Electronics Associati 13th National Convention, Sheraton Park Hotel, Washingt D.C., June 3-5.

Institute of Radio Engineers' Professional Group on Product Techniques, Third National Conference, Villa Hotel, S Mateo, Calif., June 4-5.

The Pennsylvania State University's Missiles System Engine ing Seminar, University Park, June 7-13.

Aero Club of Michigan, Industry Missile and Space Conferer Sheraton-Cadillac Hotel, Detroit, June 8-9.

American Rocket Society, Semiannual Meeting, El Cortez Ho San Diego, June 8-11.

United Nations Educational, Scientific and Cultural Organi tion, UNESCO House, Paris, June 15-20.

Cornell University Industry Engineering Seminars, Cornell U versity, Ithaca, N.Y., June 16-19.

Institute of the Aeronautical Sciences, National Summer M ing, Ambassador Hotel, Los Angeles, June 16-19.

Institute for Practical Research on Operations, The Univer of Connecticut, Storrs, June 21-July 3.

American Institute of Electrical Engineers, Air Transportat Conference, Olympic Hotel, Seattle, June 24-26.

Nuclear Industry Division, Instrument Society of America, S ond National Symposium, Idaho Falls, Idaho, June 24-26

Institute of Radio Engineers' Professional Group on Milit Electronics, Third National Convention on Military El tronics, Sheraton Park Hotel, Washington, D.C., June July 1.

Pennsylvania State University, Summer Seminar on Plastic Its Mechanical Properties, Design and Applications, U versity Park, June 29-July 3.

Advertisers' Index

Aerojet-General Corp., Sub.-General Tire & Rubber Co. 14
Agency—D'Arcy Adv. Co.

Aeronca Mfg. Corp. 10
Agency—Penn and Hamaker, Inc.

Aero Publishers, Inc. 59

American Pipe & Steel Corp. 59
Agency—Thomas M. Cavanagh, Inc.

Astromatic Div., The Electro-snap Corp. 27
Agency—Don Kemper Co., Inc.

Barco Mfg. Co. 32
Agency—Armstrong Adv. Agency

Bendix Aviation Corp., Bendix Systems Div. 42
Agency—MacManus, John & Adams, Inc.

Bristol Siddeley Engines, Ltd. 12, 13
Agency—Young & Rubicam, Ltd.

Chance Vought Aircraft, Inc. 50, 51
Agency—Tracy-Locke Co., Inc.

Conrad, Inc. 47
Agency—Lindeman Adv., Inc.

Continental Aviation & Engineering Corp., Sub.-Continental Motors Corp. 56
Agency—The Hopkins Agency

Cubic Corp. 58
Agency—Armstrong, Fenton & Vinson, Inc.

Erco Div., ACF Industries, Inc. 29
Agency—Conti Adv. Agency, Inc.

General Electric Co., Silicone Products Dept. 33
Agency—Brooke, Smith, French & Dorrance

Genisco, Inc. 60
Agency—Clyde D. Graham Adv.

Grand Central Rocket Co. 26, 61
Agency—Jakobsen Adv. Agency

B. H. Hadley, Inc. 45
Agency—Jackson & Morse Adv.

Hunter Mfg. Co. 4
Agency—Meermans, Inc.

Indiana Gear Works 43
Agency—Bozell & Jacobs, Inc.

International Business Machines Corp. 55
Agency—Benton & Bowles, Inc.

James, Pond & Clark, Inc. 46
Agency—Weir Adv.

Leach Corp., Relay Div. & Inet Div. 2
Agency—Hixson & Jorgensen, Inc.

Lear, Inc., Grand Rapids Div. 6
Agency—General Adv. Agency, Inc.

Lockheed Aircraft Corp., Missiles & Space Div. 48, 49
Agency—Hal Stebbins, Inc.

Magnavox Co., The, Government & Industrial Div. 44
Agency—Rothbardt & Haas Adv., Inc.

Marman, Div., Aeroquip Corp. 57
Agency—The Fred M. Randall Co.

Martin Co., The 38, 39
Agency—VanSant, Dugdale & Co., Inc.

North American Aviation, Inc., Autonetics Div. 8
Agency—Batten, Barton, Durstine & Osborn, Inc.

Northrop Corp. 24
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Nutt-Shel Co. 62
Agency—Welsh-Hollander Adv.

Pan American World Airways, Inc. 30

Pic Design Corp. 59
Agency—Paul Smallen Adv.

Radio Corp. of America 54
Agency—Al Paul Lefton Co., Inc.

Raytheon Mfg. Co. 34
Agency—Donahue & Coe, Inc.

Rheem Mfg. Co., Defense & Technical Products Div. 3
Agency—Gets & Sanborg, Inc.

Ryan Aeronautical Co. 53
Agency—Batten, Barton, Durstine & Osborn, Inc.

Space Technology Laboratories, Inc. 23
Agency—Gaynor & Ducas, Inc.

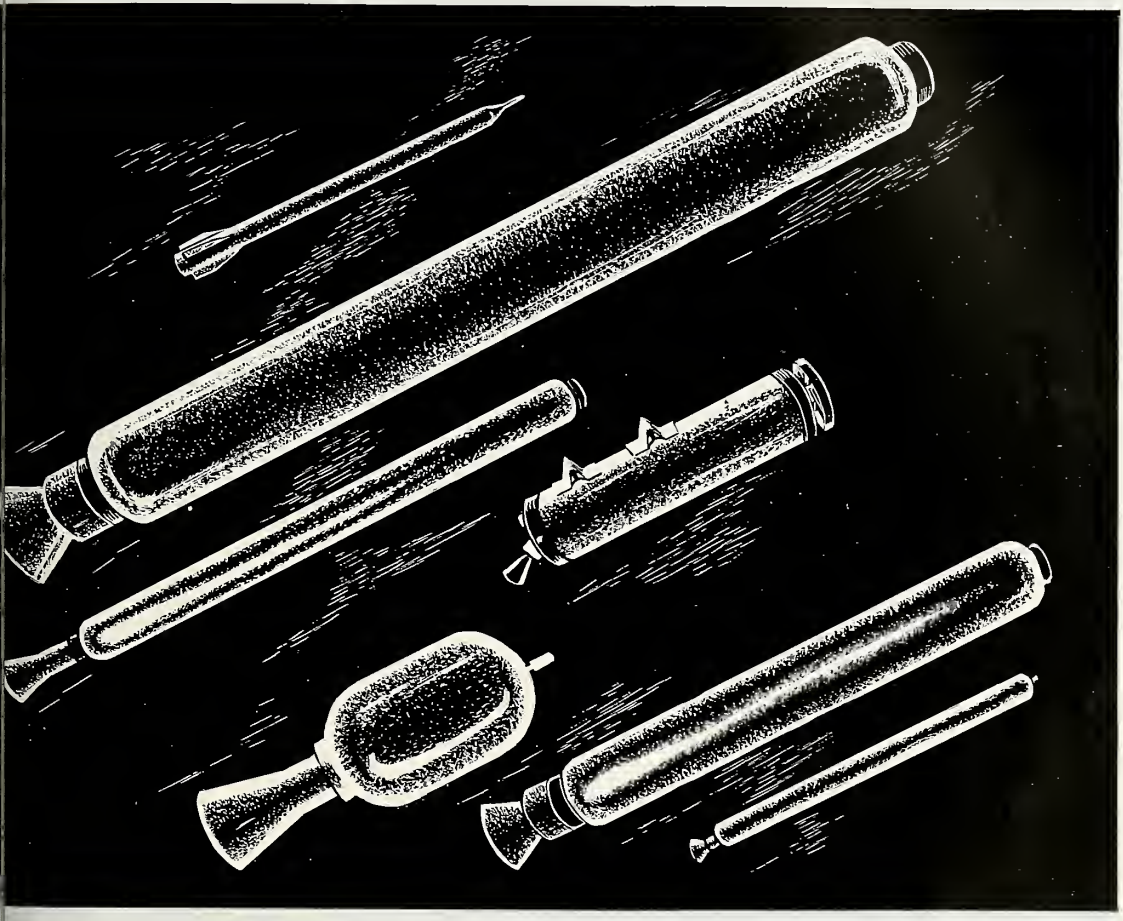
System Development Corp. 40, 41
Agency—Stromberger, LaVene, McKenzie

Telecomputing Corp. 52
Agency—Anderson-McConnell Adv. Agency, Inc.

Vickers, Inc. 16
Agency—Witte & Burden

Western Gear Corp. 31
Agency—Burke Dowling Adams, Inc.

These Rocket Motors...



ill Meet Your Specifications For Solid Propulsion nits of DEMONSTRATED PERFORMANCE *

* Sleds for general purpose or supersonic testing

Upper Atmosphere Sounding Vehicles

Retro Units

Drone Boosters

Outer Space Vehicles

Each of the motors in this group is a widely tested. high energy "work horse" that has made notable contributions to some of the Nation's most spectacular rocket programs. These motors, available for prompt delivery, produce thrusts ranging from 3,000 to 40,000 pounds for periods of one to thirty-three seconds. Total impulses range from 2,600 to 260,000 pound-seconds.

Write or telephone today for GCR Brochure No. I.

Grand Central Rocket Co.

P. O. Box 111
REDLANDS, CALIFORNIA

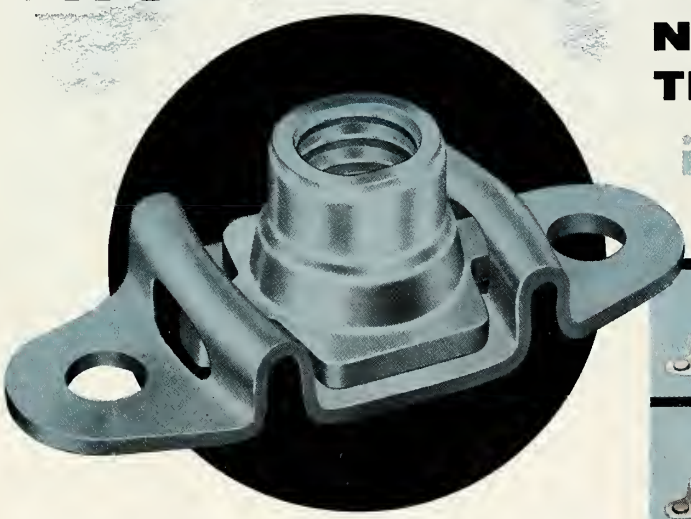
Telephone: PYramid 3-2211

ENGINEERS AND CHEMISTS
Employment inquiries are invited
Write:
Personnel Manager
Box 111, Redlands, Calif.



ENGINEERS ACCLAIM

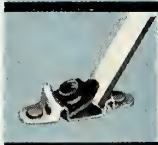
Nutt-Shel's TIMESAVERS



in 5 SECONDS you can replace the nut in a **TIMESAVER**



1. Insert removal tool, with downward pressure, between nut and shell, as shown. Lean tool against nut barrel to insure engagement.



2. Maintain downward pressure. Nut will snap out easily with a simple prying motion.



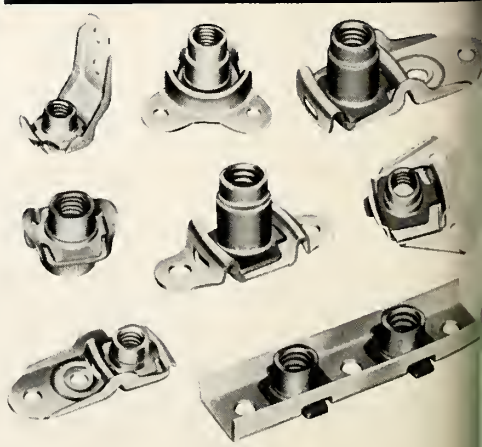
3. Install new nut by inserting one lug in shell and striking opposite lug with screwdriver. This lug snaps into place.

the greatest advancement to date in efficient fasteners

Four hundred and seventy-two engineers voluntarily wrote to us and said, in essence, *"a definite improvement that saves time and reduces costs."*

HOW MUCH SAVING? TIMESAVERS are competitively priced, but they cost you less, since savings in replacement time are greater than cost of ordinary nuts, *including installation.* They are as light as other nuts; in certain designs they *weigh less.* They meet MIL-N-25027 (ASG) and conform to NAS specifications.

May we show you why engineers and production men prefer TIMESAVERS? Write on your letterhead for new lightweight nut brochure which describes these and other Nutt-Shel fasteners.



Nutt-Shel
An **SPS** Company

2701 South Harbor Blvd.
Santa Ana, California
Phone Kimberley 5-9311

JUNE 1, 1959



missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

d Build-up in Antarctica 15
Minuteman and Railroads 18
esting the *X-15* 30

AN AMERICAN AVIATION PUBLICATION

ADVANCED FUEL MANAGEMENT ...FROM SMI



The requirements of accurately tanking missiles with propellants is but one of the areas of fuel management in which Servomechanisms, Inc. has demonstrated capability. *Propellant utilization* and *thrust control* are other areas in which SMI has developed highly accurate and precise measuring and control systems.



SMI's LOX Tanking Computer, which has been in production for the past year, accurately measures, controls and indicates the level of liquid oxygen in missile tanks. Loading is accomplished rapidly and accurately due to a unique two-mode control system. The first mode permits extremely high pumping rates until about 98% capacity is reached. The second mode then takes over and controls a precise proportioning valve which adds the necessary LOX to fill the tank within 0.1% accuracy. The second mode also provides continuous topping, thus compensating for LOX evaporation losses during standby.

SMI has currently in development, more advanced fuel management systems to meet the increasingly complex requirements of the next generation of missiles and spacecraft.

SMI would welcome the opportunity to discuss and propose solutions to your fuel management problems. Write for descriptive literature.



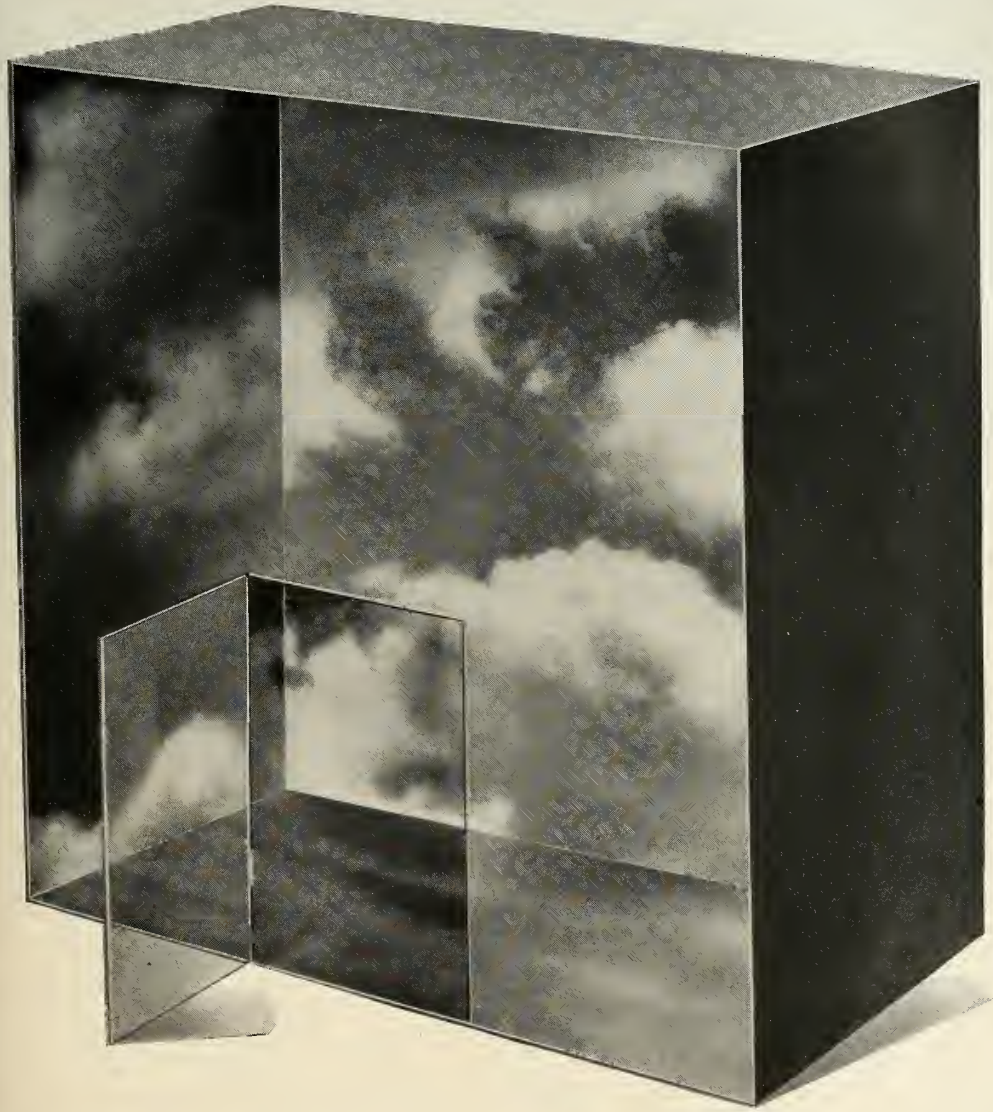
Positions are available for qualified engineers and scientists in the areas of:
Systems Synthesis and Analysis—Project Management —Qualification and Environmental Test Engineering—High Vacuum Deposition Techniques.

SERVOMECHANISMS SMI INC.

LOS ANGELES OPERATIONS: *12500 Aviation Blvd., Hawthorne, a*
MECHATROL DIVISION: *Westbury, L. I., New York*
RESEARCH AND DEVELOPMENT CENTER: *Goleta, California*

The products of SMI are available in Canada and throughout the world through Servomechanisms (Canada) Limited, Toronto 15, C

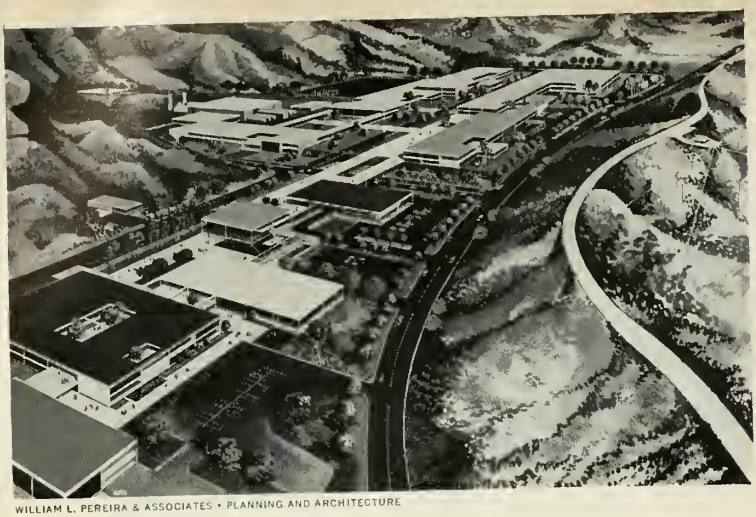
B.F.Goodrich



ring the wild blue yonder indoors...

you have to figure what happens up there . . . you'll come considerably closer by testing th B.F.Goodrich Microwave Absorbents. The specifications and details are many. Sufficient say—*all* the information is in a comprehensive new booklet. Write to The B.F.Goodrich mpany, 585 Derby Place, Shelton, Connecticut.

B.F.Goodrich ***microwave absorbents***



WILLIAM L. PEREIRA & ASSOCIATES • PLANNING AND ARCHITECTURE

LOCKHEED'S
New Multi-Million Dollar
RESEARCH CENTER

This project—destined to rank with the world's largest and most advanced Research Centers—represents not only substantial faith but a substantial investment in the future of space flight.

The new Center, now under construction near Los Angeles, will provide facilities for: Exploration of complex technological space requirements; scientific latitude and freedom; ideal environment for research; and the most modern laboratory tools available. Qualified scientists and engineers will find here ground-floor opportunities for extending man's knowledge beyond the present state of the art.

On completion, most of Lockheed's California Division's research facilities will be located in this single area. The Center will provide advanced research facilities in all fields related to atmospheric and space flight including: Propulsion, physiology, aerodynamics and space dynamics; advanced electronics in microwave propagation and infrared; acoustics; mechanical and chemical engineering and plasma/magnetohydrodynamics; thermal electricity; optics; data communications; test and servomechanisms.

Top-level scientists and engineers are invited to investigate outstanding career opportunities for your future in the new Lockheed Research Center. There are openings now for qualified personnel in: Electronics; aero and thermo dynamics; propulsion; servomechanisms; materials and processes; structures and stress; operations research; research in optics, infrared, acoustics, magnetohydrodynamics, instrumentation, mechanics and hydraulics; mathematics; and in all phases of design.

Please direct your inquiry to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1706, 2400 N. Hollywood Way, Burbank, Calif.

LOCKHEED
CALIFORNIA DIVISION

BURBANK, CALIFORNIA

Executive Editor ..... CLARKE NEW
Managing Editor .... DONALD E. PE

EDITORIAL STAFF

News Editor ..... REED B
Military & Defense ..... BETTY OS
JAMES
Electronics/Support Equipment .. HAL GET
Electronics Engineering .... CHARLES D. LA
Missile Manufacturing ..... WILLIAM E. HO
Missile Business ..... ERICA M.
NASA ..... PAUL M
Los Angeles ..... FRED HU
RICHARD VAN O
FRANK MCC
London ..... G. V. E. THOM
Paris ..... JEAN-MARIE F
Geneva ..... ANTHONY VA
Art Director ..... WILLIAM M
Ass't Art Director ..... BACIL GU

CONTRIBUTORS

Propulsion Engineering ..... MICHAEL LOR
Industry ..... JAMES J. HAGGERTY
Soviet Affairs ..... DR. ALBERT P
Space Medicine ..... DR. HUBERTUS STRUG
Astrophysics ..... DR. I. M. L
Research ..... HEYWARD CANNEY

ADVISORY BOARD

DR. WERNHER VON BRAUN — ROBERT P. HAVI
DR. PETER CASTRUCCIO — DR. ARTHUR KANTRO
KRAFFT EHRICKE — DR. EUGEN SA
R. F. GOMPERTZ — ALEXANDER S

BUSINESS STAFF

Assistant Publisher ..... E. D. MUH
Advertising Sales Manager ..... W. E. BR
Circulation Director ..... L. L. BRE
Research Manager ..... D. T. FO
Promotion Manager ..... J. E. MU
Advtg. Service Manager .. MRS. GLADYS BU
Production Manager ..... J. F. W
Ass't Production Mgr. ..... ELSIE
New York ..... 17 East 48 S
P. B. KI
Eastern Advtg. Mgr. .....
P. N. ANDE
A. B. SCHE
Detroit ..... 201 Stephenson
K. J. W
Chicago ..... 139 N. Clar
G. E. YO
Los Angeles ..... 8929 Wilshire
J. W. C
C. R. MARTZ
Miami ..... 208 Almeria Av
R. D. E
Toronto ..... 12 Richmond S
ALLIN ASSOC
London ..... 28 Brutor
NORALL &
Paris ..... 11 Rue Cond
Geneva ..... 10 Rue Gr

Missiles and Rockets Volume 5 Number

Published each Monday by American Avia
Publications, Inc., 1001 Vermont Ave., N
Washington 5, D.C.

WAYNE W. PARRISH ..... *President & Publ*
LEONARD A. EISERER ... *Executive Vice Presi*
& General Man
A. H. STACKPOLE ..... *Vice Presi*
FRED HUNTER ..... *Vice Presi*
ERIC BRAMLEY ..... *Vice Presi*
ROBERT R. PARRISH ..... *Vice Presi*

Printed at the Telegraph Press, Harrisburg
Second class postage paid at Washington,
and at additional mailing offices. Copyri
1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Pos
Union Nations—1 year, $8.00; 2 years, $12.
3 years, 14.00. Foreign—1 year, $10.00;
years, $18.00; 3 years, $26.00. Single co
rate—$.75. Subscriptions are solicited o
from persons with identifiable commerc
or professional interests in missiles s
rockets. Subscription orders and changes
address should be referred to Circulati
Fulfillment Mgr., M/R, 1001 Vermont A
Washington 5, D.C. Please allow 4 we
for change to become effective and encl
recent address label if possible.

AUDITED PAID CIRCULATION ABC — NBP — READERSHIP RESEARCH — BUSINESS LEADER ABP

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

JUNE 1 HEADLINES

Red Missile Threat in Antarctica
U.S. and other nations plainly worried about Russian bases build-up and submarine-launched missile capability 15

NASA Patent Rights Debated
Here's latest thinking on how much proprietary interest NASA should retain over inventions conceived during performance of a contract under the space agency 17

Is DOD Moving in All Directions on Reliability?
New policy statement establishes reliability monitoring points ... 21

Swiss Firm Turns Out Missiles in Italy
Contraves AG is rapidly developing into big European manufacturer with its *RSD-58* and *RSC-57* surface-to-air missiles 22

Geneva Meeting to Sift Frequencies for Satellites
Future U.S. satellites with permanent power sources will contain destruct system for transmitters 24

SPECIAL SECTION

***X-15* Pictorial Story**
More than 300 companies—large and small—involved in North American's rocket plane program 30

MISSILE SUPPORT

***Minuteman* Rail Concept Pushed**
200 missile trains appear possible which should open up a whole new field of missile support equipment 18

MISSILE ELECTRONICS

Simple Solion May Fill Low-Frequency Gap
Art is still in its infancy in applications but device shows attributes not now available in either electron tubes or transistors 39

Tubes and Transistors: How Do We Stand?
Survey by M/R shows that if anyone wins the "battle" it will be the electronics industry as a whole 41

THE MISSILE WEEK

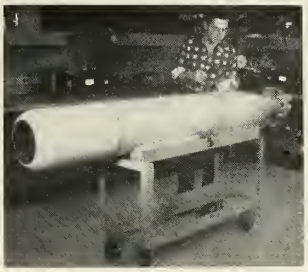
Washington Countdown 11
Industry Countdown 13
More About Missile Week 29

DEPARTMENTS

Editorial 9
Contract Awards 44
Propulsion Engineering ... 45
Letters 46
Soviet Affairs 47
West Coast Industry 48
When and Where 50



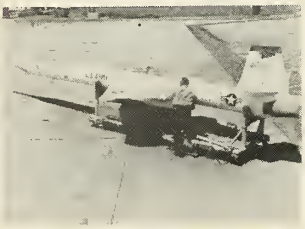
COVER: Scott Crossfield checks out *X-15* prior to first drop with engine ignition.



GE'S MK 44 acoustic homing torpedo is latest entry in Navy's arsenal. It can be surface-launched or air-dropped in the vicinity of its submerged target.



ANOTHER GE development is this Gun and Guided Missile Director MK 73 which controls the Navy's *Tartar* Surface-to-air missile. Director has gearless power drive.



GE also has developed silicone sealant for Lockheed's *Kingfisher* which improves recovery chances and cuts manufacturing costs $1600 per missile.

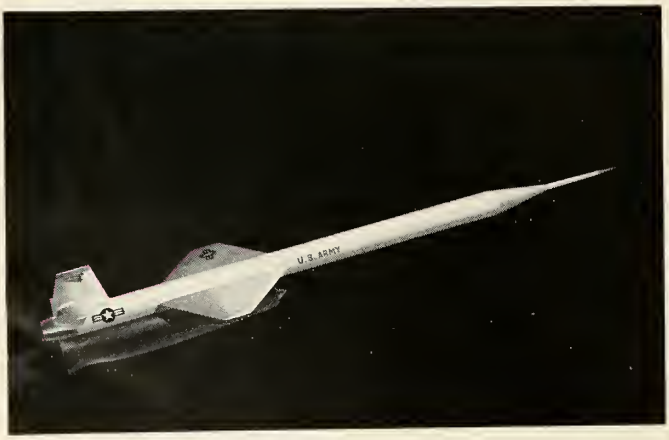
What Lockheed is doing today to develop
Tomorrow's missiles and spacecraft

The world's first polar-orbiting satellites...the world's fastest ramjet target drone...a "fuel cell" that produces auxiliary power for spacecraft in a radically different way...a TV camera-transmitter—the world's smallest—that gives engineers and scientists on the ground a televised report of what takes place in test missiles during flight. These are just a few of the many activities and achievements of Lockheed's Missiles and Space Division.

Lockheed is System Manager and Prime Contractor of the ARPA DISCOVERER satellite series—and the U. S. Navy's POLARIS missile. Both are highest priority programs of the U. S. Government. And both are ahead of schedule.

A Lockheed MSD work-force of over 16,000—including 3,500 scientists and engineers—is engaged in all phases of missile and space technology: satellite systems development; space communications; electronics; ionic, nuclear, and solar propulsion; magnetohydrodynamics; computer research and development; flight sciences; materials and processes; human engineering; electromagnetic wave propagation and radiation—and many other advanced fields.

From these efforts at Lockheed will come many significant breakthroughs and scientific "firsts"—to speed the development of tomorrow's missiles and spacecraft.



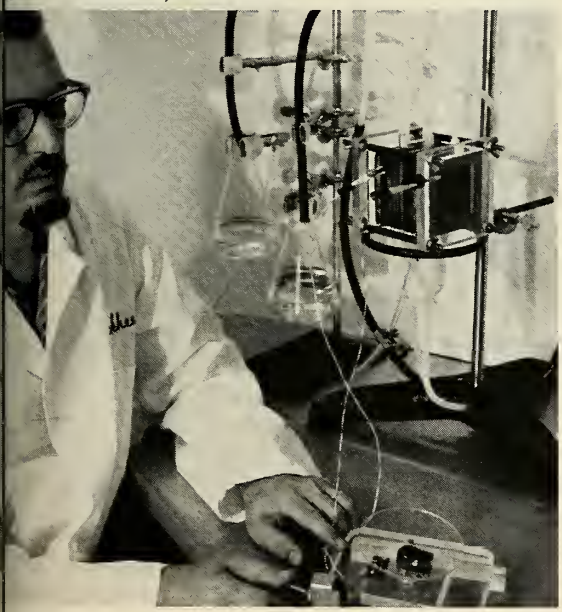
Ramjet-powered supersonic target, Lockheed Q-5 KINGFISHER electronically simulates enemy attackers—is being used by U. S. Army to evaluate and sharpen our nation's missile marksmanship, increase our defense capabilities.



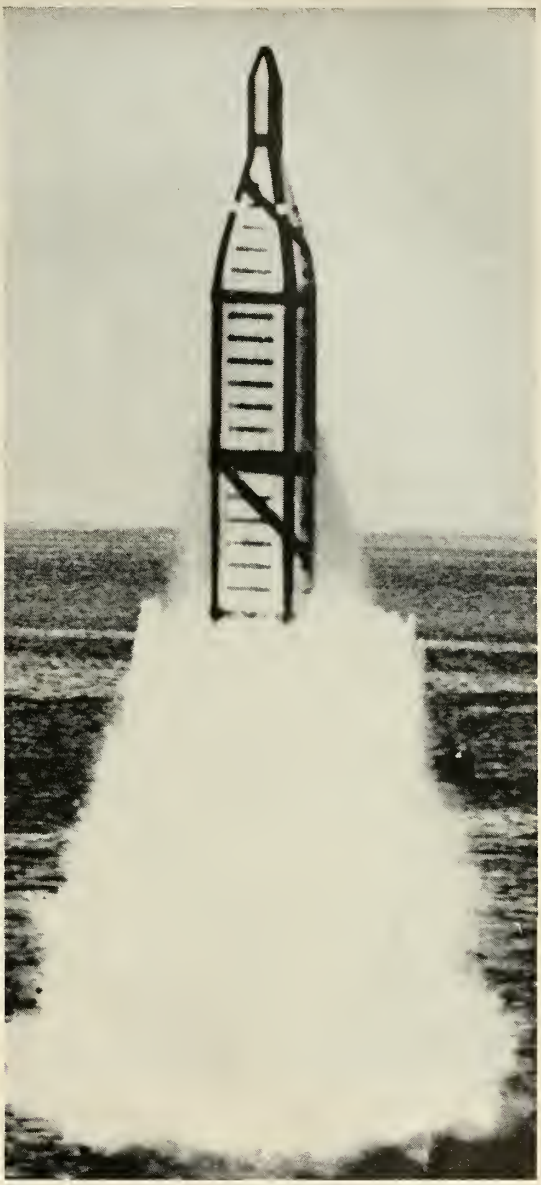
First polar-orbiting satellites, the Lockheed DISCOVERER I and II were orbited in two succ launches. Lockheed is System Manager for this advanced scientific research program.



ısmitting performance data from missiles and test vehicles, ct to ground stations, Lockheed-developed TV camera-mitter and PAM-FM telemetry systems are acknowledged to e world's smallest, world's best.



olutionary "fuel cell," under development at Lockheed, con- chemical energy directly into electrical power—for auxiliary er requirements of miniaturized spacecraft instrumentation space communications systems.



Erupting from beneath the sea, a full-scale POLARIS test vehicle demonstrates how operational missile will be launched from submerged U.S. Navy subs. Ultimate range of the POLARIS will be 1500 nautical miles.

LOCKHEED

JET TRANSPORTS • JET FIGHTERS • JET TRAINERS • COMMERCIAL & MILITARY PROP-JET TRANSPORTS • ROCKETRY
BALLISTIC MISSILE RESEARCH & DEVELOPMENT • WEAPON SYSTEM MANAGEMENT • ANTI-SUBMARINE PATROL AIRCRAFT
NUCLEAR-POWERED FLIGHT • ADVANCED ELECTRONICS • AIRBORNE EARLY-WARNING AIRCRAFT • AIRPORT MANAGEMENT
NUCLEAR REACTOR DESIGN & DEVELOPMENT • GROUND SUPPORT EQUIPMENT • WORLD-WIDE AIRCRAFT MAINTENANCE



W. P. Knight

Bill Knight is a rocket chemist. His field of interest is research on advanced solid and liquid propellants to meet the stringent requirements of today's military programs (and tomorrow's).

The continued success of the American missile program depends on men like Bill Knight.

But creation takes talent. The kind of talent that top-notch scientists and engineers can use to the utmost on Aerojet's rapidly expanding programs in chemist a other fields.

There are *many* projects at Aerojet that intrig t scientific and engineering investigator. Your res ne invited. The address: AEROJET-GENERAL CORP., P. B 296J, Azusa. California or P.O. Box 1947J, Sacra en California. Attention: Director of Scientific and En ne ing Personnel.

AEROJET-GENERAL CORP.®

GENERAL TI

AZUSA AND NEAR SACRAMENTO, CALIFORNIA • A SUBSIDIARY OF THE GENERAL TIRE & RUBBER CO

Proposed—A Unified Strategic Command

The Joint Chiefs of Staff are considering the creation by mid-1960 of a single unified command for the strategic warfare forces of this country—a command to include those components from the Air Force and the Navy which have strategic weapon systems. It would probably be called simply the U.S. Strategic Command.

The commander would report directly to the Joint Chiefs and not to his own service and he would have operational control of the combat units assigned to him, regardless of service, both in the cold war and in a hot war should it develop.

The commander would most likely be Air Force due to its preponderance of strength in the field, with the deputy a Navy man and the staff combined USAF and USN.

The formal papers proposing such a move were presented to the Joint Chiefs several days ago and have circulated widely through the higher echelons of all services of the Pentagon. The proposal recommends implementation of such a command arrangement to become effective by the time the first *Polaris*-equipped vessel is ready for operation employment (mid-1960). It also recommends that concurrently with the activation of such a command the present SAC go out of existence as a specified command, i.e., one which reports directly to the JCS as SAC now does, and remain simply as an Air Force component command.

The proposal was put forward by General Thomas White, chief of staff of the Air Force (and a member of the JCS, of course) and is known to be favored by many high officers of both the Air and Sea services.

Several cogent reasons have been advanced as to why the big bombers and long-range missiles of the Strategic Air Command and the intermediate range missiles of the Navy should be unified under one commander:

- Formation in peacetime of a strategic force which would operate effectively in the event of a war.
- Prevention of overlapping and duplicating roles.
- A firm and effective assignment of strategic targets.
- Assurance of instant response to higher command, instant reaction and instant application of full strength.

In his proposal to the Joint Chiefs, General White recommended that the Joint Staff, in conjunction with the Air Force and the Navy, join to define the mission, responsibilities and organizational establishment of the new U.S. Strategic Command. In the services, such a task would probably fall to General Thomas Power, SAC commander, and possibly to Rear Admiral L. R. Despit, Director of the Undersea Warfare Division, Office Chief of Naval Operations, since the Navy has no strategic division as such.

This combine probably would also develop organization arrangements, manning and the phasing of implementing action by timetable.

* * *

This proposal by the Air Force Chief of Staff to take a very intractable bull by the horns and wrestle it into submission is quite in keeping, both for the man and for the present trend to reorganize the services by missions rather than by color of uniform.

For one thing, General White has more than once made it known that he favors unification of the services. For another, his proposal is fully in accord with both the intent and the spirit of the Reorganization Act of 1958, other parts of which have already been implemented.

The North American Air Defense Command at Colorado Springs not only unifies the U.S. Services but includes the Canadians as well. The Alaskan Command has long been unified, as have the service units in Europe and the Far East. Before the Reorganization Act these unified commanders could give orders to other service units only through their parent organizations—usually in Washington. Now the commander has direct control and reports to the JCS, as would the new Strategic Commander proposed by General White.

When the soldiers, sailors, airmen and marines all climb into one uniform and become identified by their mission instead of their service, is a matter of conjecture, although it certainly seems inevitable. But to group the strategic forces of the country—with their overwhelmingly important task of deterrence through the threat of massive retaliation—under one unified command seems to make a great deal of sense in an imperative situation.

One of the weakest links in the American strategic position has been that the Navy and the Air Force have never been able to coordinate strategic targets. With a considerable capability in the strategic field, the Navy would never make a firm individual target commitment because of a wish to remain completely mobile. And SAC would never accept anything less than a firm specific commitment. In the event of war, the delay of decision in just this one area could be disastrous.

And . . . if this proposal is the first step toward a unified Tactical Command, a unified Training Command, a unified Materiel Command and so on—so much the better.

Clarke Newlon



...NEWS IS HAPPENING AT NORTHROP

Now being produced and delivered to the U.S. Army Signal Corps, the Radioplane SD-1 gives greater battlefield surveillance flexibility to combat units than ever before. (This photo of terrain was actually taken from an SD-1 at 1,000 feet.)

RADIOPLANE PRODUCES FIRST COMBAT-READY SURVEILLANCE DRONE

Meeting tough Army Signal Corps requirements and being produced in operational quantities, the SD-1 is proved and ready to fly unmanned photo reconnaissance missions for tactical troops.

Highly mobile, the camera-carrying SD-1 may be zero-length launched in rough terrain from a camouflaged position. It is flown by remote control over enemy installations on surveillance missions without risking a pilot's life or man-carrying aircraft. Within minutes after the SD-1 returns from its mission, photographs are delivered to the requesting unit.

Other specialized sensory equipment may be carried by the SD-1 depending on particular mission requirements.

This Army-Radioplane achievement exemplifies Radioplane teamwork with all of the U.S. Armed Forces. Radioplane provides a complete drone family spanning medium speeds through supersonic performances.

RADIOPLAN

Von Nuys, California, and El Paso, Te
A Division of
NORTHROP CORPORATION

washington countdown

IN THE PENTAGON

ARPA is pushing ahead seriously with its program aimed at developing a space platform weighing several thousand tons. The platform would be launched into space with nuclear-bomb propelled rockets. ARPA describes the team working on the program as made up of "some of the best men in the country."

• • •

The Pentagon is reportedly near a decision whether to develop a storable propellant for the Convair *Atlas*. A storable propellant for the nation's first liquid ICBM would give it two extra pluses: Faster reaction time and mobility.

• • •

A possible new interservice squabble may be in the making over who will operate the "satellite fence" developed across southern United States. ARPA directed development. Both the Army and the Air Force played a part. Now ARPA is ready to turn it over to one of the services.

• • •

The Air Force is planning to spend about $23 million in FY 1960 on development of a new secret missile—the anti-radar missile. The ARM apparently would be air-launched from attacking bombers. It most likely would foul enemy radar by dropping chaff and/or by carrying electronic jamming equipment.

• • •

The Army's *Davy Crockett* missile has blossomed into a family of weapons. The secret missile—tipped with a nuclear warhead—is understood to be small enough to be fired by an infantryman from a bazooka-type weapon.

• • •

A couple of notes on the Missile Gap calendar:

The Martin *Titan* timescale is about two years behind the Convair *Atlas*—not one as believed in many quarters, according to Congressional testimony by the late Donald Quarles.

Some six months could be shaved from the Boeing *Minuteman* program. Cost would be about $100 to $300 million depending on who in the Pentagon is doing the estimating.

• • •

The Navy wants to cut back R&D funds for two new anti-submarine missiles and boost R&D funds for two others. The cuts are slated for Minneapolis-Honeywell's *Asroc* and Westinghouse's *Astor*—understood to be an anti-submarine torpedo rocket. Boosts are slated for Goodyear's *Subroc* and *Little Lulu* —believed to be a surface-to-surface missile.

ON CAPITOL HILL

A leading Congressional figure close to the nation's space program says the Russians have made a number of space shots since *Lunik* in January. He says he received the information from "good authority." He says the Russians apparently are withholding any announcements until they have something sensational to disclose.

• • •

Some Congressmen are predicting that the Senate and House may settle their dispute over the Boeing *Bomarc* and the Western Electric *Nike-Hercules* with a compromise involving *Atlas*. The possible deal: The Senate would go along with a House desire for more funds for *Atlas*. At the same time, the House would put back some of the funds asked for *Nike-Hercules*.

• • •

Despite opposition from the Administration and some influential Congressmen, Congress appears certain to keep a double hold on NASA. The House already has voted to make NASA secure Congressional authorization for all programs before securing any appropriations in the next five years. Many powerful senators want to make the arrangement permanent. Outlook: The least NASA can expect is the House's five-year clause.

AT NASA

The schedule for Project *Mercury* includes more than two dozen launchings before any attempt will be made to put a man into orbit. One of the last before the big one will be the firing of a manned space capsule down the Atlantic Missile Range with a *Redstone* booster.

AROUND TOWN

Plans are moving ahead rapidly to make Raytheon *Hawks* the first American-type missile to be produced cooperatively by NATO countries. The second probably will be Philco *Sidewinders*. The U.S. military aid program is helping get the programs under way. The NATO countries involved are reported ready to pay $400 million for the NATO-made *Hawks*.



AIR FREIGHT EXCLUSIVE

Personalized service by United Air Lines means satisfied shippers, more efficient shipping

Air freight service by United Air Lines is personalized just for you. Guaranteed space is yours for the asking, and your shipments always receive the personal attention of United Cargo Representatives. Handling procedures, too, are custom-tailored to each kind of cargo. And freight is monitored every minute and mile of the way.

AND MORE "EXTRAS"

Reserved Air Freight guarantees space at the regular rate on any United flight going anywhere.

2000-community service lets you reach more major markets direct than on any other single airline.

Mainliner® and Cargoliner flights both carry freight, and assure you of frequent high-capacity service.

Door-to-door service is another convenient United feature for minimum handling and top speed.

FREE BOOKLET

Tells how United Air Lines Air Freight provides better service and lower costs for shippers. Just write to Cargo Sales Division, United Air Lines, 36 South Wabash Avenue, Chicago 3, Ill.



YOU PAY NO MORE FOR EXTRA CARE WHEN YOU SHIP UNITED AIR LINE

the
issile
week

industry countdown

STRUCTURES

Thoric—intercontinental version of Douglas *Thor* IRBM—is being evaluated by Air Force as means of accelerating nation's ICBM readiness. Question is whether *Thoric* should be advanced on "crash" basis to back up *Atlas*. Configuration would be adaptation of liquid two-stage *Thor-Able* test vehicle which has hurled experimental nose cones 5000 miles down Atlantic Missile Range.

• • •

Cincinnati Testing Labs will receive contract to produce nose cones for Martin-Orlando's *Pershing*—800-mile MRBM solid-fueled successor to *Redstone*.

• • •

Steel gantry 305 feet high—tall as a 28-story building and the largest in U.S.—will be constructed at Redstone soon to erect and service *Saturn* space vehicle. Hugh mobile tower is indicative of the size of ABMA-ARPA's giant rocket, which will have a cluster of eight H-1 Rocketdyne engines as its booster and three other stages. Fire and lightning protection, heating and air conditioning will be incorporated in the structure along with three elevators, bridge crane, "on-board" diesel electric generator and six service platforms. AOMC and Army Corps of Engineers developed the gantry design in conjunction with Maurice H. Connell & Associates, Miami A&E.

• • •

In midst of heated DOD and Congressional sniping at the interceptor missile program, Air Force last week launched first Boeing "super" *Bomarc-B*. Despite charges it will be ineffective against ICBM's, many Capitol observers say 400-mile *Bomarc-B* probably will be phased in when ready as "best available"—with cut in *Nike-Hercules* program.

• • •

A $20 million tag is attached to the Air Launched Ballistic Missile program in the 1960 defense budget. This will pay for six-month design-cost study getting under way by Douglas and early prototype development.

• • •

Russian "mole" missile? Rocket tunnel digger which spouts compressed air and liquid fuel-fed flame to eat through rock and earth is being used by Soviets, according to Hungarian magazine *Magyar Nemzet*. (Translation available in Scientific Information Report issued by U.S. Commerce Department Office of Technical Services.)

PROPULSION

Watch for first static firing of Pratt & Whitney liquid hydrogen rocket motor about mid-fall. Test will be conducted near Lake Okeechobee.

• • •

Little progress is reported in merger talks being conducted by Thiokol Chemical and Marquardt Corp. Thiokol expects sales to hit $150 million in 1959—against $89 million last year—with a slight upward movement in earnings.

ELECTRONICS

Small Business Administration is licensing Electronics Capital Corp., San Diego., as closed-end non-diversified management investment company. It will be the first to concentrate in one field—small business electronics. ECC plans through 1.8 million stock issue to acquire $16 million for investment in small business securities. No government funds are involved.

• • •

Air Force contract for prototype development of transistorized SAGE computer is being awarded to IBM. For underground installation, computer will be 1/9 size present models and reportedly will have computation capability increased sevenfold.

ASTROPHYSICS

Capture of micrometeorites 150 miles in space and bringing them back to earth will be attempted in September by ARDC and Cambridge Research Center. Scientists will use Aerojet-General *Aerobee* rocket with snap-open nose cone. Micrometeorites will imbed in strip of sticky film. Recovery will be with a parachute. If successful project would yield first real data on composition of debris encountered by missiles and space vehicles.

SPACE MEDICINE

Full-pressure space suit being unveiled June 2 by Navy and B. F. Goodrich is designed to allow man to walk on moon. Wearers can withstand 19 g's in first 40 inches of ejection test and dunking in brine solution at −60°F. Navy says pilot wearing suit would survive as long as one hour after ditching in Arctic waters.

More about the Missile Week on page 29.



PIONEERING IN SOLID PROPULSION SYSTEMS

From the first American jet-assisted airplane takeoff to the first of our second generation guided ballistic missile systems, the Jet Propulsion Laboratory continues to be an active pioneer

In August 1941, America's first jet-assisted airplane takeoff was accomplished with an Ercoupe monoplane, using JPL developed solid propellant rockets. Scientists at JPL shortly discovered that a powdered perchlorate oxidizer, mixed with a liquefied plastic fuel binder, could be cast directly in plastic-lined light-weight motor cases. Thus a safe and cheap method was now available for preparing large internal-burning composite propellant charges. This basic process became the foundation for the modern solid propellant industry.

In 1954, U. S. Army Ordnance requested JPL to develop a compact, rugged long-range guided missile weapon system that could be transported, aimed and fired as simply as a cannon. Within five years, JPL perfected the Sergeant, the first of America's second-generation guided ballistic missiles. In January 1958, clusters of small- Sergeants helped launch America's earth satellite, the JPL built Exp which provided vital space environ information.

Now under the direction of the tional Aeronautics and Space Adm tration, the experienced JPL rese and development team continue apply solid propellant vehicles for s exploration.

jpl

CALIFORNIA INSTITUTE OF TECHNOLOGY

JET PROPULSION LABORATORY

A Research Facility of the National Aeronautics and Space Administration

PASADENA, CALIFORNIA

OPPORTUNITIES NOW OPEN IN THESE FIELDS ▶ APPLIED MATHEMATICIANS · PHYSICISTS · SYSTEMS ANALYSTS · CHEMISTS · IBM-704 PROGRAMM ELECTRONIC, MECHANICAL, CHEMICAL, PROPULSION, INSTRUMENTATION, MICROWAVE, AERONAUTICAL AND STRUCTURAL ENGIN

1, 1959—VOL. 5, NO. 22

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Red Threat From Antarctica

U.S. and other nations are worried about Russian bases build-up and submarine missile launching potential

by James Baar

VASHINGTON—At the frozen bot- of the earth Russia is moving a position from which its missile drons could outflank the Free ld.

Half of Antarctica—that empty, d continent twice the size of the ed States—is rapidly turning from e to red.

Meantime, the United States at for the present is accepting sec- place to Russia in the comparative e of its Antarctic operations.

Proposals to equip American bases portable nuclear reactors and to d a year-round jet landing field at Murdo Sound are presently stalled lack of funds.

Another proposal to build a satel- tracking station at the South Pole has been at least temporarily ved.

Many knowledgeable officials in the ed States, Australia, South Amer- New Zealand and Africa are look- toward the South with increasing n.

• **Southern exposure**—From the vy Antarctic coasts and plateaus sia is in a position to have the re Southern Hemisphere within missile range. Moreover, big Rus- ICBM's could strike the United es from Antarctica without notice. The multi-billion dollar BMEWS em—designed to give SAC a life- eath 15 minute warning of ICBM's aking across the North Pole— ld be silent.

Naval patrols watching for missile- ching submarines on the U.S. East West Coasts would find nothing. lear death would come from the uarded and undefended South.

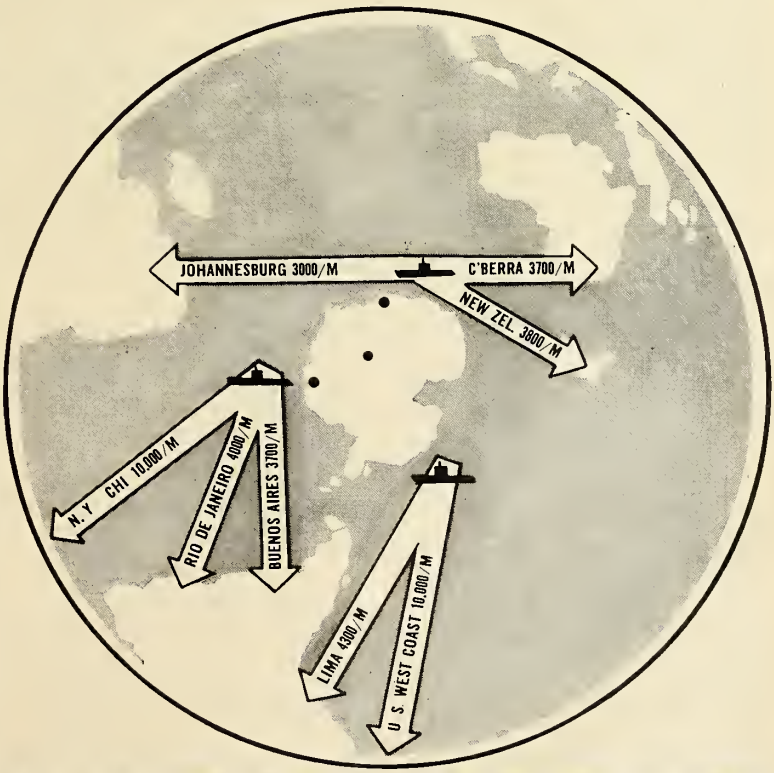
The earliest Antarctic threat involves the use of missile-launching conventional submarines operating out of the Soviet Union's increasing number of Antarctic bases.

Missile-armed submarine packs drawn from the Soviet Union's huge fleet of some 450 submarines could be sent into the South Polar seas at any time. There they could hide along the thousands of miles of empty Antarctic coast, waiting for the signal to strike.

Johannesburg . . . Canberra . . . Lima . . . Buenos Aires . . . Rio de Janeiro . . . Melbourne . . . Wellington . . . all are within a maximum of some 4000 miles of the White Continent.

• **Bases by hundreds?**—But using submarines is only the first and easiest step. The Soviets can put their ICBM's on Antarctica itself.

Missile sites—soft, or hardened—



SOVIET SUBS working from Antarctic could strike many targets without detection.

No U.S. Plans for Missile Site . . .

can be built inside the Antarctic glacier, in the opinion of U.S. experts. The Russians could build hundreds of them both near the Soviet-occupied coasts of East Antarctica and on the great plateaus in the interior.

New York . . . Washington . . . Chicago . . . Denver . . . Seattle . . . Los Angeles . . . all of the United States lying within a huge 10,000-mile arc would be reachable.

The effect on the cold war would be tremendous.

Not only would U.S. warning systems and defenses be outflanked, but three powerful new factors would be introduced into the East-West conflict:

• The U.S. heartland for the first time since the American Revolution would be menaced simultaneously on two broad fronts. Russia would have found a counter to U.S. overseas bases.

• Much U.S. ICBM power would have to be turned toward the unpopulated Antarctic wastes, thereby lessening the value of the ICBM squadrons as a deterrent of terror.

• South America and Africa would become much more sensitive to Soviet pressure as the shadow of Soviet missile might spread across both continents.

U.S. experts see nothing insurmountable in the way of establishing Soviet ICBM bases in Antarctica. As for firing missiles under Antarctic conditions, they note the United States already has fired missiles under generally similar conditions at Fort Churchill, Canada.

As for building Antarctic missile sites, they note that the United States already is building research living quarters in the Arctic glacier near Thule, Greenland.

The research building near Thule is being constructed mostly out of insulating materials put together inside a hole dug out of the glacier with a specially-designed Peters snow plow. Walls of the hole support the building.

One expert said under-glacier installations could be hardened merely by putting them deeper into the glacier.

He said that so far the United States has no plans for building such a missile site itself. However, he said it had been given a considerable amount of thought by engineers.

Officials closest to U.S. Antarctic expeditions say they have seen no evidence so far that the Russians are about to build South Polar missile sites.

• **Red carpets**—However, they say there is no question that the Russians are in Antarctica to stay and that they are expanding their operations. And these operations—still scientific—are laying a basis that could rapidly take on a military character whenever Moscow so decreed.

At present, the Russians occupy Antarctic sites at Mirny and Lazarev on the East Antarctic Coast and Komsomol'skaya and Vostok in the interior. The Poles have been given the Soviet interior base called Oazis. The Mirny base has carpets on the floor and wallpaper on the walls.

The Soviets are planning overland exploratory trips from Mirny to Lazarev via the Pole of Inaccessability and possibly one far west into Marie Byrd Land and the Bellinghausen Coast where much U.S. exploration has been concentrated.

Also, the Soviet Slava whaling flotilla recently circumnavigated Antarctica for the first time and was last reported headed toward the Bellinghausen Sea off Marie Byrd Land.

So far, Soviet rocket activity in Antarctica has been confined to the firing of some two dozen sounding rockets from the Soviet vessel 'Ob off the Antarctic coasts. Soviet scientists previously have said Russia was considering launching satellites from Antarctica.

• **U.S. de-emphasis**—As Soviet operations in Antarctica have increased, U.S. operations have decreased somewhat since the end of the International Geophysical Year in 1958.

The United States during IGY operated seven bases: McMurdo, Byrd, Ellsworth, Hallett, Wilkes, Little America and Scott-Amundsen at the South Pole.

At present, the United States is continuing to operate McMurdo, Byrd and Scott-Amundsen. It is operating Hallett jointly with New Zealand, Wilkes with Australia and Ellsworth with Argentina. Argentina and Australia have taken custody of Wilkes and Ellsworth.

Little America, considered the most important American base scientifically, has been closed because of lack of money.

• **Some planning**—The National Science Foundation has asked for $4 million dollars for FY 1960 for Antarctic research. The Navy has asked for nearly $16 million to provide logistical support.

No money is included for the nuclear reactors, the McMurdo landing field or a tracking station.

The reactors, which could be t ported by plane, are estimated to $3 million each.

Cost of building a 7800-foot field on the ground at McMur estimated at about $85 million. mated cost of a 10,000-foot ai capable of accommodating any j about $100 million.

The reactors would provide power for McMurdo, Byrd and S Amundsen bases, reducing the am of shipping to Antarctica by a half. The airfield would open Southern Hemisphere Great C route over the South Pole.

The polar tracking station w enable U.S. technicians to track satellites on every pass around earth. It also would serve as a c point for detecting unannounced silent polar satellites launched Russia.

Supporters of the tracking st proposal contend it would be only first step in the assumption of an portant role for Antarctica in Space Age.

They say Antarctica is the obv gateway to space because of the in the deadly Van Allen Radiation over the polar regions.

For this reason as well as scien and overriding strategic reasons are urging increases in the U.S. arctic effort.

Meantime, tractors bearing flags are moving through the Antar snows in increasing numbers. The sile submarines, then the missile s could come at any time.

Connector Reliability Improvement Is Urged

BALTIMORE—Electrical connec are an important part of any mis system. Many are in critical locati where their failure could cause fai of a whole system. Consequently, e though they are small and uncom cated, more attention must be gi to improving their reliability.

L. L. Resser and M. J. Sm engineers for The Martin Co., sented a paper at the AIEE meet here this month, outlining sev parameters that should be conside in connector design.

Some possible solutions suggest

• Double seals at the mating face of the connectors.

• Seals at the ends of the c nectors.

• Potting or single-piece constr tion of the insert proper.

• Snap-in contacts for cable-shi ing connections, with bonded foll up grommets.

NASA Patents Rights Debated

Question is how much proprietary interest should space agency retain over inventions performed under contract

ASHINGTON—How much of a ietary interest should NASA re- ver inventions conceived during erformance of a NASA contract? is question recently has been the t of strong debate at patent r meetings across the country, t waiver-of-patent hearings held ASA in Washington.

ASA held the hearings to give e and rocket industry patent rs a chance to voice their criticism e present interim regulations be- NASA drafts permanent regula-

fter the hearing, NASA General sel John A. Johnson stated that egulations would be modified after d his staff had an opportunity to the criticisms voiced by the in- y lawyers.

ASA's present regulations come fire from companies used to do- usiness with the Department of se because they are stricter than patent regulations. Conversely, ical companies used to contract- nder the very strict Atomic En- Commission patent rules find A's regulations very agreeable.

he missile and rocket industry oint is that NASA regulations d retain too many patents for the nment. NASA lawyers believe that nt regulations are not as harsh as try lawyers think, and that it is nterest of the United States" for A to retain proprietary interests me patents.

he effect of present NASA regu- s and the definition of the term he interest of the United States" oints much in dispute.

Here are complaints—Basic com- ts lodged by industry patent law- are:

. The regulations discourage indus- rom entering into NASA contracts use the decision as to who gets s to inventions is not decided un- ter the contract is signed;

. NASA keeps too many of the nts. All they really need is a non-exclusive royalty-free license to use the invention;

3. It is unfair to take an invention of one company and give the exclusive license for the production of that invention to another company;

4. The burden of proof is on the company to show why it should retain rights to its own inventions;

5. The regulations are not "in the interest of the United States" because in many cases the most competent contractor will refuse to accept a NASA contract under the current regulations.

• **Answers**—The NASA legal staff's answers to the above objections are:

If NASA's Administrator allowed the contracting officer to waive possible future patents in the contract, the Administrator would be surrendering his discretionary power, would put him in an untenable position under the law. Industry interest in NASA contracts has been high, indicating that the patent regulations do not discourage bids.

Because of the restrictions as to what type of patents NASA can retain, and because of NASA's pre-stated intention to administer the regulations liberally, fewer patents will be retained than many industry lawyers think. If NASA only retained a non-exclusive license on some inventions, it could not get risk capital to produce the invention.

In many cases a contractor does not want to, or by law cannot acquire rights to an invention. NASA needs the power to give an exclusive license of one company's invention to another in order that the invention can be fully developed and produced in the interest of the United States.

The burden of proof on the contractor to show why he should retain rights to his own invention is very limited, and is necessary to carry out the provisions of the law.

The regulations, though in need of modification, are in the interests in the United States in that they allow the fullest development and use of important inventions in the area of space development.

• **Contrary policies**—NASA lawyers point out that the agency's patent provisions are stricter than DOD's because Congress made them stricter.

They point to the statement made recently by Administrator T. Keith Glennan in which he stated that: "Two such contrary patent policies followed by Government agencies working in closely related fields of research and development, can be detrimental to the kind of cooperation that we must have from industry, if our joint effort is to go forward with effectiveness and dispatch. We are well aware of the attitude of industry toward this question. On the other hand, it must be recognized that these rules are written into the law, and we cannot ignore them. The Administrator of NASA has authority to waive these patent rights, but only if his judgment tells him that such an action is clearly in the public interest."

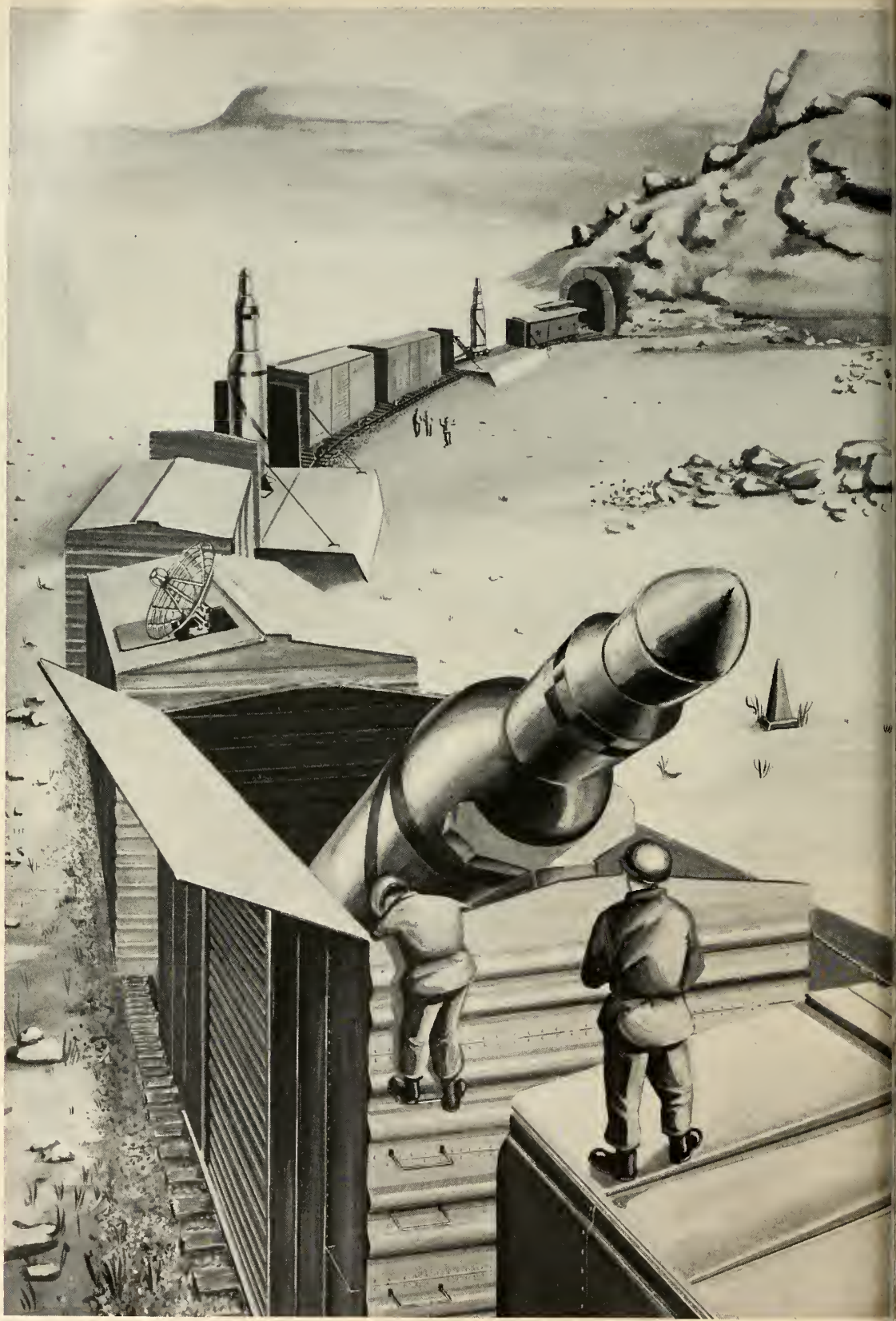
• **Revision?**—Many industry and NASA patent lawyers think that Congress may revise the two organizations' patent regulations in order to reconcile them.

But NASA lawyers do not intend to ask Congress to do so. They feel that the provisions of the law are broad enough to allow them to work out regulations acceptable to industry.

Under the law, the Administrator has the power to waive patents, and the major dispute between industry and NASA is where to draw the line.

Industry would like inventions to be indexed into classes, with the waiver of patent rights by NASA on certain classes of inventions to be automatic. NASA counters that such a system would be infeasible in that an invention in any devised class or category could be so vital to the national interest that the government should retain proprietary rights.

The consensus is that the revisions NASA is presently making of its waiver-of-patent regulations will meet some, but not all of industry's objections.



Minuteman Rail Concept Pushed

200 missile trains appear possible which should open up a whole new field of missile support equipment running into multi-million dollar program

by William E. Howard

WASHINGTON—*Minuteman* is in the ess of being married to a boxcar.

mbracing the theory that mobility make the nation's ICBM deterrent knock-out proof, U.S. strategists well-advanced plans to mount the -fueled Boeing *Minuteman* on rails mouflaged as ordinary freight s, M/R has learned.

ntinually shunted around the try on secret schedules, missile s would be invulnerable to all but cky hit. The enemy would never for sure where they were. In time ert they could hide out in tunnels mine entrances.

he cars would be specially con- ted, perhaps "hardened" to 5 or psi, and air-conditioned to pro- the crew from radioactive fallout. trains would speed in time of at- to a pre-determined firing point g the track, or possibly a siding, nuclear-tipped missiles would be ched in moments directly from cars.

his concept of mobile task forces ing pushed hard by the Air Force. he time *Minuteman* is operational 963, its wedding to a train is cted to carve out a whole new of missile support running into ireds of millions of dollars.

t is possible that as many as 200 ile trains may be mobilized, re- ing special railroad cars and other ile handling and support equip- t.

On war game "sandtables" elusive ile trains add up to one of the t unstoppable weapon systems yet sed in the chill sweat to find an imate" deterrent to Russia. For in ition to will-o'-the-wisp deploy- t, they have the key tactical ad- tage of being able to fire from wn reference points. All targeting data would be "pre-cut" to benchmarks or mile posts strung beside the railroad track.

Thus, a boxcar-launched *Minuteman* would have all the accuracy, but not the vulnerability, of one in an underground silo, which can be zeroed in like a "sitting duck" by an enemy missile.

"Mobility and hardness are the two basic parameters," a high Defense Department planner told M/R. "The higher the degree of each in combination, the more difficult it'll be for the other fellow to knock you out. That's what is so important about this missile train concept.

"This is how it can be done—and should be done."

• *Titan* **mobility**—In the quickening drift toward mobility, M/R has been told, plans also are being developed by the Air Force Ballistic Missile Division to use barges, oil tankers and special truck task forces as ICBM launching platforms.

Moreover, considerable study is being given to adapting the liquid-fueled *Thor* IRBM and *Atlas* and *Titan* to one or more of these moveable platforms. Size and fuel handling are problems with the 90-foot *Titan* and 75-foot *Atlas*. However, a decision reportedly is in the mill at the Pentagon whether to go ahead with development of a storable liquid propellant for *Atlas*.

If one is devised, it could be a major step toward making both *Atlas* and *Titan* mobile. This could be a factor, too, in plans to build several billion dollars worth of underground ICBM bases, in addition to those under construction.

Fourth of a Series on Missile Support

Asked recently by a House Appropriations Subcommittee member if missile mobility is a "countermeasure" to the Navy's submarine-launched *Polaris*, former BMD commander Maj. Gen. Bernard A. Schriever replied:

"No. We are just getting tired of being accused of having our feet set in concrete."

Production of *Minuteman* presently is programmed at 2600 units and consideration is being given to making half of them mobile. If one train could handle six missiles, it would take 200 trains to mobilize 1200 *Minutemen*.

• **Cost factor**—Air Force authorities estimate that it will cost $1.5 million to put one *Minuteman* in a silo—including the missile, which is expected to come off the production line at about $750,000 apiece. Chief advantage of the fixed launching site is in lower maintenance cost. *Minuteman* was conceived as a second generation ICBM which, because of its solid fuel, can be deployed in squadrons of 60 in remote areas in tamper-proof silos under "black-box" surveillance—removing the requirement of crews to check on the condition of fuel, launch and guidance systems.

By utilizing existing rolling stock, the cost of putting *Minuteman* on rails would be comparable to a fixed system. But the cost of operating a train with a crew of 30 to 40 men would boost the overall annual outlay.

Research and analysis of the feasibility of mobile platforms, M/R has learned, was part of the proposal when Boeing was awarded the *Minuteman* contract last fall. To generate some broad parameters on performance and economics, a study was initiated and is still underway. Contributing, among others, are the Association of American Railroads and American Car & Foundry, one of the nation's largest railroad car manufacturers.

• **Two designs**—Studies thus far have produced at least two distinct designs, both centering around the launching car. In one detailed to some degree by the BMD, the missile car would be 110 feet long and capable of accommodating two 55-foot *Minutemen*. It would have a rounded, hinged cover under which the missiles would ride horizontally, protected by special cushioning gear.

For launching, the cover would be thrown back and the missiles raised to a vertical position on a ring stand. The car would be protected for possible re-use by a special blast deflector.

Remainder of the train would be made up of standard equipment.

The second, more elaborate concept calls for complete concealment in standard-appearing boxcars—so the train would be indistinguishable from another freight. This would make it that much harder for enemy agents to keep track of the train's whereabouts.

Since the standard boxcar averages 43 feet, the missile car would have to be specially tailored to fit the 55-foot length of *Minuteman*. This limitation probably would restrict the car to carrying one missile. To launch, the hinged sides and top of the car would fold out to the ground. As with the oversized double missile car, *Minuteman* would be raised on a ring stand with an electrically powered hydraulic lifting arm.

Extra shock absorbing effects are required in both designs to prevent damage to the missile while in transit. And the missile car decks and end panels probably would be fabricated of high-temperature resistant steel alloys to withstand takeoff blast.

More engineering and expense would be required to convert available rolling stock for a camouflaged missile train into cars to accommodate communication, telemetry and data processing, personnel and dining.

To harden the cars to withstand bomb blast over pressures of even 5 psi, some experts say, would run up the cost of the trains to an exorbitant figure. Moreover, they point out that hardening could not be very effective anyway, since it is more than likely a nuclear bomb blast at any proximity would knock a railroad car off its tracks. They contend it would be much more feasible therefore to run the trains into tunnels and mines during an alert.

• **15-car train**—A typical missile train of the camouflaged variety is conceived as being comprised of about 15 cars. They would include, in addition to six missile launchers, one car each for communications and telemetry-data processing, one for equipment, two for spare missiles, two personnel cars, a diner and—to make it look real—a caboose.

While no firm estimates have been made available, AAR figures indicate a fully-equipped missile car for a camouflaged train would cost in the neighborhood of $100,000—exclusive of the missile. A 110-foot car might be $150,000 or more. Cost of outfitting cars for personnel—$50,000 each. And the other cars also would have to be specially fitted and air-conditioned at about the same price. Thus a 15-car missile train would come to about $1 million. The diesel electric engine, if not leased from a railroad, would add another $250,000 for a total of $1,250,000.

In comparison, a luxury streamliner consisting of a two-unit diesel locomotive and 13 cars would cost $2.7 million.

Equipping the missile train communications and targeting cars along with other support equipment, however, might entail expenditure of another $1 million, bringing the total for one train ready for deployment with missiles to approximately $6.7 million.

This appears relatively cheap compared to a hardened *Titan* base, which costs about $40 million just for the brick and mortar to house personnel and silos for nine missiles.

• **Blocked tracks?**—One obvious drawback of a rail launching system is its inflexibility. In time of emergency, missile trains might be prevented from moving to their target control points by rail traffic, bomb damage or even sabotage to the tracks. This is one reason why some experts are in favor of a missile truck convoy which would prowl the nation's superhighways in continual readiness to respond to an attack.

Railroad authorities believe that through efficient planning and careful routing the drawback may be minimized. They point out that there is ample room on the sprawling rail network covering some 386,000 miles to "lose" a couple of hundred trains. Each day approximately 30,000 trains—half of them freight—are on the move over the country. This is approximately 50% of the trains operating in 1930 during the railroad heyday.

A prototype rail launching car for *Minuteman* is under development. Schriever says the Air Force is "going down the line simultaneously" on both the fixed and mobile operational concepts.

First firing of *Minuteman* from a silo could come late next year—either at Cape Canaveral or at Edwards AFB. Facilities are being built at both. And the first shot from a boxcar may be scheduled at the same time.

New Transducer Uses Seen in Space Medicine

PHILADELPHIA—Space medicine have issued a transducer challeng the electronics industry. At a Phil phia's Franklin Institute sympos medicine experts pointed out that and better transducers are neede provide the answers that medicine have to know if man can surviv space. And they are looking to tronics to provide the means to s and transmit the many physiolo parameters they must measure.

The one-day Space Medicine E tronics Symposium brought toge representatives of medicine and tronics in industry, the armed fo and government agencies.

To date, communications bet electronics and medicine has been little to produce any significant re The Philadelphia meeting was an e to bring about better communica and acquaint electronics with s medicine problems.

Theodore Kaslow, vice presiden gineering of the Decker Corpora defined the ideal transducer and po out three parameters that are espec important to medicine and are, t beyond the state of the art:

1. An objective measure of threshold and level;

2. An objective measure of ness, or awareness; and

3. A measure of cerebral cir tion.

Some work has been done by Decker Corporation on the cer circulation problem. Preliminary using an opthalmic artery pulse pi indicate that techniques and transd can be developed to provide the swers needed.

Present medical methods of ob ing physiological data—skin and temperatures, pulse and respiration blood pressure, skin resistance, action, etc.—are too crude and l to be used on a man in a space ronment. The subject's comfort, matic pickup and recording/tran ting capability, volume and weight itations, and other requirements al tate entirely different techniques equipment from those used in the tor's office.

Gordon Vaeth of ARPA said "we cannot prove today that ma survive and perform in space." H that in spite of the feeling by som man is an obsolete and expensive h in a space vehicle, he feels that has a function to perform that c be accomplished by machines.

He pointed out that man is the complete and flexible computer able today and can serve as a efficient data filter or discriminat

How Is DOD Moving on Reliability?

Some observers say it is in all directions but Air Force has come up with a new reliability monitoring system which should give better standards

by Betty Oswald

WASHINGTON—Reliability is rapidly ›oming the most important headache ·d both by the Defense Depart·t and the National Aeronautics and ce Administration. The old slogan 9.44% pure just isn't good enough the thousands of pieces and sub·ems which make up advanced pons and space systems.

But how do you achieve reliability? ense Department, according to e observers is moving in all direc·s at one time. However, effort ts for the most part at design level er than at the level of materials ch make reliability of design components themselves feasible. ether this is good enough is furi·ly debated among research people, icularly those who are concerned a the failure to develop a firm ma·als research program looking ahead a new generation of requirements.

Latest DOD effort deals with en·ering drawings and associated lists M-D-70327) which spell out in e 25 pages exactly what shall be the engineering drawings, and how erials, parts and components are to identified. And to "insure quality design activity (either military or ufacturer) is required to establish maintain an adequate procedure checking, review and maintenance rawings, associated lists, and docu·ts prepared or furnished under this ·ification."

• **New monitoring**—And the Air ce has developed a reliability mon·ing program designed to correct as ckly as possible situations such as recent development of "bugs" af·ing the *Atlas,* which resulted in r faulty firings in a row.

The policy statement is contained AFL 84-1. It is predicated on the mption that "reliability is a param·" that can be quantitatively speci·, estimated, assessed or measured at designated steps or monitoring nts of a weapon system's life cycle ." It recognizes, however, that in·ased funding will be required, in e cases, to obtain higher confidence els in the demonstration testing se.

AF's program is supplemental. It does not replace contractor's normal reliability monitoring as well as surveillance by AF contracting agencies. It is based on an expression of quantitative contractor reliability (i.e. 50% at a certain date, 95-100% by another date).

Reliability monitoring points established by the AF are: (1) Detailed design study, which includes studies of both system and subsystem reliability covering the entire design and including prediction of reliability wherever feasible; (2) Pre-prototype, involving design engineering inspection or a release of nearly all of the engineering; (3) Prototype, at which time laboratory testing has established compatibility of weapon systems and subsystems and special test vehicles have been used to obtain data for improvement of design, etc.; (4) Pre-production demonstration. Here sufficient reliability must be shown to warrant a production go-ahead; (5) Service evaluation. Here the question is whether the system is capable of being produced in quantity without significant loss of reliability or performance; (6) Full-scale production, during which the effort is to assure that the level of reliability designed into the system is maintained; and, (7) Product improvement, during which AF hopes to move close to the perfect.

• **Reliability specified**—At each of these points, the degree of reliability required will be specified in the contract. At each of these points the status of reliability is to be reviewed and, on the answers found, a determination will be made whether to move to the next step in the life cycle of the weapon.

However, it's uncertain whether this latest program is good enough. Indications are that there will be more emphasis on the bits and pieces which go to make up the missile system, and perhaps somewhat less emphasis on the complete weapon system. This means more technical development work as recommended by the Stever Committee which recently reviewed the status of the Air Force research effort.

Thor Plastered



TECHNICIANS coat nose cone of *Thor-Able* re-entry vehicle with plaster to make cast of its surface. Vehicle is first to be recovered after successful flight over 5000-mile ICBM distance. Avco's Research and Advanced Development Division developed ablating heat shield material which protected cone from extreme temperatures encountered during re-entry into earth's atmospbere. (Dark substance behind cone is ablative material which flowed back over main body during re-entry heating.)



Swiss Firm Turns Out Most Missiles in Italy

Contraves AG developing into big supplier with its RSD-58 and RSC-57 missiles

by Anthony Vandyk

ZURICH—Contraves AG, which is developing into one of Europe's most respected missile manufacturers, is a Swiss firm which turns out most of its products in Italy.

The head office and plant of Contraves, a component of Switzerland's Oerlikon-Buehrle industrial empire, are located in a suburb of this great manufacturing city. But production is mainly handled by an Italian subsidiary company, Contraves Italiana.

This unusual arrangement is a result of Switzerland's traditional neutrality. Swiss policy does not encourage the export of armaments—and the market within the country is extremely limited. Furthermore, since Switzerland is outside NATO, prospects for a Swiss company trying to sell its products to NATO member countries—the main European military market—obviously are not good.

• **No Red business**—These factors were behind the decision of Contraves to set up Contraves Italiana in Rome. Using the design of prototype facilities of the Swiss organization, Contraves Italiana as an Italian company is in an excellent position to obtain orders from NATO countries. The Contraves organization also takes orders from countries outside NATO but has a policy of not doing business with Iron Curtain countries.

To date, most of Contraves' missile business has come from the Italian and Swiss governments, but there have been token orders from the U.S., Japan, and Germany. Contracts are being negotiated with other countries.

The U.S. Air Force was Contraves' American customer. It evaluated the Swiss anti-aircraft missile at the Holloman Air Development Center in 1953.

Because Contraves missiles are developed without government financing, the company's salesmen are not hampered by security in their efforts to sell their products on the world market. There are no aspects of the *RSD-58* and *RSC-57* SAM's or the *Mosquito* SSM which cannot be freely discussed with potential customers.

Contraves makes no attempt to avoid talking prices. The tactical *RSD-58* version of the anti-aircraft missile is priced at between $15,000 and $18,000 per round, while the training *RSC-57* version costs roughly twice as much. The anti-tank *Mosquito* is tagged at $900 in both its training and tactical versions.

• **"Against birds"**—Now able to offer two highly competitive types of missiles on the world market, Contraves has come a long way since its foundation in 1936 as a modest anti-aircraft research organization (Contra-Aves means "against birds"!). The first products that stemmed from its work were tracking systems; from the original pre-war models were developed complex theodolites, which form the basis of the Contraves EOTS (Electronic Optical Tracking System), standard equipment at the leading missile ranges of the Western World. More than 100 sets of EOTS equipment have been sold by Contraves.

Another Contraves specialty is fire control equipment. The Fledermaus probably represents the ultimate in this type of equipment for anti-aircraft guns. Experience in this field obviously has aided in perfecting fire control systems for Contraves missiles.

The Japanese Self-Defense Force expects to fire its first Contraves anti-aircraft training missile this summer. The Swiss company has concluded a licensing and agency agreement with Mitsubishi Electric Manufacturing Company of Tokyo. Prospects are good that the Self-Defense Force will place a production order with this conce Under the terms of the agreem Mitsubishi can sell Japanese-built n siles to any neighboring countries cept those in the Communist bloc.

• **Heavy subcontracting**—Contra policy favors maximum subcontract and most of its anti-aircraft missile s tem is manufactured by subcontracto Much of the radar comes from Alt werke, a Zurich electronic compa that was one of Contraves' early ba ers. The beam guidance radar conta a HF transmitter made by another Swiss company, Brown Boveri. Forei companies also figure in the Contra program. For example, Belgiu MBLE company is responsible for t target-tracking radar.

Although the basic Contraves SA is not new, constant improvements being made. Operating radius has be increased to over 20 miles and a so



CONTAINER with two missiles weig only 23 lbs. and is strapped on bac

ppellant is being substituted for the crrently-used liquid-fuel rocket mo-t. The present motor develops about 200 lbs. thrust and combustion lasts about 45 seconds, sufficient to move t missile up to Mach 2.5,

A particular selling point made by Contraves officials is that since neither t SAM nor the little *Mosquito* SSM e boosters they can be deployed close t inhabited locations and troop con-ntrations.

One of the main features of the Contraves SAM system is its mobility, c imed to be at least as great as that c a normal heavy-caliber anti-aircraft a illery battery. The heaviest of the ssile battery's units weighs only 12,-00 pounds. Nonetheless, the *RSD-58* t tical missile can attain Mach 2.5 d has an operating radius of over 2 miles and a ceiling of 30 miles.

The minimum distance at which i can be used is from 8000 to 16,500 et, according to the speed of the t get. Launching weight is about 900 s. The warhead contains about 90 s. of high explosive. Behind it is an ectronic equipment also weighing out 90 lbs.

• **Fast firing**—The beam guidance stem permits several missiles to be ed simultaneously from the same bat-ry. Up to twelve missiles a minute ay be launched. This high rate of fire quires fast loading on the double unching ramps; this is largely achieved rough automation.

The training version of the *RSD-58,* e *RSC-57,* is fitted with a parachute stead of a warhead and thus is not pendable. The recovery system in-udes two parachutes and special echanism. After the end of combus-on, the missile is split into two parts, the nose and the main body returning to earth separately. As many as ten recoveries have been made with individual missiles tested at the Italian Air Force's range on the Mediterranean island of Sardinia.

• **Anti-tank**—Contraves is working very closely with the German firm of Bolkow in connection with its program for the little *Mosquito* anti-tank missile. This wire-guided SSM competes in a market so far dominated by France's Nord *SS-10* and *SS-11* missiles.

The Swiss-designed SSM is considerably smaller than the French weapon and weighs only about 23 lbs. A container with two missiles including warhead that can be strapped on to a soldier's back (see photos) weighs only 54 lbs. Guidance equipment weighs 8 lbs. Despite its modest size (3 feet long and 2 feet in wing span) the *Mosquito* has a remarkable performance. It travels at 16,500 ft. per minute and has an operating radius of about 6000 ft.

Although the missiles of its own design are tops in their category, there is little doubt that Contraves would be extremely interested in acquiring the license to build advanced birds of foreign design. Notably missing from the company's catalog is an AAM in the *Sidewinder* category.

It could well be that by the time the Swiss Air Force is ready to make its choice of a supersonic fighter, probably this fall, Contraves will have a proposal regarding the weapon system. In all events, it seems that the company's success with its past projects guarantees it a permanent place among the leaders of the European missile industry.



CONTRAVES *Mosquito* SSM uses boosters that can be deployed closed to inhabited locations and troop concentrations.

S. K. Hoffman Receives M/R's Goddard Trophy

WASHINGTON—Samuel K. Hoffman, vice president and general manager of the Rocketdyne Division of North American Aviation Inc., last week was awarded the Dr. Robert H. Goddard Memorial Trophy—an annual presentation by Missiles and Rockets.

The award was made at the end of a three-day National Missile Industry Conference sponsored by the National Rocket Club. Hoffman was honored for leadership in producing the *Jupiter C* liquid rocket engines which launched the first U.S. earth satellite *Explorer I,* on Jan. 31, 1958, and engines for the first successful flight of a long-range ballistic missile, an *Atlas.*

An industry award presented by Borg-Warner Corp. also cited Rocketdyne for outstanding achievement with liquid-propellant engines.

Dr. William H. Pickering of Jet Propulsion Laboratory received the Daniel, Mann, Johnson & Mendenhall Space Flight Achievement Award.

Space Industries Small Business awards were presented to: Cooper Development Corp., Monrovia, Calif., for design and fabrication of the three final *Jupiter C* stages used in the *Explorer* series; and Cincinnati Testing Laboratory for developing the first successful IRBM re-entry nose cone.

Other Highlights—During one of the work sessions, Dr. Herbert F. York, the DOD's director of R&E, reported that the ARPA-Army cluster of eight *Jupiters* for *Saturn's* space booster will be effective if only seven of its motors ignite. York also forecast a need for more research money for NASA and DOD as the astronautics program diverges more from the missile program.

"Off-again-on-again" Pentagon plans for a nuclear-powered plane (CAMAL) were critized by Sen. Henry M. Jackson (D-Wash.), a member of the Armed Services Committee and long-time supporter of the project. Jackson challenged whether development of the plane would take five years, as estimated in recently released Congressional testimony by Lt. Gen. Roscoe C. Wilson, Air Force deputy chief of staff for development. The Senator thinks it could be done sooner, and that the first one should be a seaplane.

And William S. Palmer, vice president of Templeton, Dobbrow and Vance, Inc., mutual fund managers, cautioned that prices of missile stocks have reached "unrealistic" heights because of "wild speculation."

U.S. May Seek Pact to Silence Outworn Satellites

Delegation at Geneva meeting will also propose radio frequencies to be reserved for space use only

by Paul Means

WASHINGTON—Future U.S. satellites containing permanent power sources will house destruct mechanisms allowing their transmitters to be turned off when their usefulness is over.

An attempt to obtain an international regulation to this effect may be made this August at the Radio Conference of the International Telegraphic Union at Geneva, which will also take up the problem of the allocation of frequencies for space use.

The problem of permanent power sources in satellites first arose when the Navy launched *Vanguard I*. The satellite's batteries were charged by solar cells, allowing it to send signals back to earth ad infinitum.

Because of its almost perfect orbit, *Vanguard I* still provides useful information to the nation's scientists. But when the value of its information is ended, there will be no way to turn *Vanguard I's* transmitter off.

And a great many satellites in space with permanent power sources would clutter up valuable frequency bands for many years to come.

The next two satellites with solar cell-charged batteries that the U.S. intends to orbit are *Thor-Able III* (the paddle wheel satellite) and *Explorer VI*.

A destruct mechanism in *Thor-Able III* will not be necessary because its orbit (30,000-mile apogee, 150-mile perigee) will be short-lived. But *Explorer VI*, a long-life radiation experiment satellite, will contain either a destruct mechanism which will turn the transmitter off, or a device allowing the transmitter to be turned off and on as information is needed. Its power will be supplied by solar cells charging nickel cadmium batteries.

A satellite transmitter's signal can be terminated by: (1) a circuit breaker; (2) by applying too much volt to a transistor, allowing the oscilla to burn it out, or (3) by using a ti fuze.

Because some satellites in sta orbits will give useful information fr time to time in years to come, NA and ARPA scientists are also perfe ing a device that would allow the tra mitter to be turned on and off as formation is to be required.

• **Space bands**—Another probl created by the Space Age is the fir ing of frequency bands for space u in a radio spectrum already burden by military and commercial commu cations.

The U.S. proposal before the 1(nation International Telegraphic Uni will be that 25.600 to 25.650 mc., reserved for the exclusive use of spa transmissions. This band would used for earth-space transmissio fixed service transmissions (radio a television network satellites), mob service transmissions and space-to-spa transmissions.

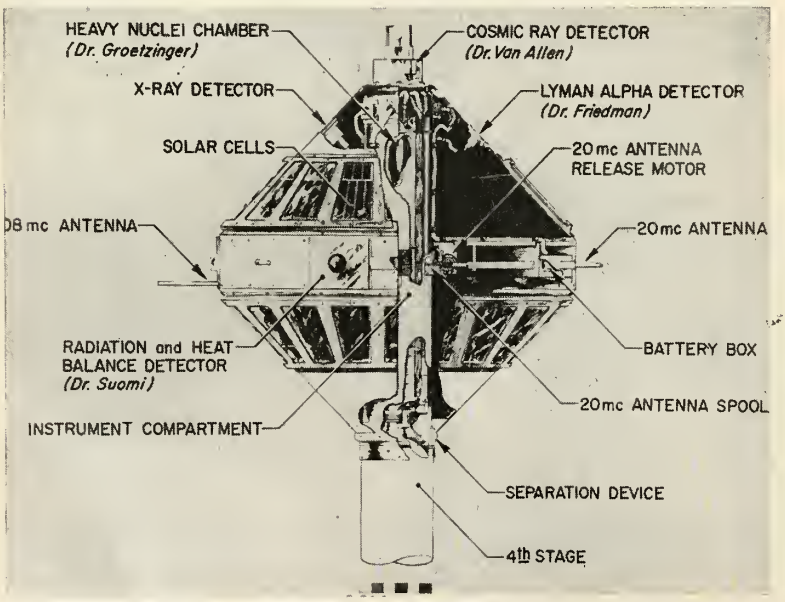
Recognizing that space operatio will demand more frequency bands the future, the U.S. proposal will al request that the following bands al be set aside for space use: 1700-17 mc.; 1825 to 1850 mc.; 2275 to 23 mc.; 8300 to 8400 mc.; 15,150 15,250 mc.; and 31,500 to 31,800 m

The U.S. proposal requests that t latter frequencies be used primarily f ground-to-space station, and space-t space transmissions. The propos would not exclude fixed and mobi service uses of these frequencies pr vided this would not hamper spa vehicles and stations in communicati with each other and the ground.

• **Hopeful outlook**—Since the Sovi Union is the only other space powe what are the possibilities of effecting a international agreement allocating fr quencies for space?

U.S. officials think chances a pretty good.

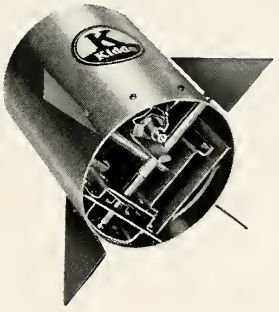
They point out that internation agreements become difficult to effe



PAYLOAD of *Explorer VI* will contain a transmitter powered by solar cells. Plans call for a device to either shut off or control output of the transmitter at will.

Don't miss it!

Be sure to see the working models of the new Kidde hot and cold gas servo systems at the Western National Astronautical Society Exposition of the American Rocket Society at the El Cortez Hotel in San Diego June 9 to 11 Booth 83



Kidde hot and cold gas servo systems can be tailored to fit a wide range of applications. Illustrated above, rocket guidance control. They are low in cost, light in weight. Kidde gas servo systems have low current and gas consumption, have few moving parts, and are extremely reliable. They operate at temperatures exceeding 1600° F.

Kidde's hot and cold gas servo system components have been developed, tested and are now on the shelf. If you have a problem involving servo valve systems, write for complete information to Kidde today. Chances are we already have the answer.

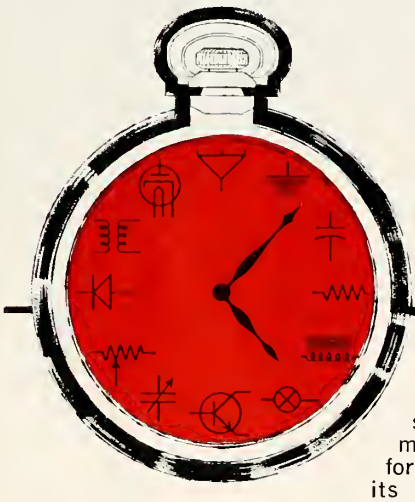
Walter Kidde & Company, Inc., Aviation Division
620 Main Street, Belleville 9, N. J.

Kidde

District Sales Engineering Offices: Dallas, Tex. Dayton, Ohio—St. Louis, Mo.—San Diego, Calif. Seattle, Wash.—Van Nuys, Calif.—Washington, D. C.

Walter Kidde-Pacific, Van Nuys, California
Walter Kidde & Company of Canada Ltd.
Montreal—Toronto—Vancouver

Electronic Creativity is a timeless quest



. . . and those qualified to participate may achieve real stature in their respective fields.

Electronic elements of the nation's space exploration and defense fall within our scope. This advanced equipment is created and produced for the U. S. government and its major prime contractors.

Opportunities are now available at Melpar in the following areas:

Reconnaissance Systems	Detection & Identification Systems
Airborne Equipment	Antenna & Radiation Systems
Ground Data Handling Equipment	Chemistry Laboratory
Ground Support Equipment	Applied Physics Laboratory
Simulation & Training Systems	Production Engineering
Communication & Navigation Systems	Quality Control

Interviews Arranged In Your Locale

For Details Wire Collect or Write to: Professional Employment Supervisor

MELPAR INC
A SUBSIDIARY OF WESTINGHOUSE AIR BRAKE COMPANY

3310 Arlington Boulevard
Falls Church, Virginia

only when nations have proprietary terests involved. At this point, no tion has much of a vested interes space.

In 1946 at Atlantic City, the had little difficulty in bringing a an international agreement for quency allocations. Both the Soviet U.S. delegations signed the agreem and it has been kept. The coming the Space Age is the major reason modifying the 1946 agreement.

The pact reached by the ITU comes a multilateral treaty after ra cation by the governments of the m ber nations. And the treaty is bin on those nations signing the agreem

Another point encouraging ITU cials is that the Radio Conference be held in August—the same mo that the Summit Conference is expe to be held. The Russians are expe to be on their best behavior—should sign agreements as non-con versial as the allocation of frequen for space.

Details of *Atlas* Construction Disclosed

WASHINGTON—Details of some the materials and manufacturing m ods involved in production of *A* have been revealed by J. R. Demp vice president of Convair's Astro tics Division, which makes the big

In a recent talk here, Dempsey that thin-gauge tank walls of the mi form the complete frame. He ad that the tank, about 60 feet in le and 10 feet in diameter, has no inte framework and hence must be kept der pressure, like a football, even w it is unfueled.

The material used is a special c rolled austenitic steel (AISI grade 3 produced by Washington Steel Co Washington, Pa., Dempsey disclo It is delivered in coils consisting long flexible bands about one wide. The tank is welded together its thinnest wall section meets a sp fication for minimum tensile stre of about 200,000 psi.

The bulkhead separates two pro lant storage tanks. A domed stair steel bulkhead forms the forward of the tank and a third bulkhead conical shape makes up the aft sect

After welding is completed, tank is pressurized by gas to take wrinkles out of its skin. Pressures less than 10 pounds per square are required in the tanks.

Advantage of the tank const tion, Dempsey said, is that it can converted to other missions witl any change in the basic design or w ing equipment. He denied that pressurization made the missile e vulnerable to damage or destructi

Electronic Creativity is a timeless quest



- Original Conception
- Design
- Expedited Production

Melpar's deep reservoir of technological electrocraft is solving problems of almost incredible complexity—with the utmost scientific precision.

Electronic elements of the nation's space exploration and defense fall within our scope. This advanced equipment is created and produced for the U.S. government and its major prime contractors.

MELPAR INC

A SUBSIDIARY OF WESTINGHOUSE AIR BRAKE COMPANY

For details on provocative job openings in advanced scientific engineering areas, write to: Professional Employment Supervisor

3606 Arlington Boulevard, Falls Church, Virginia



Bendix* has long been a leader in supplying controls and fuel systems for all types of aircraft engines. Today, Bendix is proving to be a natural for new challenges in related missile fields—on ram jets, rockets, nuclear power, and other advanced propulsion systems. So, when it comes to controls, remember that Bendix has the background—and is anxious to share it in solving your problems. *REG. U.S. PAT OFF.

BENDIX PRODUCTS DIVISION **SOUTH BEND, IND.**

Bendix AVIATION CORPORATION

enate is expected shortly to ap-
e the House-passed four-year ex-
on of the Renegotiation Act,
h expires June 30. The bill omits
stry-backed proposals to broaden
ptions and allow higher profit
s.

At Cape Canaveral, 1500 workers
ing a carpenters' strike against
ractors returned to work in
rests of national defense," al-
gh still supporting the strike. So
no missile firings have been af-
d by the walkout.

Sharp attack on both the Army
-*Hercules* and Air Force *Bomarc*
ceptors has been made by Vice
iral J. T. Hayward, deputy chief
Naval Operations. The $25 billion
defense network is a soon-to-be-
ated Maginot Line, Hayward says,
use of the 15-minute ballistic mis-
warning time. His recommenda-
stop pouring money into a fixed
ing and defense system.

rmy scientist Dr. Ernst Stuhlinger
ves in 1965-70 period nuclear-
ered unmanned ferry may be de-
ped to haul building material,
pment, food, water and oxygen to
ly a base on the moon. Total
ht of space ferry would be 84 tons
a payload capacity of 50 tons,
h would be a detachable landing
cle propelled by hydrogen and
X engines.

The Air Force is acting as execu-
agent for ARPA on *Midas* (missile
nse alarm satellite). Order was
ed in November, 1958. ARPA has
geted $18 million in FY 1960 for
project—an increase of $6 million
n the current fiscal year.

exaco Inc. is moving into the high-
gy fuel R&D field with the acquisi-
of Experiment Incorporated, Rich-
nd, Va. . . . On the West Coast,
Reduction Pacific Co. is building
million LOX, liquid nitrogen and
n plant at Richmond, Calif., with
aily 30-ton capacity . . . Linde
's new 165-ton-a-day LOX and
id nitrogen plant at Pittsburg,
if., began deliveries May 14—a
nth ahead of schedule. The com-
y says the advanced production
e "relieved what could have become
ritical shortage." . . . NASA has
en Callery Chemical a $175,000
tract to evaluate a new rocket pro-
pellant with liquid and solid applications which—if practicable—will permit substantial increases in payload weights.

Improvement of vapor phase deposition of chromium, molybdenum and tungsten is reported by Alloyd Research Corp., Watertown, Mass. Possible electronic industry applications include component coating with high-purity, high-density tungsten to prevent contaminants in base materials from adversely affecting electronic emission characteristics. Thicker "coatings" raises possibility of fabricating thin electronic parts of refractory metals. Heavy coating of tungsten on graphite also may be feasible for improving heat characteristics of rocket nozzles.

Space balloon to probe atmospheric density at 300 miles will be launched soon by Air Force Cambridge Research Center. Boosted by *Arobee* and *Sparrow* rockets, balloon will be ejected in 18-pound package, which will unfold into 9-foot mylar plastic sphere reinforced by dacron threads. Inflation will be accomplished by evaporation of ethyl alcohol followed by capsule discharge of freon gas into plastic struts inside the balloon. System was designed by Arthur D. Little Co.

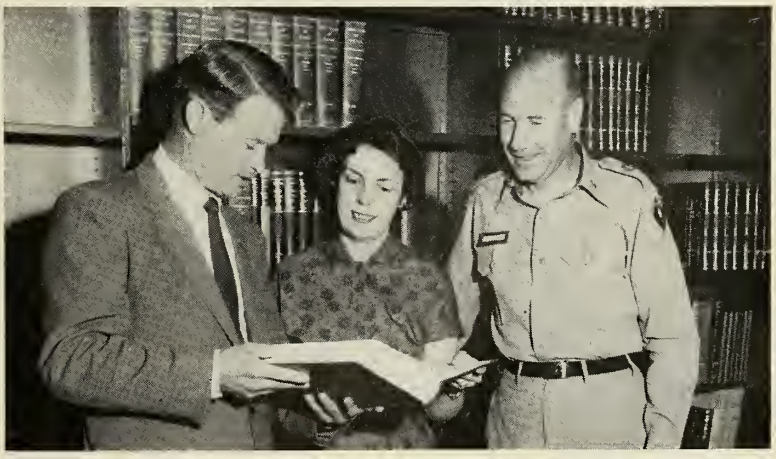
Prime contract has been awarded Marquardt Corp. by Air Force to expand its effort on project *Pluto*—joint AF and AEC feasibility study of nuclear ramjet engines.

Fast tax write-off certification has been granted by the OCDM to Bendix Aviation for missile R&D—60% of $1 million; Hughes Aircraft for electronic systems R&D—65% of $400,000; Lear Inc. for R&D and production of missile components—60% of $1.9 million.

Mergers & Expansions—Royal Industries has acquired Pacific Electronic Controls Corp., Monravia, Calif., potentiometer maker . . . Machlett Laboratories Inc. stockholders and those of Raytheon Inc. have approved merger conditions . . . Hewlett-Packard Co. has initiated $1.9 million in building construction for a planned $2.7 million expansion at Stanford Industrial Park, Palo Alto, Calif. . . . 28% more plant space will be added by Sperry Electronic Tube Division of Sperry Rand at Gainsville, Fla., to expand production of microwave tubes. Employment will be boosted by 30% to more than 800 by mid-1960, the company says . . . Electronic Communications Inc. is building a 150,000-square-foot manufacturing plant at St. Petersburg, Fla.

Russia, says National Bureau of Standards Director Allen V. Astin, is leading the "entire world" in high-temperature development. And equally important in the Missile Gap, Astin says the U.S. is behind the Soviets in industry-wide verification of industrial and scientific instrument calibration. He says Russians have established a network of calibration centers for the mandatory interchange of data about technological components.

Magazines for 'Space Academy'



FIRST MISSILE library, at Army Ordnance Guided Missile School, Redstone Arsenal, gets bound copies of M/R. Executive Editor Clarke Newlon makes the presentation.

SCOUTING THE FRINGE OF SPA



5 manned research vehicle rehearses for first flight



by Erica M. Karr

If all goes according to plan, the *X-15* will have made its first powered flight before the next two months are up. The hybrid rocket-plane, offspring of a nationwide project involving over 300 companies—large and small—recently completed its fourth captive flight test and is expected to undergo a glide-flight landing test within the next two weeks. First space-fringe flight to 100 miles is due "sometime next year," according to prime contractor North American Aviation, Inc.

Primary role of the *X-15* is to get data on actual flight conditions beyond the atmosphere and the effects on man and machine during exit and re-entry. To do the job the vehicle will carry over 1300 pounds of instrumentation involving approximately 600 temperature pickups and 140 pressure pickups.

Minor bugs have been worked out of the system during an extensive ground testing program and the captive flights have proven out all systems except the engine. During these trial runs, the *X-15*, locked under the wing of a B-52, has been under continual surveillance by two television cameras in the mother plane which has taken the manned space bird to 42,000 feet at Mach .8.

The mated combination has been checked out for aerodynamic characteristics while North American's design engineer and test pilot, Scott Crossfield, checked out the control and communications systems from the cockpit during simulated launch.

Although Crossfield will take the 50-foot ship through final flight test phases,

---

NEEDLENOSED *X-15,* being readied for captive flight test under B-52 wing, is fed helium gas which is chilled by passage through liquid nitrogen of minus 320°. Nitrogen, which boils at this temperature, causes ground fog. Chilling gas increases fuel load.

Another Exclusive
Cornell Capa Picture Story

. . . two faces of one man







Air Force Maj. Bob White will probably be the man who will nose the *X-15* in and out of the atmosphere on its first full flight.

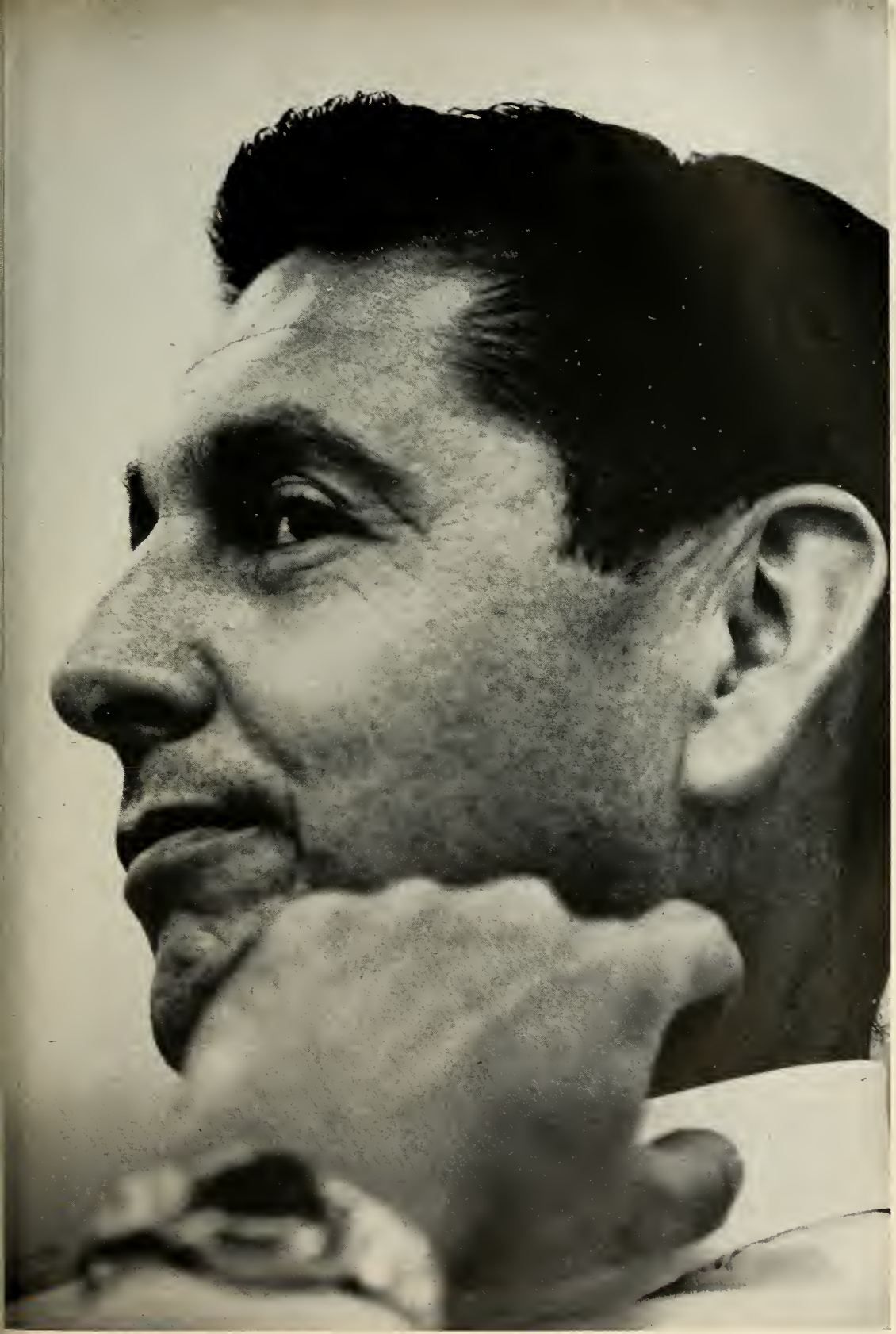
In this unusual account, the camera of Photographer Cornell Capa has caught behind-the-scenes highlights before, during and after a recent captive flight, culmination of the over 3½ years' work to date in bringing the *X-15* to the threshold of proven reliability.

Crossfield, who has lived with the program since its inception, often putting in 100-hour weeks toward its realization, and the *X-15* both will undergo their stiffest test to date in the glide-landing run. Falling vertically with an initial speed of 100 mph, and moving with a ground speed over 400 mph, Crossfield will have about two minutes to test control responses before he tackles the tricky problem of landing.

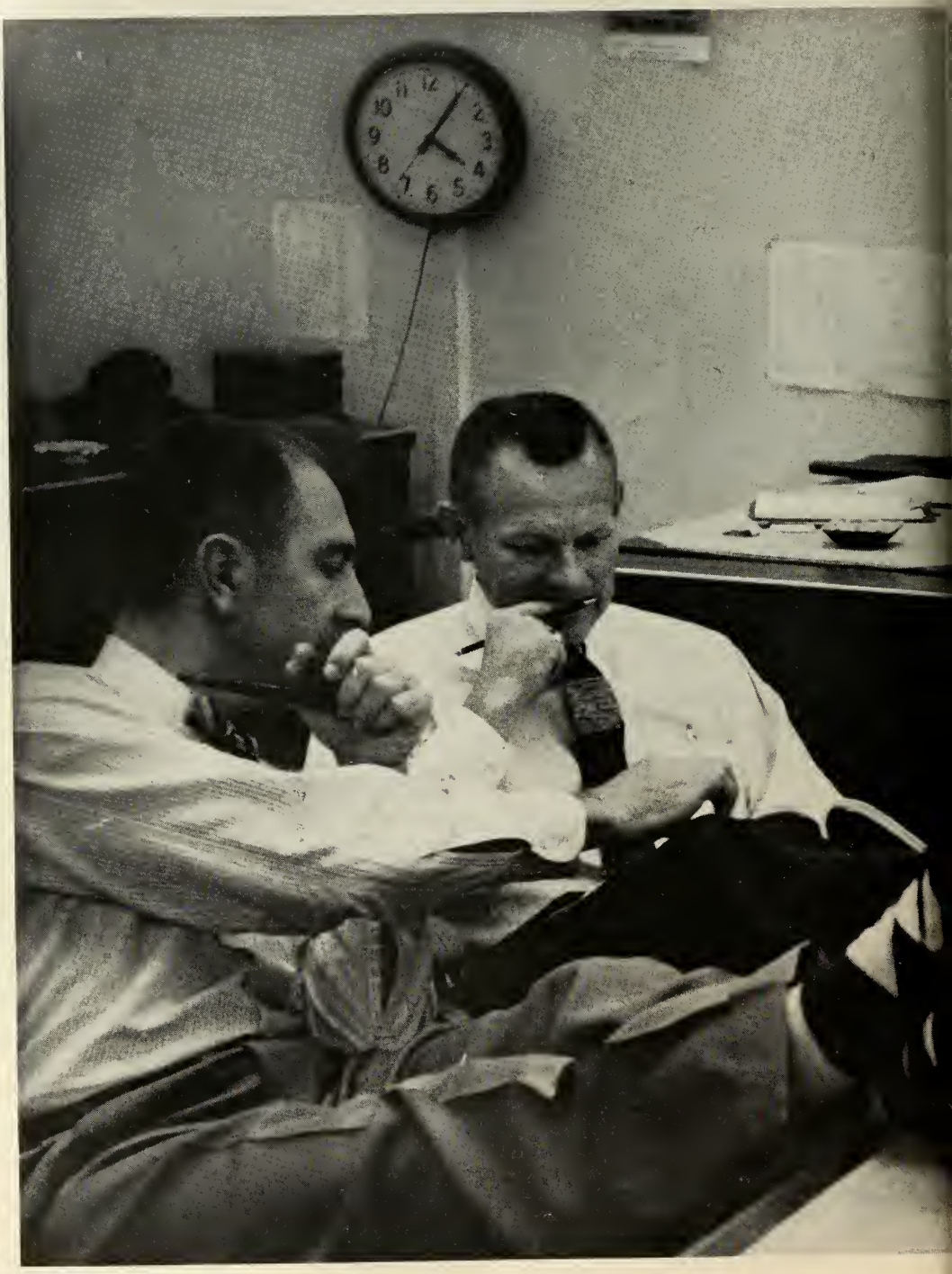
Among major contributors to the program which is expected to cost over $120 million through the third vehicle: Reaction Motors Division of Thiokol Corp. supplies the liquid propellant powerplant which will boost the *X-15* to 4000 mph. Auxiliary power units come from General Electric's Accessory Engine Division. Garrett Corp. makes the liquid nitrogen cooling and pressurization system. Pressurization suit, tested by Crossfield in the captive tests, was developed by a brassiere and girdle manufacturer, the David Clark Co. The nickel alloy—Inconel X—from International Nickel Co. will bring the *X-15* through the high temperatures of re-entry.

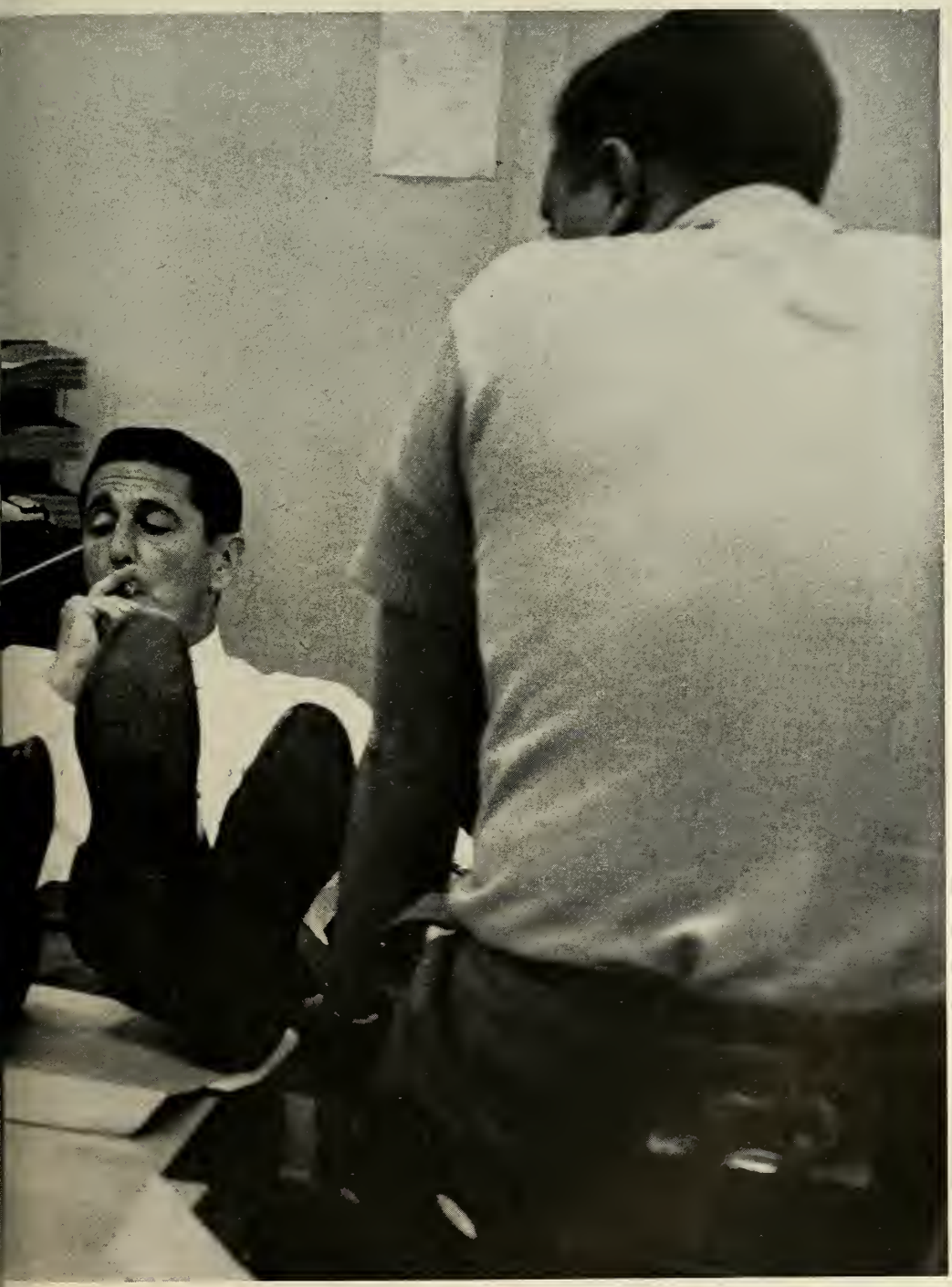
Ballistic rockets for out-of-the-atmosphere control come from Bell Aircraft, while Sperry Gyroscope developed the in-flight electronic indicator system to transmit altitude, speed and angle of attack to the pilot and recording apparatus. Instrumentation, much of it produced by Lear and NASA, will have a temperature environment provided by a system developed at AiResearch Mfg. Co.

DISTORTED FACE of test pilot Scott Crossfield reflects terrific pull of 4 g's forward and 7.33 g's down in *X-15* re-entry simulation. Right: The normal Crossfield face.



. . . Relaxed conference with vital implications





FEET ON DESK, North American's Sam Richter, flight test engineer; Q. C. Harvey, test operations supervisor; Crossfield and Bill Berkowitz, launch panel operator, discuss countdown procedure for new *X-15* test.



TOWER WATCH. Assistant project engineers Raun Robinson and Bud Benner watch captive flight while tuned in on radio with control unit.



***X-15* PILOTS,** present and future, Joe Walker, NASA; AF Capt. Bob White, LCDR Petersen and Scott.



NASA, Air Force and Navy pilots will put *X-15* through paces where NAA's Scott Crossfield leaves off.



Final checkout on suit and machine, ready for takeoff . . .



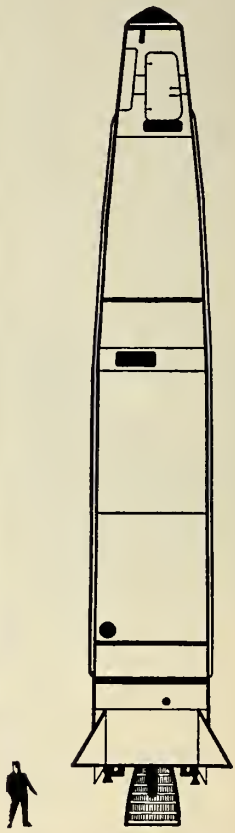
The man:

. . . a launch-control specialist in a *Thor* SAC squadron. His instruments report each automatic step in the launching procedure of the big IRBM. U.S. Air Force and Royal Air Force missilemen are receiving *Thor* training side-by-side . . . have readied and fired these missiles within a 20-minute count-down.



The missions:

. . . are many—because of the Douglas *Thor's* versatility. As a highly mobile weapon with atomic capability, it sternly warns potential enemies against aggression. As a powerful and reliable booster, it is playing a leading role in our exploration of outer space with satellites and probes.



The missile:

. . . can destroy targets as far as 1500 miles away within minutes after hostile action is detected. Douglas *Thor* missiles were the first intermediate range ballistic missiles to be deployed overseas. The United Kingdom has announced the delivery of the first *Thors*, for operation by Royal Air Force personnel.

Depend on **DOUGLAS**

The Nation's Partner in Defense



Simple Solion May Fill Low-Frequency Gap

Very small and lightweight, solion gives high sensitivity, low power input. Here lead wires are welded on integrator.

by Charles D. LaFond

WASHINGTON—The solion, a liquid-state device, is one of the newer additions to the electronic components field providing one more link in the evolution of dynamic circuit elements. Employing ions in solution as a charge carrier, the solion contrasts sharply with vacuum tubes and transistors in which the charges are transported by electrons.

Much research has been devoted to development of solion technology, but the art is still in its infancy with respect to application. So far, the solion has shown some very desirable attributes not now available in either electron tubes or transistors. A rapid summary of some of the virtues of solion units will readily explain why interest is spreading.

• **Strong points**—Solions, for low-frequency use, require low voltage and no power (0.9V dry cell supply and lowest of all devices produced consume 10-15 milliwatts standby). They are highly stable (with some exceptions), long-lived, rugged, light and compact.

They can provide high amplification and circuits free of electrical circuit memory. When they are used as detectors, flows as small as 10^{-5} milliliters/sec. can be indicated and pressures as low as 1 dyne/sq. cm. will get a response.

Finally, they are simple in design, easy to manufacture and uncomplicated in operation.

• **And drawbacks**—Solions also have certain characteristics and limitations that will confine their use. They are restricted to low-frequency applications. They are unique technologically and designers require sound electrochemical knowledge. They are sensitive to temperature change, vibration, and position (these can be anticipated and compensated). Current manufacturing facilities including mass-production machinery are either limited or nonexistent.

• **Description**—The simplest type of solion (the term is generic) is a sealed unit containing two electrodes immersed in an electrolyte—the whole functioning as a diode. Configurations vary with the role. In general, the electrodes are fabricated from platinum or other noble metal. Serving as conductive surfaces only, they are not a part of the electrochemical reaction.

The electrolyte most commonly used is iodine-potassium iodide. It provides a reversible system (redox) wherein there is never a net change in any solution component—only local concentrations vary at the electrodes.

Highly sensitive to low-level stimuli, the solion is most suitable for low-frequency (0-200 cps) applications. Requiring from 0.01 to 0.001 the power required for transistors, research indicates that within its frequency range it may be more efficient than transistors.

Reason for the frequency limitation is the inherently high ratio of the ion mass to that of an electron (in an iodine solution, the ratio is about 233,000:1). On the other hand, since vacuum tubes and transistors are not used at such low frequencies—that is, without burdensome circuitry—the solion fills the gap.

• **History of solion**—The idea of concentration polarization, determined by Nernst in 1904, is a foundation of solion technology. The principle is basic to the consideration of polarography and a primary strut in the theories of electrochemical overvoltage. Basic quantitative theory in these areas has achieved wide dissemination in European technical publications and behind the Iron Curtain.

Dr. D. S. Muzzey, Jr., then of Shell Oil Company, first studied the effects of using an electrode in a solution for acoustic and pressure transducers.

Later studies during World War II at the U.S. Naval Ordnance Laboratory (NOL), Silver Spring, Md., demonstrated the reversibility of an iodine-iodide closed system.

Following proof of feasibility for practical solion units, the Emhart Manufacturing Company of Hartford, Conn., successfully completed a contract for the Navy Bureau of Ordnance to manufacture some small units.

Pioneering in early applications of the solion, National Carbon Company, a division of Union Carbide Corporation, together with Texas Research Associates has been developing a whole line of experimental solion components.

• **Basic principles**—All of the so-called liquid state devices are electrochemical units, and certain common fundamental laws or theories govern the phenomena associated with each. To better understand the function and operation of a solion device, a few of the more dominant concepts should be reviewed.

In a galvanic cell, the voltage measured at the point of zero current flow in an electrode is called reversible potential. Applying an emf with an increasing current to one electrode will eventually cause the measured potential to change from the reversible potential. The amount of this voltage deviation from the reversible potential is the overvoltage; the electrode is considered to be polarized.

Overvoltage is a function of chemical processes at the electrode and can be considered as the result of three different processes: (1) Activation overvoltage is caused by a too-slow chemical reaction; (2) Film overvoltage results from formation of an insoluble film over the electrode surface. Actually the film serves as a resistance in

the circuit and results in a proportional voltage drop; (3) Concentration overvoltage, or concentration polarization, is caused by an electrolytic diffusion rate that is too slow at the surface of the electrode.

In an electrochemical system the rate of diffusion serves as a current limiter since the current flow is proportional to electrode area, salt concentration, and the diffusion coefficient of the cation or anion under consideration. This limit, the diffusion current, is proportional to the concentration of the solution. (Polarography is an analytic technique using this knowledge of specific diffusion currents for different compounds in solution.)

It follows then that to make use of the concentration polarization, the solutions must be affected with an external force in a manner associated with function of the particular solion device; that is, disturb the solution to alter or upset the diffusion layer, or force the flow of different concentrations of solution in juxtaposition about the same electrode.

Finally, two additional phenomena should be discussed. Between a solid surface and a solution there exists a state of electrical imbalance. An "electrical double layer" of ions is distributed along the boundary. Oppositely charged ions are tightly bound to the will move with respect to this surface. The result is a situation similar to a charged parallel plate condenser, although the potential drop perpendicular to the surface is not as sharp as in solid surface, but a few farther away a condenser. The ions in motion have a net charge opposite to that of the fixed ions.

To utilize this phenomenon, capillary tubes can be used to permit a net charge in this second layer significantly high with respect to the rest of the solution. Considering only one tube and providing that electrodes are located at the tube ends, with an applied potential, the fluid will be moved in one direction by a phenomenon known as electro-osmosis.

• **Progress to date**—What has been accomplished so far with solion? Early research at NOL and DRL indicated feasibility of the following: an electrochemical readout integrator, a low-frequency acoustic flow-detector (with logarithmic response and full range of at least 80 db), a micropump, an amplifier (with amplification factor of 300), and product units.

The solion is still considered experimental by the company, which has not yet decided to move to commercial production. High on their list of potentials is their electrical readout integrator. (Samples are available to other companies interested in the present or future use of solions.)

As described by National Carbon Co., the following is a list of anticipated uses for their existing solion components:

• **Solion Electrical Readout Integrator (SERI)**—

(1) Integration of output from tomatic product analyzer to deter necessary input correction.

(2) To sense temperature and duce error signal for correction o put through control circuit.

(3) Very-low-frequency ampl (to dc) for use in control circuits.

(4) Integration of output from vironmental sensors of various for use in routine testing and in term rocket or missile flights.

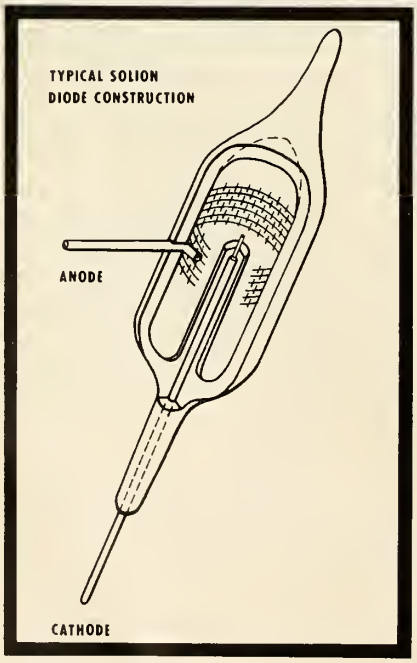
• **Solion Visual Readout Int tor—**

The solion visual readout integ has much larger integral capacity the SERI and the ability to retain integral for several months to an a racy within 5%. This type unit is ently being used to integrate the ou from a microphone in a noise meter.

• **Solion Detectors—**

The solion flow detector prod small electrical currents in respons applied pressure at frequencies bet 0.001 and 200 cps. The functi form of the relation between cu and pressure can be varied over a range by proper electrode config tions. One type of solion detect presently being used experimentall detect low-frequency acoustic signa water. Another type detector is b used in an experimental accelerom

The Emhart Manufacturing Co the first manufacturer for the N has the production know-how for lion fabrication. Company spokes have indicated that it is still too to predict future commercializatio solions.



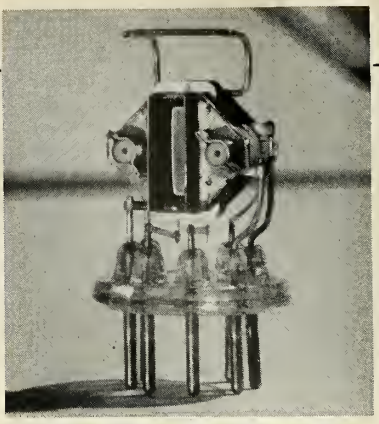
CHARACTERISTICS of solion integrator, left; circuit arrangements employing concept, right.

PROPOSED SOLION CIRCUIT COMPONENTS

DEVICE	FUNCTION	BLOCK DIAGRAM
Diode	Switch, rectifier, clipper	
Pressure Transducer	Converts pressure to voltage—linear function	
Pressure Transducer	Converts pressure to voltage—exponential function	
Osmotic Pressure Transducer	Converts electrical input to pressure output	
Derivative Unit	Converts pressure to voltage—rate function	
Derivative Unit	Output voltage proportional to the derivative of input voltage	
Product Unit	Output voltage proportional to the product of input current and pressure	
Product Unit	Output voltage is proportional to the product of two input currents	
Integrator	Output voltage is proportional to the integral of input current	

Tubes and Transistors: Where Do We Stand?

M/R survey shows that if anyone wins 'battle' it'll be to benefit of entire industry



SYLVANIA's stack tubes combine advantages of glass and ceramic.

by Hal Gettings

WASHINGTON—If anyone wins the le" between tubes and transistors ust be the electronics industry as a e. The development and phenomeprowth of the transistor has served oaden the scope of electronics and nce the state of the art at a faster than ever before. The tube industan thank the transistor for giving kick in its transconductance and ng it make some unprecedented ress of its own.

Tubes have seen many significant ovements made recently. The istor, the ceramic tube, coldode, Sarong, and other innovations served to cut down on many of vacuum tube's shortcomings. Transrs, too, have jumped ahead to new ibilities with the new high-temperagallium-arsenide semiconductors, solid-circuit modules, the erroney-named "molecular electronics," more rigidly controlled production niques.

In spite of the fantastic increase in number of transistor units sold year, the receiving tube has lost ground. Indeed, more tubes are cted to be sold in 1965 than before. The obvious conclusion is the market is expanding at a rate parable to the transistor's growth.

• **Intelligent design**—At the risk of necessarily elaborating on the obs, the only solution to the problem tubes vs. transistors is intelligent ification and design. This seems to he consensus of the industry and rnment representatives, design eners, prime contractors, and conants contacted by M/R editors to lve the problem.

The day may sometime come when engineer can crank all the desired acteristics, application, size, weight, shape of a proposed system into a computer and come up immediately with an answer as to what circuits and components to use.

Until that day, however, this work must be done by man. And for that man to do a satisfactory job on the design he must know and consider many things.

Two facets of this "intelligent" approach seem to have particular merit:

1) All factors must be thoroughly considered before specifying or designing either tubes or transistors into a circuit;

2) Consideration must be given to marriage of the two when advantages can be gained by so doing.

The first point requires that the final decision be made as far down the line as possible. The design engineer who must, in the end, tie the circuit together and make it work, should be given as much freedom as possible in making the choice, subject to other factors in the system or circuit design.

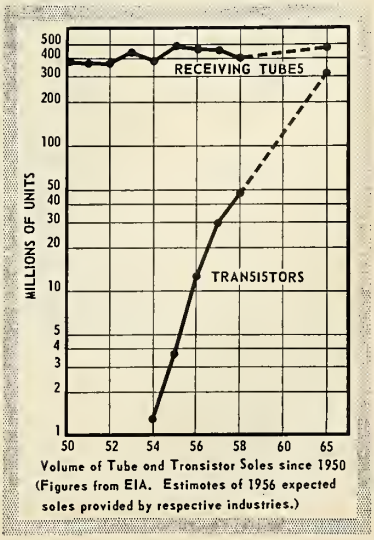
And he, of course, must make his decision based on a thorough study of the problem and the best solution. Ideally, such a man should be entirely objective in his choice; he should have no preconceived notions as to one being better than the other.

• **Hybrid techniques**—Possibly one of the greatest relatively unexplored possibilities is that of using hybrid techniques: designing tube/transistor combinations to take advantage of the best features of each. Some little has been done here—Motorola has a hybrid automobile radio that reportedly is a good basic design—but undoubtedly much more can be accomplished. Such an approach may solve many problems and open up new areas not even considered before.

There are, of course, many applications where nearly everyone agrees that transistors are the answer. Where



GE's solid-state thyratron can switch kilowatts of power in microseconds.



Volume of Tube and Transistor Sales since 1950
(Figures from EIA. Estimates of 1956 expected sales provided by respective industries.)

size and weight and power dissipation requirements are of first importance—and are not overweighed by other factors—then transistors can unquestionably do the job.

They have been proven in computers, battery-powered devices, underwater communication cable amplifiers, dc-dc and dc-ac converters, audio amplifiers, etc., where their obvious advantages make them first choice. Transistors' main selling points—small size, light weight, efficiency—can certainly be used to advantage in today's requirement for things smaller, lighter, and cheaper to build and operate.

Currently, IBM is developing a prototype transistorized SAGE computer under an Air Force contract. This unit will reportedly have seven times the computation capability of the present unit and will be only about 10% its size. Some thought is being given to ultimately transistorizing the entire SAGE installation.

• **Transistorization buys**—In a paper delivered last week at the National Telemetering Conference, Max A. Lowy, Data Control Systems, Inc., made an interesting comparison of identical transistor and vacuum tube 16-band FM/FM telemetry systems.

A condensed summary of his findings are shown in the table. His conclusion is that transistorized systems are more expensive, but this extra money buys reduced volume, reduced weight, better performances, and higher reliability in this particular case.

Other things being equal, the transistor has been and will be the obvious choice between the two for its size, weight, and power advantage. Not ; however, nor in the foreseeable fut can it do everything the tube can It's a mistake to expect it to an greater mistake to try to force it to jobs beyond its capabilities.

Ideally, it would seem that should be able to draw a graph: h are the parameters within which tube is best, here the transistors, ; here either or both. Unfortunately, question is not that simple. Altho frequency, heat, power, radiation, ; any number of other considerati influence the choice between the t the lines cannot be sharply drawn.

Much propaganda has been put by both tube and transistor manu turers. Both are competing for a m ket and their respective claims m be, to a certain extent, subject Consider some of the areas stres by one or the other and see if definite conclusions can be reached

• **Reliability**—So many factors e into considerations of reliability t generalities cannot be easily defi Both tubes and transistors have formed well in rugged applicati where the initial design and packag techniques were good. At the hig temperatures and over wide ranges signal and power levels, tubes defini hold an edge. Under extreme envir ments, transistors are generally c ceded to be better. Especially after initial operating period, transistors sh an exceptional stability over long t periods. Some variation of characte tics has been shown by transistors a relatively long storage.

• **Radiation**—Tube manufactu argue that transistors are inhere much more susceptible to high-ene gamma radiation, and this is t Transistors have been subject to m more radiation testing than tubes, h ever, and more data is available. In dition, the semiconductor makers p out that the tolerance levels of so state devices are as high and someti higher than those of other circuit c ponents and personnel.

• **Noise**—In applications wh noise is an important considerat tubes definitely are the choice. Tran tors have an inherently higher n figure.

• **Size and weight:**—Here the t sistor is indisputably king so long the advantage is not thrown away compensatory or protection circuits.

• **Temperature**—Transistors are more sensitive to temperature variati than tubes and cannot operate at higher temperatures (over 200°) or c wide ranges with reliable stability. P ress is being made in this area, h ever, by such devices as Texas Ins ment's gallium arsenide diode wh operates up to 325°C.

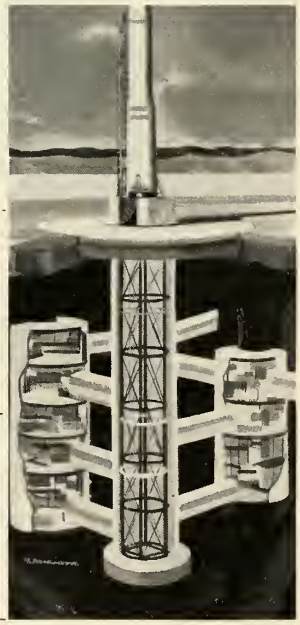
COMPARISON OF IDENTICAL VACUUM TUBE AND TRANSISTOR TELEMETRY SYSTEMS

	Vacuum Tube		Transistor	
	UNIT 1	UNIT 2	UNIT 1	UNIT 2
Total Battery Power (watts)	81	155	10	4.5
Total Volume (cu. in.)	208	375	103	197
Total Weight (lbs.) (incl. battery)	21	29	8	13
Total cost of system (less mtg. base & battery box)	$4315	$6610	$9710	$7805

1939
Ets-Hokin and Galvan installed "Mousetrap" rocket launchers on U.S. Navy sub-chasers.

1956
EHG pioneered in the installation of electronic systems of test and launching complexes for Intercontinental Ballistic Missiles.

1959
EHG has now installed or serviced the electrical and electronic phases on most of the ICBM complexes in the United States.



Installation Specialists to the Space Age

I INSTRUMENTATION WIRING
C COMPLETE INSTALLATION
B BASE COMMUNICATION SYSTEMS
M MISSILE GROUND SUPPORT SYSTEMS

EHG
ETS-HOKIN & GALVAN
551 Mission Street, San Francisco, California
Wilmington, San Diego, Stockton, Monterey, Oakland, Sacramento, Vandenberg AFB, San Mateo and Downey, California; Cape Canaveral, Florida; Denver, Colorado; Phoenix, Arizona; Cheyenne, Wyoming; Las Vegas, Nevada.

• **Impedance**—Low-impedance cir-ts definitely favor transistors. High edance (over 200 ohm) requires es. A wide range of both input and put impedance is available with es.

• **Frequency**—Transistors are gen-ly suitable only at the lower fre-ncies. With careful selection and, in e cases, compensation, satisfactory formance may be obtained even up 300 mc. Generally speaking, of rse, power is universely proportional requency.

• **Power dissipation**—The transistor ere, again, the acknowledged leader. ecially in huge computer installa-s, where the cooling load is tremen-s and a cooling equipment break-n could be critical, transistorization rs many advantages. It must be re-nbered, however, that transistor cir-ry must sometimes also be temper-e-regulated and that it is much e sensitive to even relatively slight ations.

• **Voltage**—Tubes are definitely the ice where higher voltages (over v) are used and where the circuit is ect to surges and transients. Where sistors are used under adverse con-ns, some of their advantages must sacrificed for protection of the ipment.

• **Uniformity**—Tubes justly claim ormity and interchangeability as of their significant advantages. nsistor manufacturers admit that ormity of characteristics is hard to ntain. For critical applications, users forced to reject from one-tenth to half of production-run lots. Even elected groups, a 2 to 1 spread in is not unusual.

• **Power**—At the lower frequencies nc and down) tubes and transistors considered about equal. Tubes are e suitable at the higher power rat-. Power transistors sacrifice some antage with cooling measures.

There are perhaps just as many, or e, "tube" men as there are "tran-r" men. The rapid progress of elec-ics leaves no room for engineers or specification writers with prej-es and preconceived notions who there is only one way—theirs—to a job. The industry feels it can't d specifications calling for transis-ing at any price; neither can it d obsolete designs that use tubes because they were good enough last .

The strongest conclusion that can drawn from these "facts" is that ner tubes nor transistors can claim significant overall advantage over other—which goes back to the or-al statement that an intelligent de-n as to which to use must be based ntelligent appraisal of all the factors.

people

Louis N. Ridenour, Jr., vice president and general manager of Lockheed Aircraft Corp.'s Electronics and Avionics Division, died suddenly here last week. Death was from natural causes. He was 47 years old.

Dr. Ridenour had some to Washington to act as chairman of the National Aeronautics and Space Administration's Science Advisory Committee on Navigation, Guidance and Electronics. He presided at the two-day organization meeting.



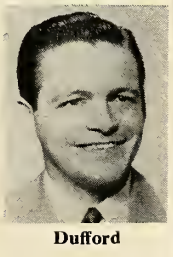
Ridenour

Internationally known for his work in both nuclear physics and electronics, Ridenour was a member of the Air Force's Scientific Advisory Board, heading up the electronics panel. He was first chief scientist of the AF. In 1950-1951, he headed a special committee which surveyed the AF's science and research effort. The report which bears his name was considered responsible for creation of the Air Research & Development Command and the organization of the deputy chief of staff (development). The report is also considered the basis for current attempts to revitalize ARDC.

During World War II, as assistant director of the Radiation Laboratory at Massachusetts Institute of Technology, he was instrumental in development of airborne radar and radar bombing systems. For this work, he received the President's Medal of Merit.

Ridenour was the author of a number of scientific books, as well as many technical and non-technical papers. He was a member of the American Physical Society, the American Association for the Advancement of Science, the Institute of Radio Engineers and the American Rocket Society.

Donald E. Dufford has been named head of applications engineering at Genesys Corp., manufacturers of digital process control computer systems. Dufford earlier was associated with Autonetics, Marquardt Aircraft, and previously the Telecomputing Corp.

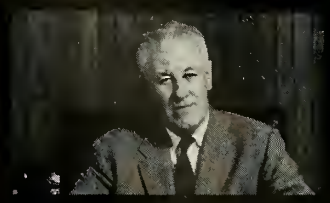


Dufford

To meet numerous requests from readers, M/R has made available reprints of the recent series of articles by Dr. S. Fred Singer on the meaning of Project Argus. Copies of the combined series may be obtained by writing to the magazine. The rate is 50¢ for a single order (bulk rates on request).

A Personal Invitation to

ENGINEERS



from ROBERT McCULLOCH

President

"If you would like to be a member of a select corps of Engineers, working for an interesting, growing company . . in one of the country's most stimulating areas . . I invite you to write to Temco. Temco's growth is sound and planned, its products are diversified and challenging, our facilities are modern. Every benefit, for you professionally and in good living for you and your family, is here. Below are some of the areas in which jobs are open now."

INSTRUMENTATION

Graduate Electronics Engineer or Physicist to perform analysis and design of instrumentation, telemetering, and other data-gathering components for use in missile and electronic system test programs. Individual will develop the instrumentation system concept, make decisions on the most practicable types, application, and arrangement of equipment, and perform actual design of components, circuits, and linking of the entire system.

AUTOMATIC CONTROLS

Graduate Electronics, Mechanical, Aeronautical Engineer, or Mathematician or Physicist to perform analysis and design of automatic flight control equipment and corresponding missile stabilization mechanisms. Individual will be responsible for analyzing the performance characteristics of particular configurations and developing motion-sensitive electronic apparatus and servo-mechanisms to provide the necessary control-surface corrections and make guided or directed flight possible.

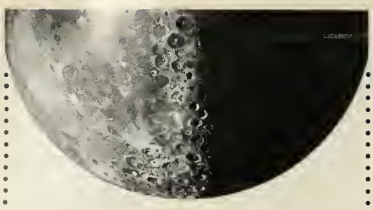
Write BILL G. HICKEY

Supervisor Technical Employment

Room 406M, P. O. Box 6191

TEMCO

AIRCRAFT CORPORATION • DALLAS 22, TEXAS



Help us solve
the problems of

ION PROPULSION

Our Advanced Design Group is seeking engineers and scientists to work on low-thrust propulsion systems that will make possible the manned exploration of Outer Space. These are a few of the challenging positions:

Theoretical Physicist

Experienced in the field of particle physics, magneto-hydrodynamics and plasma physics, comparative performance of electrical propulsion systems, new methods of developing thrust from electrical propulsion systems, and direct conversion processes.

Chemical Physicists

To make studies on propellants for ion propulsion. Experienced in electronics, atomic physics, and physical chemistry.

Physicists

Primary activities will be in the field of ion sources and high vacuum techniques. Experienced in particle accelerators, ion sources, and electronics.

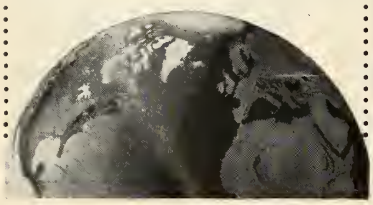
Electrical Engineer

Analysis of electrical power generators, preliminary stages designs of permanent magnet, AC induction and electrostatic generators.

Please write: Mr. D. F. Jamieson, Engineering Personnel Dept., 6633 Canoga Avenue, Canoga Park, Calif.

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.
FIRST WITH POWER FOR OUTER SPACE



contract awards

NAVY

$11,000,000—**Remington Rand Univac, Div. of Sperry Rand Corp.,** for an advanced computer to be used aboard ship.

$800,000—**FXR, Inc.** Woodside, N.Y., for high-voltage supply for classified AN/SPG-55A shipboard radar set (subcontract from **Sperry Gyroscope Co.**).

$500,000—**Gladding, McBean & Co.,** Los Angeles, for production of ceramic radomes (contract awarded by **Raytheon Mfg. Co.**).

$292,431—**Loewy-Hydropress Div. of Baldwin-Lima-Hamilton Corp.,** New York, for services, labor and material to fabricate and test one complete warhead handling system, prototype for *Talos*.

$136,544—**McKittrick Construction Co.,** Huntington Park, Calif., for construction of technical services engineering facility at Point Mugu.

$64,560—**Hazeltine Corp., Electronics Div.,** Little Neck, L. I., N.Y., for 48 man months of field engineering services in the installation and operation of APA-127 and ASA-23 missile launching accessories in F3H-2 aircraft.

ARMY

$1,038,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for secret item for ARPA.

$977,941—**Cubic Corp.,** San Diego, for research and development for electronic measuring system.

$881,599—**Douglas Aircraft Co.,** for *Nike-Hercules* components, *Nike* repair parts and classified material (three contracts).

$513,248—**Ryan Aeronautical Co.,** San Diego, for research and development for target missile.

$455,237—**Western Electric Co., Inc.,** New York, for *Nike* spare parts and components, (three contracts).

$200,000—**California Institute of Technology,** Pasadena, for research and development to be performed at the Jet Propulsion Laboratory.

$173,238—**Rheem Manufacturing Co.,** Downey, Calif., for design and development work.

$164,703—**Bridgeport Brass Co.,** Riverside, Calif., for inside tube remover.

$125,000—**North American Aviation, Inc., Rocketdyne Div.,** Canoga Park, Calif., for missile spare parts.

$86,900—**Wiancko Engineering Co.,** Pasadena, for data systems components.

$85,809—**Wiancko Engineering Co.,** Pasadena, for eighteen items of oscillators, linearity controls and pressure pickups.

$75,470—**Allegany Instrument Co., Inc.,** Cumberland, Md., for multi-component static test stand.

$73,850—**The Firestone Tire & Rubber Co.,** for engineering services.

$71,174—**Gilfillan Brothers, Inc.,** Los Angeles, for engineering services and *Corporal* missile spare parts (two contracts).

$70,000—**Polytechnic Institute of Brooklyn,** for basic research on performance comparison of various system satellite re-entry.

$59,882—**Dow Chemical Co.,** Tulsa development of procedure for c ing *Jupiter* suction lines and tank

$51,565—**Consolidated Electrodyna Corp.,** Atlanta, for nine items of vanometers, CEC type.

$46,060—**Aerojet-General Corpor** Azusa, Calif., for study-process o hesive bonding.

$44,172—**Preshaw and Thompson,** Van Nuys, Calif., for spare parts.

AIR FORCE

$3,000,000—**International Business chines Corp., Military Products** for components of the AN/A bomb navigational system used o B-52G.

$2,500,000—**Melpar, Inc.,** Falls Ch Va., for flight simulators and re equipment.

$1,742,500—**General Electric Co.,** J son City, N.Y., for component automatic flight control systems the F-105D and the F-105E.

$470,000—**Curtiss-Wright Corp.,** S Barbara, Calif., for aerial t drones, launch rail adapters and equipment of the *GAR-8* missile.

$391,000—**Consolidated Systems C subsidiary of Consolidated Electr namics Corp.,** for propellant-uti tion-system exercisers to be use *Atlas* program at Vandenberg (subcontracts from RCA).

$233,099—**Block Associates, Inc.,** C bridge, Mass., for research dire toward the design, development testing of small rocketborne spe radiometer systems.

$233,000—**Leeds & Northrup Co.,** P delphia, for precision potentiom and accessories.

$215,000—**Gladding, McBean &** Los Angeles, for further research development on ceramic radome

$196,706—**Convair Div. of General namics Corp.,** San Diego, for pr PR 59-1131, SA #7. This is an crease in funds.

$76,631—**J. W. Frecker, Inc.,** Pittsbu for equatorial table to be use support of project 5177.

$76,253—**Consolidated Controls C** Bethel, Conn., for miscellan switch-pressure consolidated contr

$63,000—**Kuthe Labs., Inc.,** Newark, N for electron tubes.

$53,669—**Olin Mathieson Chemical C Chemicals Div.,** Baltimore, for n tethyl hydrazine for testing and ev ation in support of Weapon Sys 138A.

$53,667—**Tektronix, Inc.,** Portland, O for miscellaneous oscilloscopes, amplifiers, tubes and standard spa

$51,525—**Westinghouse Electric Corp.,** mira, N.Y., for miscellaneous elec tubes.

$40,243—**Grand Central Rocket Co.,** lands, Calif., for rocket motors t used in support of Project 7850.

The Marquardt Corporation's AST Div. has been awarded a prime cont for expansion of its efforts on Pr *Pluto*. (Amount not disclosed).

opulsion engineering

Vary the thrust to get optimum performance from a nuclear ket, say C. J. Wang, G. W. Anthony and H. R. Lawrence of Space nology Laboratories in the current (May) *ARS Journal*. They the thrust should be variable, and programmed, to take advant- of partial molecular dissociation and then recombination of gase- propellants. Dissociation drastically increases specific heat which gives an I_{sp} greater than normally expected by using the square- -of-temperature law.

There is "an optimum way of programming the thrust to fulfill articular mission" of a nuclear rocket, the Space Technology a says. Dissociation characteristics of gaseous propellants now idered potential nuclear rocket propellants are such that this ossible: At a given temperature, decrease the operating pressure, consequently the thrust, and you will increase the specific impulse.

'Energy communicated to the rocket at burnout of the total gy injected into the rocket system" is a maximum under their d theory. Wang, Anthony and Lawrence discuss a case where ciation of the gaseous propellant was taken into consideration, a program of varying thrust was designed. Their conclusion: e optimum thrust program results in much better performance the usual constant thrust operation."

Another unconventional propellant situation is analyzed in detail he same *ARS Journal*. A team formerly with Food Machinery Chemical outlines all the important physical properties for the gen tetroxide-nitric oxide system from minus 100°F to 0°F. This ne of the systems most highly touted to become an important izer in prepackaged, storable liquid engines. Presented for the time: Vapor pressure, density, viscosity, surface tension. To e the data more valuable to designers of rockets and equipment, as taken on *commercial grades* of the mixed oxides. For workers want it, Donat B. Brice, now with The Fluor Corp., and man Fishman, now at Stanford Research Institute, include de- d drawings of their apparatus.

Trapped free radicals will give up all their secrets, or at least National Bureau of Standards will make every effort to force them at the Fourth International Symposium on Free Radical Stabili- on late this summer. Theme of the meeting, to be held Aug. Sept. 2 at NBS in Washington, is "Trapped Radicals at Low Tem- atures." Deadline for preregistration forms was March 25, however . 1 is the deadline for getting a short communication into the ussion part of the program. Nature of these brief reports should ent to Dr. A. M. Bass, National Bureau of Standards, Wash- n 25, D.C. So far, the program includes tours of NBS labora- s participating in the free radical work, and these discussion cs: Low-Temperature Chemistry, Method of Production of pped Radicals and Physical Properties of Radical-Trapping Solids, tity and Concentrations of Trapped Radicals, Future Trends in e Radical Stabilization, Interaction of Free Radicals with Solids.

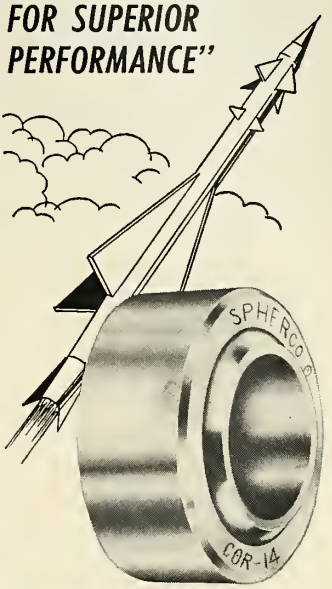
Shape of refractory plugs influences their durability, a Russian ker notes. Not a surprising conclusion, but I. Sh. Shvartsman ls this out in detail in *Ogneupory*, Vol. 22, No. 4. He says longi- nal cracks develop in screw plugs with thick-walled spherical parts. s does not happen in the case of bolt plugs with thinner, lighter erical parts, he reports.

Low-cost corrosion inhibitor for refrigeration and cooling systems be sodium molybdate, now that the price barrier has been crashed research. Sodium molybdate always has been an excellent— expensive—corrosion inhibitor in these systems. Climax Molyb- um chemists now say it can be mixed with very small amounts orthophosphate to achieve full inhibiting action. Result: A ller amount goes a longer way.

SPHERCO®

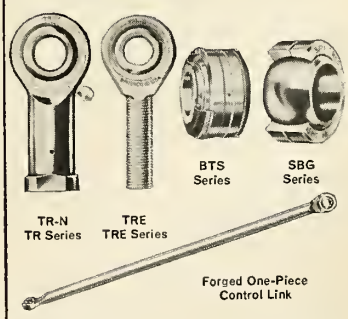
SPHERICAL BEARINGS & ROD ENDS

"PRECISION BUILT FOR SUPERIOR PERFORMANCE"



FEATURING...

- Quality engineered and produced
- Solid inserts
- Swage staking of 3-piece rod end
- Wide range of metals for races



WRITE FOR BULLETIN 257

SPHERCO

A PRODUCT OF SEALMASTER BEARING DIVISION STEPHENS-ADAMSON MFG. CO.

25 RIDGEWAY AVE. • AURORA, ILL.

letters

Optik Goes to London

To the Editor:

I have read with much interest in the April 27 issue of M/R the proposal for standardization of velocity terms in astronautics and the suggestion of "Optik" put forward by Major Mannix.

This is to advise you that at the IAF Congress to be held in London in September this year, I will raise this important question.

Meanwhile, I have prepared a memorandum which I intend to discuss with Mr. (Andrew G.) Haley, President of IAF, at the end of this month, when he will be in Rome.

Glauco Partel
President
Terminology and Classification
Committee
IAF
Rome, Italy

Praise for Optik

To the Editor:

Cheers for Major William C. Mannix on his new proposal for a space velocity unit in the April 27 issue! Already the aerodynamicists have almost captured the field with their thoroughly incongruous unit of "Mach Number" based on the velocity of sound in air. This term obviously has no meaning in free space and worst of all is utterly dependent on the temperature of the medium. While its use is admittedly of value in aerodynamic problems, it is practically worthless in kinematic analyses or ballistic problems.

We should act quickly and energetically to adopt a unit of absolute velocity to alleviate somewhat the hopeless situation which has developed in English-speaking countries in regard to dimensional units.

For example, engineers use a horrible conglomeration of units, horsepower, slugs, foot-pounds, pounds-force, pounds-mass, BTUs, cu. yards, rods, miles, yards, acres, sq. mi., knots, kilowatts, gals. (both U.S. and British), feet/sec., m.p.h., Mach No., tons (short and long), barrels, fathoms, bushels, etc., ad infinitum, ad nauseum.

The wonder is that British and U.S. engineers have ever been able to develop anything with such a hodge-podge of units. How many hours are wasted in tedious conversions?

Scientists generally use the metric system although even here the physicist uses the centimeter-gram-second system while the meteorologist uses the meter-kilogram-second system. There are other variations in use. Perhaps the engineers and the scientists would work more closely together if their systems of units were made more nearly uniform.

Take the matter of charts used for navigation and aerial flight. Long distances are usually in nautical miles, short distances in yards, heights in feet, and depths in fathoms. The units now employed for velocity are as numerous as there are combinations of units for length and time.

The unit of "Optik" proposed by Major Mannix fulfills the requirements suggested by Messrs. A. Hurlick and E. B. Bell at the Second Symposium on Hypervelocity Impact Effects in 1957. It is referenced to a natural phenomenon and one as nearly absolute in a quantitative sense as is possible. Furthermore, the subdivision of making the basic unit one-millionth of the velocity of light permits the statement of all velocities in convenient quantities.

The name itself, "Optik," is a natural. Since the world is becoming smaller and people closer together, because of the increase in velocity of travel, the word should be one easily recognizable in all languages.

Certainly the final "k" is a small concession to be ask of English-speaking peoples. Names such as "Roemer" should be avoided. This name is at home only in German-speaking countries. With all due respect, the choice of "Roentgen" for a unit of ionizing effect of high-energy radiation is unfortunate because of the difficulty of pronunciation by non-German-speaking peoples. In sum, the name "Optik" not only denotes its origin, but should be easily transcribed and pronounced in any language on earth.

I vote loudly for the adoption of the term and its definition by all engineering and scientific professions.

John O. F. Dorsett,
Captain, USN (Ret.),
Johns Hopkins University,
Operation Research Office

'Furlong per Fortnight'

To the Editor:

In response to the recent proposal by Major William C. Mannix (M/R, April 27), concerning a unit of velocity, I suggest that we bestir ourselves now, while on the threshold of the Space Age, and adopt a different unit for velocity. It is the "furlong per fortnight." Although the unit appears to be somewhat illogical, I believe it will satisfy our need for having the largest of everything (somewhat lacking in satellites of late).

Thus, our satellites will be reported as having an orbital velocity of 47,000,000 furlongs per fortnight as compared to the insignificant 18,000 mph.

John R. Osborn
1409 Center Street
Lafayette, Ind.

'Back to Newton'?

To the Editor:

In connection with the April 27 c
(Dr. Edward Teller proposes test of
stein Theory), it would be quite a
able, for everyone who likes to i
tigate so-called "relativistic theories,"
to study quite carefully the book of
Georges de Bothezat, "Back to New
(available in libraries).

Prof. Bothezat, formerly of Princ
University, a great scientist, mathe
tician, author of many books and
ventor, may give *the proper directio*
evaluating the *fallacies* of relativity th

Victor A. Ivanoff,
Research Engineer
524 E. 5th Street
New York 9, N.Y.

Lunar Bases

To the Editor:

I have just read the April 20
of M/R and note on page 48 a refer
to articles written by Dr. Castrucci
the "strategic advantages of lunar b
and on lunar power supplies using
energy. I am very much interested
obtaining copies of these articles
would appreciate any information
could offer as to how I might o
copies and/or references to where
articles appeared.

L. Reiffel
Director of Physics Resear
Armour Research Foundat
Illinois Institute of Techn
Chicago

Stock Slip

To the Editor:

In your May 25 issue, part o
article on missile financing said th
firm obtaining equity capital from
SBIC is required "to buy stock in
SBIC up to 2 per cent of the loa
$50,000, whichever is less."

The law reads that a borrowing
pany must purchase stock in the
from 2 to 5 per cent, depending
the amount of capital it borrows.
SBIC not using Government funds f
financing may issue such stock wi
repurchase option for the borrowe

I hope you will include a corre
of this error in a subsequent issue, c
wise missile firms might be under
apprehension as to Small Business
ministration financial policies and
lations.

Arthur Hachten
Director
Office of Information
Small Business Administra

viet affairs

by Dr. Albert Parry

In what patents can we find descriptions of fuels needed in ketry? Who in the world is making a carburetor for a certain fuel? What metal alloy is necessary for this or that machine that the machine or a vital part of it would work well under n conditions? Man should be able to get quick and complete wers to such questions by just telephoning a central office where ecial machine would have the solutions to all the problems which e been solved anywhere on earth. The need for such an "inform- n machine," to be built on the latest findings and inventions in tronics, is discussed at length in *Izvestia* by Professor L. enmakher.

He points out that the limit of human absorption can be reached a man if he reads 12 hours a day for 50 years at the speed of words per second, finally totaling 18,000 books of 300 pages n. Yet the already-accumulated printed works of mankind are e than 50 million titles. Patents registered in all the world's ntries exceed 5 million. The world's annual output of books and nals is nearly 200,000 titles. Scientific, engineering and technical rmation on hand is growing at a terrific rate, thanks to the in- ant work of the world's 500,000 scientists and many millions engineers and technicians.

The world's treasury of all this information is "more valuable n any reserves of gold, diamonds, or uranium," the Soviet pro- or declares. The problem of its proper utilization is far more plex than any problem of ore mining, he continues. Scientists adays know more and more about their steadily narrowing cialties, and "the ever-expanding terminology of these narrow ls separates experts of adjacent fields even more than any such sion can be caused by foreign languages."

The Soviet scientist proposes that in the future whatever gets ted be simultaneously processed electronically into capsules for new information machine. The Soviets must lead the world once e, by being first to build this information machine, the Russian fessor insists. He writes: "If the creation of ordinary writing and invention of the printing press served as the foundation of contemporary civilization, then the future invention of what may called machine writing will be characteristic of the epoch of mmunism."

Steps necessary for the creation of such a machine were dis- sed recently at a nationwide Soviet conference on problems of chine linguistics, attended by Russia's outstanding specialists in tronics, mathematics and languages. Present also were a few ntists from Red China and Czechoslovakia who read reports on chine linguistics in their countries. In giving details of this con- nce, L. Voronkova in the Moscow *Trud* makes it clear that ingrad was chosen as the site of the conference because that is fast becoming the Red empire's foremost center of such erimentation. She claims that the world's first subdivision of thematical linguistics and experimental laboratory of machine nslation were established at the Philology Department of the Uni- sity of Leningrad.

The laboratory is now working to evolve 17 systems which the ssians define as "alogorhythms," and among which the Soviet ntists have already included the Indonesian, Burmese, Arabic l other Oriental languages. The inclusion of these and other tern tongues for machine translation and "information machine" erimentation shows Moscow's conviction that the time is not far when scientists of the Orient will increasingly contribute to the rld's storehouse of modern knowledge.

NEW PROGRAMS

have created

IMMEDIATE OPENINGS

for top quality engineers with experience in—

Preliminary Analysis
Aerodynamics
Flight Dynamics
Structural Dynamics
Aero-Thermodynamics
Flight Simulation
Space Communication
Space Instrumentation
Radar Systems & Techniques
Electronic Countermeasures
Guidance
Instrumentation
Electronics Test
Design
Computing
Reliability
Human Factors

Well paid jobs for qualified people.
Relocating expenses paid.
For information on these and other engineering positions, write:

B. J. Ralph, Dept. 451 M
Missile Division
North American Aviation, Inc.
12214 Lakewood Blvd.
Downey, California

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.

Immediate openings for

STRUCTURES ENGINEERS

STRESS ANALYSTS

PLANNING ENGINEERS

Degree plus 2 to 10 years experience desirable.

Select assignments now for qualified men to work on advanced programs at Vought.

Send confidential resume to:

J. W. LARSON,
Assistant Chief Engineer
Administrative

Room 518 **P. O. Box 5907**

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

Now Available

NUCLEAR EXPLOSIONS IN SPACE

by Prof. S. Fred Singer

the story behind
Project ARGUS

Reprints of this exclusive M/R report are now available due to repeated requests.

A series of four illustrated articles combined, this important M/R special contains scientific explanations of:

* **project ARGUS**
* **creation of an artificial particle belt**
* **effect on manned space vehicles and nuclear warheads**
* **effects on radar and long-range communications**
* **scientific techniques for detecting such explosions**

50 cents per copy
(bulk rates on request from publisher)

missiles and rockets
1001 Vermont Ave., N.W.
Washington, D.C.

west coast industry

by Fred S. Hunter

In this initial-conscious age, Lockheed hopes its selection of name for the new Lockheed Electronics and Avionics Divis (LEAD) turns out to be prophetic. It may well be.

At the annual meeting of shareholders, Chairman Robert E. Gr said Lockheed was starting the new electronics enterprise with modest capital outlay. It is spending approximately $400,000 in furbishing the former Constellation subassembly plant in southe Los Angeles for a headquarters and manufacturing facility. Lockhe already owned the property.

Gross also said the division will grow "slowly and soundly." this writing, the payroll numbers 27 persons. The employment p jection is for 450 by the end of this year.

In its first year, Lockheed's Missile Systems Division had sa of $7.2 million, but, barring a windfall, LEAD's first-year revent will be substantially less. In 1954, the new missile division, th located wholly at Van Nuys, was given a head start by the trans of the *X-7* test vehicle program from the California division. LEA is starting from scratch, with no diversions from other divisions, a its primary objective right now is to establish its capabilities.

Initially, Lockheed is preparing 163,000 square feet of a to plant area of approximately 380,000 square feet for occupancy the new electronics division. New walls have been installed to sl off engineering, manufacturing, shipping and receiving and oth areas. "They're moveable—we can expand in any direction," s Russell C. Galbraith, the former director of financial operatic for the California division, who came over to fill the No. 2 execut post as assistant general manager of LEAD.

The plant—first occupied temporarily during World War II the production of P-38 assemblies and then, after a lapse of 10 yea purchased in 1955 to expedite Super Constellation subassembly wo —is to be a permanent manufacturing facility for LEAD. H quarters here for the general office and engineering staffs will temporary. Lockheed has its eye on a site in the Newport Bea area, where it plans a new facility specially designed to house t administrative and engineering staffs.

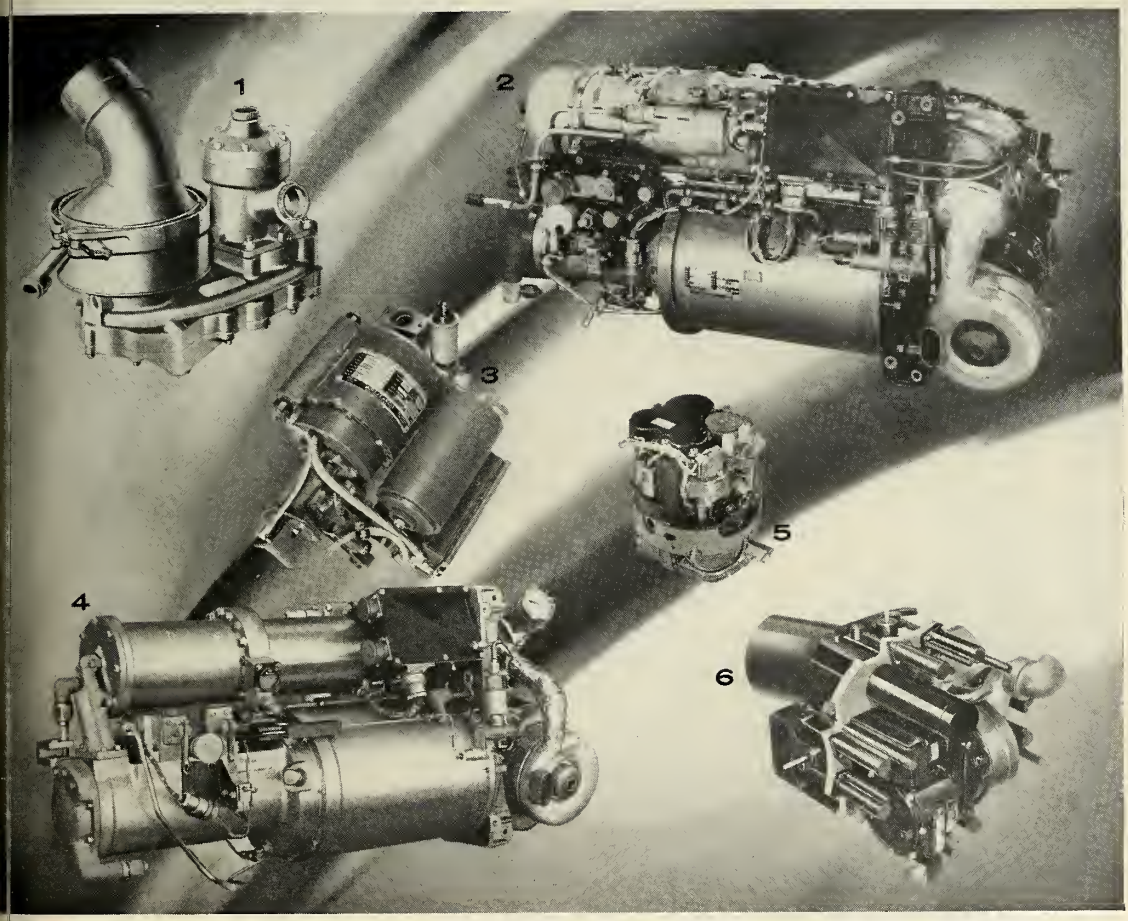
Lockheed is in the hardware business in all its divisions a LEAD will be no exception. This means it will be striving for co petence in the production of systems. Its first efforts will be in strumentation and subsystems useful principally for military systen but it will also investigate the possibilities of entering industrial a commercial markets. "We have no aspirations in the consumer fiel said Stephen J. Jatras, acting director of marketing.

Lockheed has started on the job of staffing the new divisi across the board—engineering, manufacturing, administrative. "W must have men who stand at the top of their fields," said K. Kiddoo, who worked on personnel procurement for Lockheed wh it established its missile division and is now doing the same thi for the new electronics division.

Some of the key jobs will be filled by people drawn from oth divisions of the company, but others will come from outside. "It w depend upon where we find the capabilities we require," said Howa S. Hagen, director of industrial relations.

By June 15, Lockheed expects to have procured a number of t people it needs. By the same time, it will be ready to start movi in some of its machines. It will then be in a position to step to the production development stage.

DELIVERED—thousands of missile APUs



olid propellant—hydraulic output **2.** *Liquid propellant—hydraulic and electric output* **3.** *Solid propellant—electric and mechanical drive output*
4. *Liquid propellant—hydraulic and electric output* **5.** *Solid propellant—hydraulic and electric output*
6. *Solid propellant—hydraulic, electric and steering outputs*

Research has designed, developed, nufactured and delivered thousands o missile accessory power units. Ex- mely reliable and lightweight, these rious solid and liquid monopropel- t APUs are completely self-sustain- within the missile system. Designed minimum space and weight require- nts, they are built to withstand high loading and severe temperature e remes.

The several units pictured above provide hydraulic, electrical and/or steering surface control depending on the customer's requirement. Delivered horsepower ranges from 1.2 to 35 h.p. over hot gas operating durations from 30 seconds to 20 minutes. Electrical regulation is maintained as closely as ±½%. A significant advance in missile APUs is unit #6 pictured above. This package represents the first integrated hydraulic and electrical power unit providing a steering surface actuation system.

These tailored systems utilize the extensive hardware experience and complete laboratory, test and production facilities of AiResearch needed for quick and efficient quantity production of complex APU systems. AiResearch is the world's largest and most experienced manufacturer of lightweight turbomachinery—the key component of its APU systems. Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

when and where

JUNE

Institute of Radio Engineers' Professional Group on Microwave Theory & Techniques, National Symposium, Harvard University Cambridge, Mass., June 1-3.

Armed Forces Communications and Electronics Association, 13th National Convention, Sheraton Park Hotel, Washington, D.C., June 3-5.

Institute of Radio Engineers' Professional Group on Production Techniques, Third National Conference, Villa Hotel, San Mateo, Calif., June 4-5.

The Pennsylvania State University's Missiles System Engineering Seminar, University Park, June 7-13.

Aero Club of Michigan, Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, June 8-9.

American Rocket Society, Semiannual Meeting, El Cortez Hotel, San Diego, June 8-11.

American Society of Mechanical Engineers, Semiannual Meeting, Chase-Park Plaza Hotel, St. Louis, June 14-18.

United Nations Educational, Scientific and Cultural Organization, UNESCO House, Paris, June 15-20.

Michigan Aeronautics and Space Association, Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, June 16-17.

Cornell University Industry Engineering Seminars, Cornell University, Ithaca, N.Y., June 16-19.

Institute of the Aeronautical Sciences, National Summer Meeting, Ambassador Hotel, Los Angeles, June 16-19.

Institute for Practical Research on Operations, The University of Connecticut, Storrs, June 21-July 3.

American Institute of Electrical Engineers, Air Transportation Conference, Olympic Hotel, Seattle, June 24-26.

Nuclear Industry Division, Instrument Society of America, Second National Symposium, Idaho Falls, Idaho, June 24-26.

Institute of Radio Engineers' Professional Group on Military Electronics, Third National Convention on Military Electronics, Sheraton Park Hotel, Washington, D.C., June 29-July 1.

Pennsylvania State University, Summer Seminar on Plastics—Its Mechanical Properties, Design and Applications, University Park, June 29-July 3.

JULY

Tenth Annual Basic Statistical Quality Institute, University of Connecticut, Storrs, July 12-24.

Radio Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Third Biennial Joint Meeting, Ambassador Hotel, Los Angeles, July 16-17.

Second Annual Institute on Missile Technology, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 26-Aug. 7.

The Denver Research Institute of the University of Denver, 6th Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 30-31.

AUGUST

Institute of Investigation of Biological Sciences, sponsored by Air Force Office of Scientific Research-Aeromedical Div., World Health Organization and United Nations Educational, Scientific and Cultural Organization, Montevideo, Uruguay, Aug. 2-7.

William Frederick Durand Centennial Conference, Problems of Hypersonic and Space Flight, Stanford University, Stanford, Calif., Aug. 5-7.

Institute of Radio Engineers, Western Electronic Show & Convention, Cow Palace, San Francisco, Aug. 18-21.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

Advertisers' Index

Aerojet-General Corp., Sub.-General Tire & Rubber Co. .....
Agency—D'Arcy Adv. Co.
AiResearch Mfg. Co., Div.-The Garrett Corp. 4
Agency—J. Walter Thompson Co.
Avco Corp. 1
Agency—Benton & Bowles, Inc.
Bendix Aviation Corp., Bendix Products Div. .....
Agency—MacManus, John & Adams, Inc.
Douglas Aircraft Co., Inc. .....
Agency—J. Walter Thompson Co.
Ets-Hokin and Galvan .....
B. F. Goodrich Co., The, Sponge Products Div. .....
Agency—Cunningham & Walsh, Inc.
Jet Propulsion Laboratory, California Institute of Technology .....
Agency—Stebbins & Cochran
Walter Kidde & Co., Aviation Div. ..
Agency—Cunningham & Walsh, Inc.
Ling Electronics, Inc. .....
Agency—John Ramsey Co., Adv.
Lockheed Aircraft Corp., California Div. .....
Agency—Hal Stebbins, Inc.
Lockheed Aircraft Corp. 6,
Agency—Foote, Cone & Belding
Melpar, Inc. 26,
Agency—Larrabee Associates Adv.
North American Aviation, Inc., Missile Development Div. .....
Rocketdyne Div. .....
Agency—Batten, Barton, Durstine & Osbor Inc.
Northrop Corp. .....
Agency—Erwin Wasey, Ruthrauff & Ryan, In
Poly-Scientific Corp. .....
Agency—Houck & Co., Inc.
Servomechanisms, Inc. .....
Agency—Hixson & Jorgensen, Inc.
Stephens-Adamson Mfg. Co., Spherco Bearings & Rod Ends Div. .....
Agency—Connor Associates, Inc.
Temco Aircraft Corp. .....
Agency—Rogers & Smith Adv. Agents.
United Air Lines .....
Agency—N. W. Ayer & Son, Inc.

EMPLOYMENT SECTION

Chance Vought Aircraft, Inc. .....
Agency—Tracy-Locke Co., Inc.

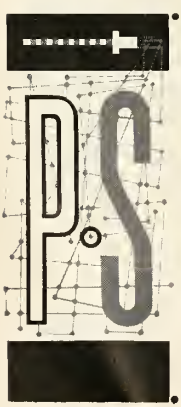
CLASSIFIED

AN FITTINGS & HARDWARE

Stainless, Aluminum, Brass, Steel. All sizes immediate delivery from world's largest shelf stoc Buy direct from manufacturer. Lower prices Quicker service. Send for free wall charts showi complete line of AN & MS fittings and hardwa We also machine parts to your own special pri

COLLINS ENGINEERING CORPORATIO

9050 Washington Blvd., Culver City, Californ

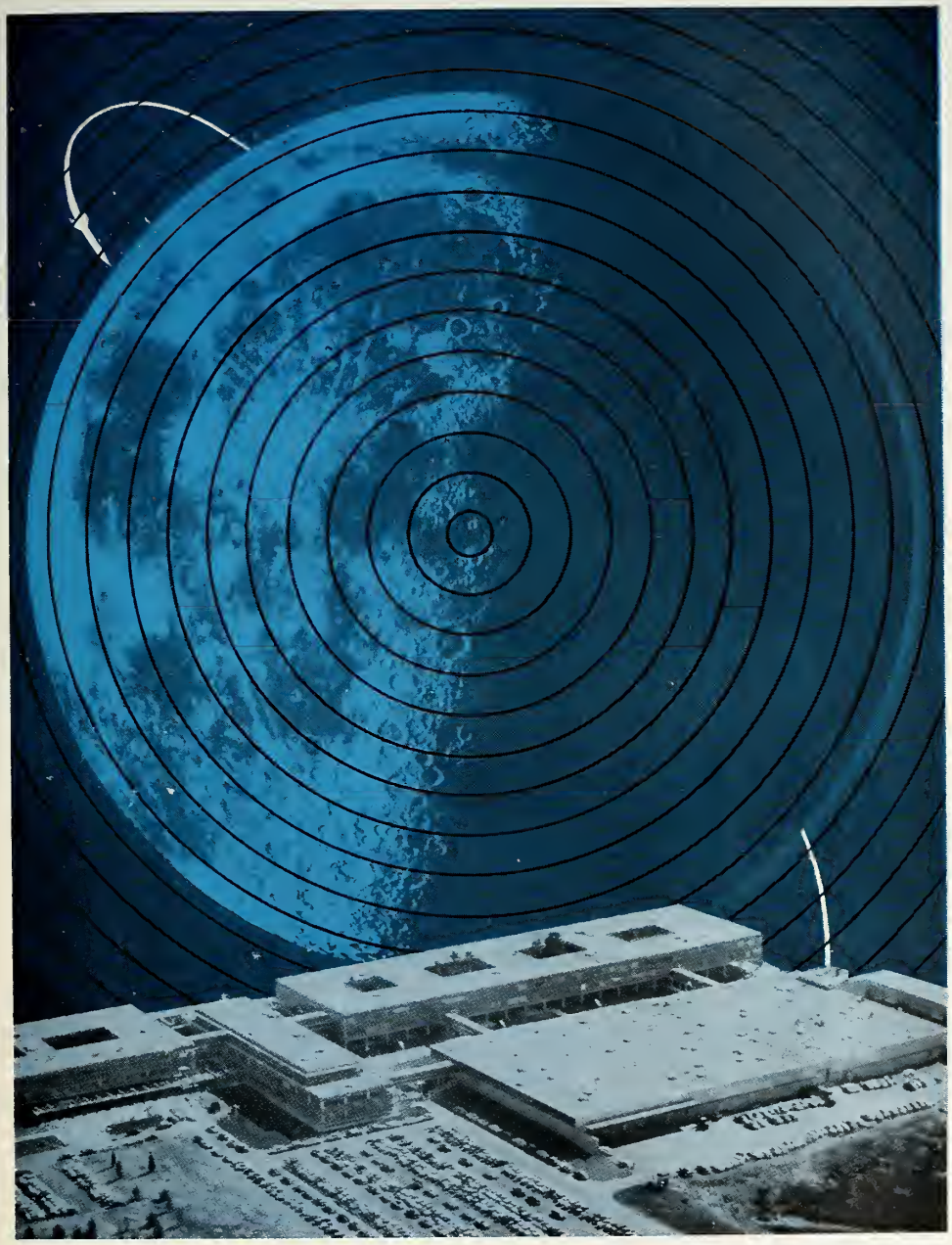


Reliable! Dependable! Available!

For high-performance slip rings, brushes, commutators and switches the name to remember is

POLY-SCIENTIFIC CORPORATION

BLACKSBURG, VIRGINIA

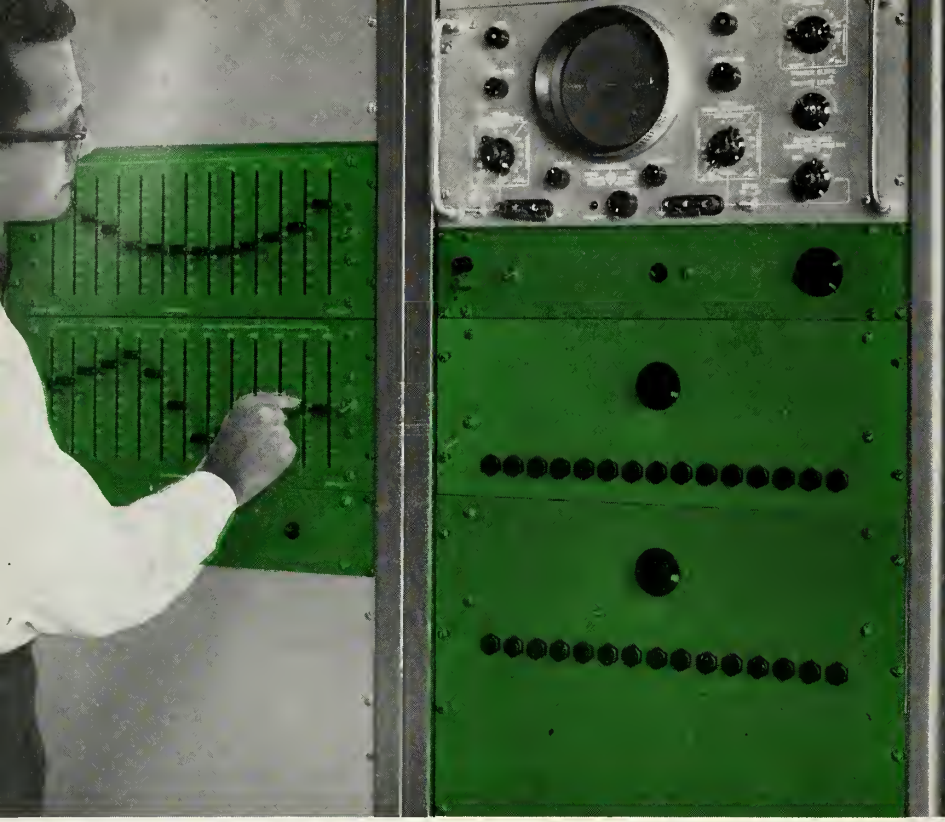


Space age research gets a new headquarters—One of the largest and best-equipped research facilities in the nation is the new 16-million-dollar Avco Research Center at Wilmington, Massachusetts. Here, research and development in space age technology is already being conducted In areas ranging from missile re-entry to satellite design. From work such as this—and equally important work at the nearby Avco Research Laboratory—will come further contributions to national security and the conquest of space.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY.

Avco

AVCO MAKES THINGS BETTER FOR AMERICA / AVCO CORPORATION / 750 THIRD AVENUE, NEW YORK 17, N. Y.



ESD-20
Spectral Densi
Equalizer
(left panel)
allows rapid, accurate equalization of vibration and high-intensity sound systems for random testing. Adjustments can be made during testing at any vibration level.

ASD-20
Spectral Densi
Analyzer
(right panel)
generates a continuous power spectral density plot of a random wave vibration signal for display on a cathode ray oscilloscope.

Ling announces a major breakthrough in random wave equalization and contr

New Spectral Density Equalizer/Analyzer System

...for continuous and parallel observation and control of test spectrum in vibration and acoustic testing programs

Announcing another Ling first—the new Spectral Density Equalizer/Analyzer System! This new system allows *continuous, parallel* observation and control of the entire spectrum of energy distribution during random wave vibration or high-intensity sound testing.

The Ling ESD-20/ASD-20 System reduces peak and notch filter set-ups...eliminates tedious adjustments for system response uniformity...makes continuous, accurate equalization possible at any vibration level.

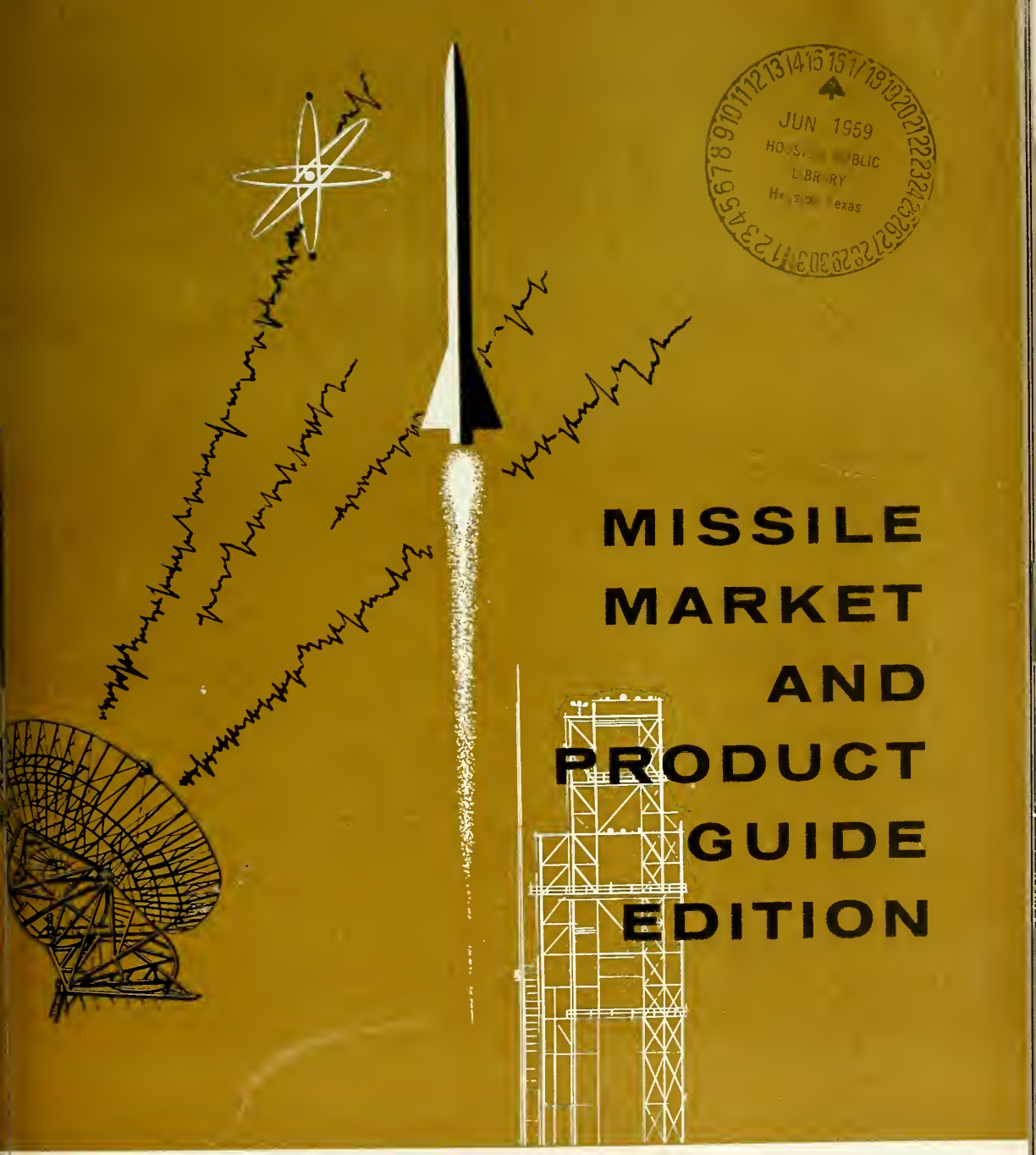
In the Ling Spectral Density System, the random source output is divided into 26 frequency bands—each independently controlled by a simple vertical attenuator. Outputs from all 26 bands are rapidly and sequentially sampled and displayed on a cathode ray oscilloscope to provide the operator with a continuous view of the spectrum during the test. This new equalization system may be added to existing random wave vibration test systems...or incorporated in any new Ling random wave system. Available *only* from Ling Electronics.

5 Major advantages of new Ling ESD-20/ASD-20 Syst

1 **FASTER**—Reduces set-up time to a few
2 **MORE ACCURATE**—Permits continuous, observation and control of entire spect Load shifts during test can be detected corrected immediately.
3 **BETTER EQUALIZATION**—Compensates a non-linearities in specimen or system co
4 **EASIER TO OPERATE**—Operator has cont picture of shaker vibration spectrum on o ...makes corrections with simple level adjustments of filter attenuators.
5 **BETTER SPECIMEN PROTECTION**—New L system prevents over stress of specime set-up stages.

LING ELECTRO INC.

Factory Sales Offices:
9937 West Jefferson Blvd., Culver City, California,
12[illegible] Cross Street, Winchester, Massachusetts, Wi[illegible]



JUN 1959
PUBLIC
LIBRARY
Texas

MISSILE MARKET AND PRODUCT GUIDE EDITION

missiles and rockets

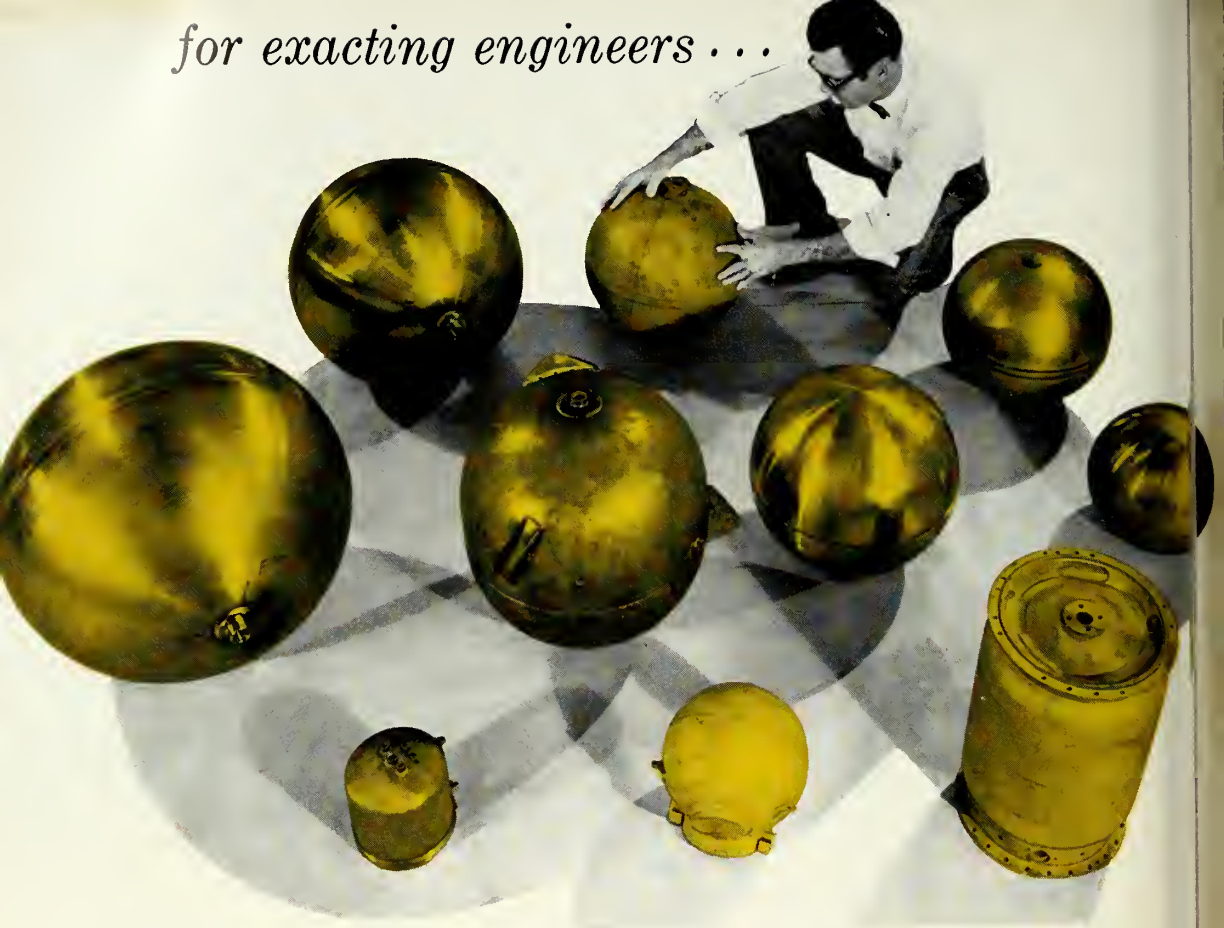
MAGAZINE OF WORLD ASTRONAUTICS

AN AMERICAN AVIATION PUBLICATION

THIS ISSUE—$4.00

MID-MAY 1959

for exacting engineers . . .



RHEEM PRESSURE VESSELS

When the "go no-go" signal depends upon a complexity of parts and pieces supplied by scores of subcontractors, a missile systems engineer with prime contractor responsibility must have confidence that the multitude of components will stand up to the principles of his design. In the design of modern high-performance aircraft and missiles, often the heart of the propulsion system (or of a major auxiliary system) is a pressure vessel.

Whether specifications call for titanium or stainless steel spheres, or more specialized configurations of even newer metals and alloys, it is the ultimate reliability of the hardware that will prove or disprove the system design. That is why exacting engineers specify pressure vessels by Rheem. That is why over the past seven years companies like Convair, North American Aviation, and Lockheed Aircraft Corporation have ordered more than 26,000 Rheem pressure vessels for applications in the major aircraft and space projects of the nation.

When an experienced hand in critical welding and machining operations is needed for the production of vessels that can be relied upon, consult the leader in pressure vessels. Consult Rheem early. Let Rheem engineers assist you in the development, as well as in the production, of vessels and containers to meet your specialized needs. Write to Dept. MR-717-1.

First in Pressure Vessels

RHEEM MANUFACTURING COMPANY

Defense and Technical Products Division

11711 woodruff avenue, downey, california

Rheem

PRESSURE VESSELS • PROPULSION & MISSILE SYSTEMS • ORDNANCE • DRONES • ELECTRONICS • RESEARC

Fill in No. 7 on Subscriber Service Card.



SOME DOWN-TO-EARTH THOUGHTS ABOUT THE SPACE AGE

Like all those who participate in the progress of aviation, we are awed by the prospect of the conquest of space. But before we rush headlong into the cosmic dust, let's hang up our space helmets for a moment for some sober reflection on what it will take to get there.

In the race toward tomorrow, look to the reliable as well as the swift. Our recent missile successes and "failures" clearly indicate that space conquest will depend not only on technological *breakthroughs*, but equally on the virtual elimination of mechanical *breakdowns*. Good hardware is even more important in the space age.

For over 16 years, Hydro-Aire has built a reputation on building better hardware for airborne vehicles. Today these products function reliably on virtually every type of aircraft. The same ingenuity and dependability that made these products possible is now the key to solving the problems of more hostile environments, more stringent operating conditions.

The men whose space vehicles will be equipped with these products, can don *their* space helmets with confidence.

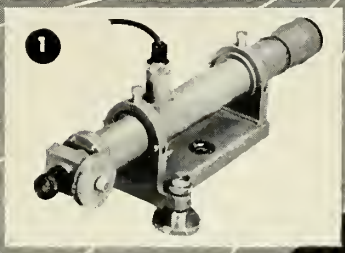
Challenging positions are now open for qualified design engineers on Hydro-Aire's expanding staff. Submit inquiries to Mr. D. B. Nickerson, Chief Engineer, Hydro-Aire, 3000 Winona Avenue, Burbank, Calif.

HYDRO-AIRE
BURBANK, CALIFORNIA
Division of CRANE CO.
Anti-Skid Braking Systems • Fuel System Controls • Pneumatic Controls • Hydraulic Controls Actuation Systems • Electronic Devices

roducing Controls for Every Basic Airborne System

gaging...
micro-inches or miles

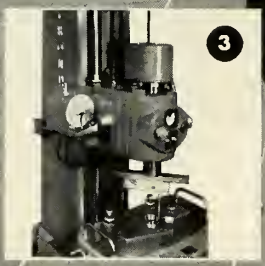
FLATNESS, STRAIGHTNESS,
ANGLES TO .000001"*



POINT ALIGNMENT TO .0002"

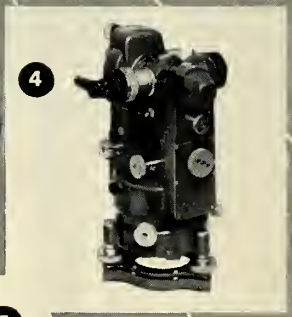


ROUNDNESS,
CONCENTRICITY TO .000001"



ENGIS

20 YEARS OF PRECISION MEASUREMENT





CIRCULAR SPACING,
ELEVATION, ROTATION
TO 1 SECOND

1. **MICROPTIC AUTO-COLLIMATOR**
Detects change of angle to .1 second direct reading—range, 10 minutes. *The universal optical tooling instrument to test alignment, straightness, flatness, squareness, angles to better than .000001" per inch.

2. **MICRO-ALIGNMENT TELESCOPE**
For alignment of all points at any distance; built-in standard and high precision micrometers; improved auto-reflection and auto-collimation equipment for precise squareness setting. Complete projection accessories.

3. **TALYROND ROUNDNESS ANALYZER**
The electronic master instrument to measure and record roundness and concentricity on all products of circular cross section. Full range of magnifications, motorized adjustments, for diameters from .01" to 12".

4. **MICROPTIC THEODOLITE NO. 2**
Direct reading to 1 second; fully enclosed precision bubble; specially designed for engineering and testing application. New auto-collimation features.

5. **MICROPTIC PRECISION CLINOMETERS**
For all accurate angular settings over 360 degrees; reading direct to 1 second or to 10 seconds. The most precise instruments of a complete range.

Fully illustrated description available, together with application engineering data from years of successful optical tooling and metrology experience.

ENGIS EQUIPMENT COMPANY 431 S. DEARBORN STREET, CHICAGO 5, ILL.

OPTICAL, MECHANICAL, ELECTRONIC GAGES AND INSPECTION DEVICES

Fill in No. 9 on Subscriber Service Card.

missiles and rockets

Magazine of World Astronautics

1001 Vermont Ave., N.W., Washington 5, D.C. Tel.: STerling 3-5400

CLARKE NEWLON ..... *Executive Editor*
DONALD E. PERRY ..... *Managing Editor*
ELEANOR MILLER .. *Editor, Missile Market & Product Guide*

EDITORIAL STAFF

REED BUNDY ..... *News Editor*
BETTY OSWALD, JAMES BAAR ..... *Military & Defense*
HAL GETTINGS ..... *Electronics/Support Equipment*
CHARLES D. LAFOND ..... *Electronics Engineering*
WILLIAM E. HOWARD ..... *Missile Manufacturing*
ERICA M. KARR ..... *Missile Business*
PAUL MEANS ..... *NASA*
FRED HUNTER, RICHARD VAN OSTEN, FRANK MCGUIRE ..... *Los Angeles*
G. V. E. THOMPSON ..... *London*
JEAN-MARIE RICHE ..... *Paris*
ANTHONY VANDYK ..... *Geneva*
WILLIAM MARTIN ..... *Art Director*
BACIL GUILEY, LEONE WICKLUND ..... *Ass't Art Directors*

CONTRIBUTORS

MICHAEL LORENZO ..... *Propulsion Engineering*
JAMES J. HAGGERTY, JR. ..... *Industry*
DR. ALBERT PARRY ..... *Soviet Affairs*
DR. HUBURTUS STRUGHOLD ..... *Space Medicine*
DR. I. M. LEVITT ..... *Astrophysics*
HEYWARD CANNEY, JR. ..... *Research*

ADVISORY BOARD

DR. WERNHER VON BRAUN — ROBERT P. HAVILAND
DR. PETER CASTRUCCIO — DR. ARTHUR KANTROWITZ
KRAFFT EHRICKE — DR. EUGEN SAENGER
R. F. GOMPERTZ — ALEXANDER SATIN

BUSINESS STAFF

E. D. MUHLFELD ..... *Assistant Publisher*
W. E. BROWN ..... *Advertising Sales Manager*
L. L. BRETTNER ..... *Circulation Director*
D. T. FOSSEN ..... *Research Manager*
J. E. MULROY ..... *Promotion Manager*
MRS. GLADYS BUSSELL ..... *Advertising Service Manager*
HELEN PEARY ..... *Advertising Production*
J. F. WALEN ..... *Production Manager*
ELSIE GRAY ..... *Assistant Production Manager*

New York ..... *17 East 48 Street*
P. B. KINNEY ..... *Eastern Advertising Manager*
P. N. ANDERSON
A. B. SCHEFFLER
K. J. WELLS ..... *201 Stephenson Bldg., Detroit*
G. E. YONAN ..... *139 N. Clark St., Chicago*
J. A. CLAAR, C. R. MARTZ, JR., *8929 Wilshire Blvd., Los Angeles*
R. D. HAGER ..... *208 Almeria Avenue, Miami*
ALLIN ASSOCIATES ..... *12 Richmond St. E, Toronto*
NORALL & HART ..... *28 Bruton St., London*
11 Rue Condorcet, Paris — *10 Rue Grenus, Geneva*

missiles and rockets Vol. 5, Number 23

Published annually by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. WAYNE W. PARRISH, President & Publisher; LEONARD A. EISERER, Executive President & General Manager; A. H. STACKPOLE, Vice President; FRED HUNTER, Vice President; ERIC BRAMLEY, Vice President; ROBERT R. PARRISH, Vice President. Printed at the Telegraph Press, Harrisburg, Pa. Second class postage paid at Washington, D.C., and at additional mailing offices. Copyright 1959, American Aviation Publications, Inc.

Subscription rates; U.S. and Canada—1 year, $8.00; 2 years, $12.00; 3 years, $14.00. Foreign—1 year, $9.00; 2 years, $14.00; 3 years, $17.00. Single copy rate—$.75. (This issue $5.00). Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. Second class mail privileges authorized at Washington, D.C., with additional entry at Harrisburg. Copyright 1958, American Aviation Publications, Inc.

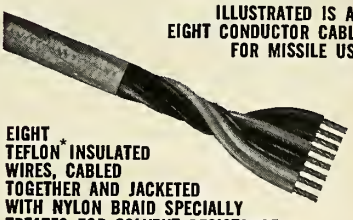


WIRE PRODUCTS

CUSTOM CONSTRUCTED CONTROL CABLES and THERMOCOUPLE- WIRE CABLES

with segregated circuits individually shielded, and with over-all shielding or with special shielding and jacketing.

ILLUSTRATED IS AN EIGHT CONDUCTOR CABLE FOR MISSILE USE.



EIGHT TEFLON* INSULATED WIRES, CABLED TOGETHER AND JACKETED WITH NYLON BRAID SPECIALLY TREATED FOR SOLVENT RESISTANCE.

FIRE-RESISTANT and HIGH TEMPERATURE RESISTANT CABLE

for circuits required to operate in 2000° F. flame for fifteen minutes. Excellent for fire-detector circuits and for use in temperatures up to 600°F.

HIGH TEMPERATURE CABLE...

Suitable for operating temperatures up to 650° F. with nickel-clad copper conductor and laminated insulation having superior dielectric strength and moisture resistance. In AWG sizes 22 thru 4/0. In accordance with MIL-C-25038.

ELECTRONIC HOOKUP WIRE...

Teflon insulated silver coated copper conductor with insulation in standard colors in accordance with MIL-C-16878.

EXTRA FLEXIBLE CABLE . . .

High Temperature and Moisture Resistant Electrical Cable. Lewis "EXFLEX" Cable, single and multi-conductor, superior for circuits on hinged or pivoted parts. Resistant to abrasion and temperatures to 500° F.

* TEFLON is a Du Pont product

The LEWIS ENGINEERING CO.
Naugatuck, Connecticut
WIRE DIVISION

Fill in No. 44 on Subscriber Service Card.

NOW AVAILABLE FROM FILTORS, THE LEAD

NEW

First AC Powrmite® Micro-Miniature



NEW

First Relays with built-in arc suppressed coil



NEW

AC Sub-Miniature Relays



NEW

.2 Grid Space Powrmite Micro-Miniature
with new "Sensi-Tork



New! First AC Powrmite micro-miniature relay. The new Powrmite crystal can micro-miniature relay is the smallest, l
AC relay made today.

New! First relays with built-in arc suppressed coil. In the same micro-miniature size Filtors' Powrmite is also made
built-in arc suppressed coil to cut radio interference a minimum of ten to one. Available also in four and six-po
miniature relays, Filtors arc suppressed relays increase life and reliability of associated circuitry.

New! AC sub-miniature relays. Filtors now manufactures the smallest, lightest four and six-pole sub-miniature herm
sealed relays for AC operation.

New! .2 grid space Powrmite micro-miniature relays. All types of Filtors Powrmite micro-miniature relays are now av
in .2 grid space in all mounting styles; .2 grid space relays feature Filtors new "Sensi-Tork" motor, a Filtors developn
greatest reliability and sensitivity.

Filtors, **the leader,** and specialist in the development and manufacture of micro and sub-miniature rotary relays n
complete line of general purpose, latching (both 2, 4 and 6 DPDT) and ⅝" sub-miniature hermetically sealed rela
Powrmite, Filtors' popular micro-miniature relay, has long been acclaimed by hundreds of users as the most reliable
field. Write for catalog!

Leading manufacturer of hermetically sealed rotary micro and sub-miniature

Main office and plant: Port Washington, N. Y.: POrt Washington 7-8220.
West coast office: 13273 Ventura Blvd., Studio City, Calif.: STanley 3-2770

FILTORS, IN

Fill in No. 10 on Subscriber Service Card.

BASIC BUILDING BLOCKS

SERVO SYSTEM COMPONENTS



- Servo Motors—Frame Sizes 5-25
- Synchros and Resolvers—Frame Sizes 5-25
- Tachometers—Damping, Rate, Integrating
- Transistorized Amplifiers —High Temperature 2.5-16 watts

Synchros—Size 25—20 sec. max. error

HYDRAULICS



6100 Series Servo Valve

Servo Valves

- Two moving parts
- Anti-clogging — over size orifices, high pressure clearing
- Flow rates—0-5, 0-10 gpm

Systems

For hi-performance hydraulic or pneumatic missile control.

COMPUTERS



- Great Circle Course and Navigational
- Inertial Position
- Guidance
- Analog and Digital for Missile Applications

Navigational Computer

INERTIAL GUIDANCE



25 lb. Inertial Platform

Components include floated gyros, single and two-axis accelerometers, first and second integrators, computers. Complete systems in production for major missile applications feature high accuracy, long-term reliability, light-weight construction.

GYROS



- Rate-floated Integrating; Spring Restrained
- Vertical—Miniature, Self-Contained
- Two Axis Free For Missile Control
- Directional, Conventional and Roll Stabilized
- 3 Gyro, 3 and 4 Gimbal Platforms
- North Seeking Theodolites

Miniature Floated Gyro

GROUND SUPPORT



Completely integrated ground support equipment based on unique Kearfott test equipment modules for analog or digital, manual, semi-automatic or fully automatic testing of components, sub-systems or systems.

Digital Logging System

MICROWAVE



- Waveguides, Strip Transmission Lines, Ferrite Components
- Radar rf and Antenna Assemblies
- Transponder Systems, Target Simulators, Test Sets
- Traveling Wave Assemblies

Antenna Array

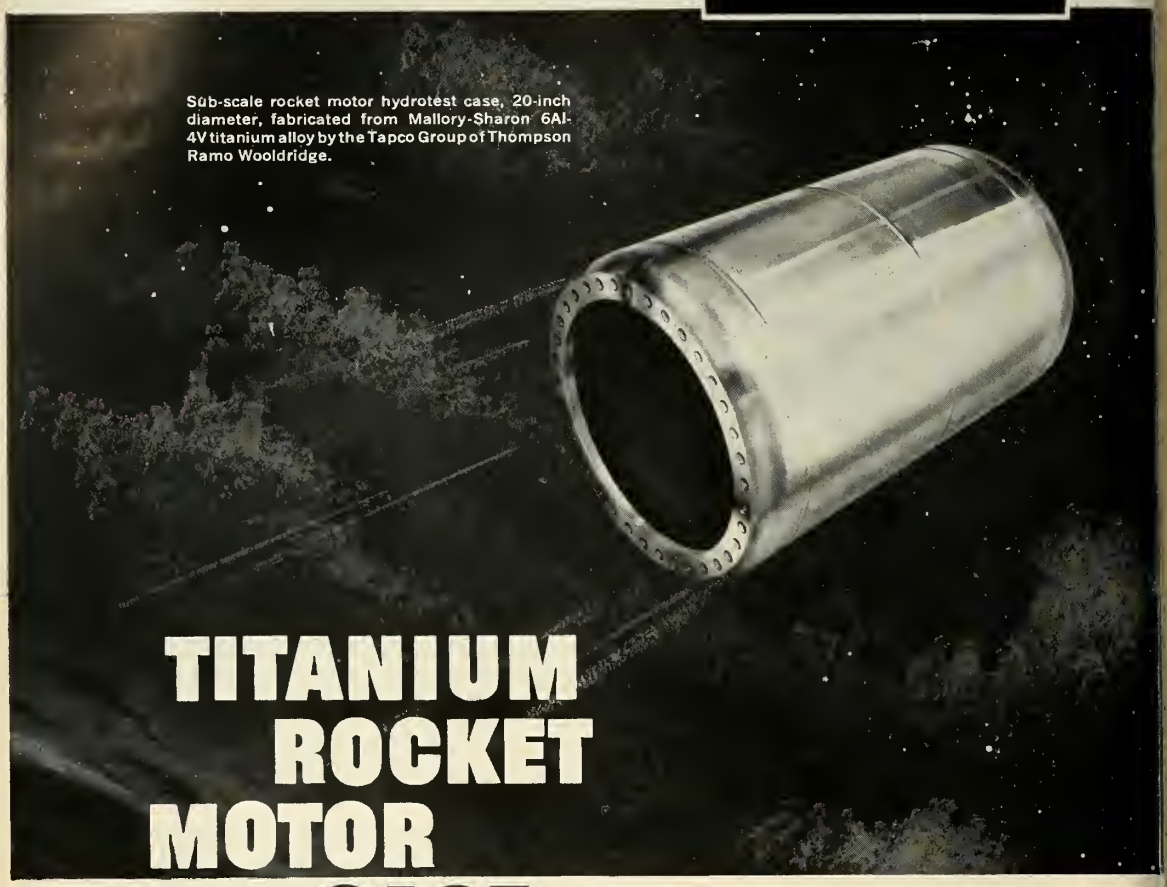
Engineers:

Kearfott offers challenging opportunities in advanced component and system development

Kearfott | A GENERAL PRECISION COMPANY

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation
Sales and Engineering Offices: 1500 Main Avenue, Clifton, N. J.
Midwest Office: 23 W. Calendar Avenue, La Grange, Illinois
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vineda Avenue, Pasadena, California

Another important advance in **TITANIUM**

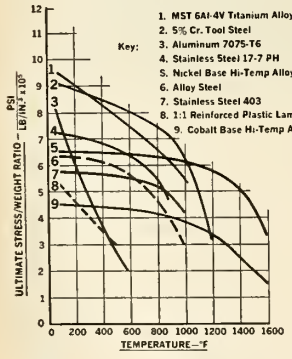


Sub-scale rocket motor hydrotest case, 20-inch diameter, fabricated from Mallory-Sharon 6Al-4V titanium alloy by the Tapco Group of Thompson Ramo Wooldridge.

TITANIUM ROCKET MOTOR CASE

with guaranteed tensile strength/weight ratio of 960,000

VARIATION OF ULTIMATE STRENGTH/WEIGHT RATIO WITH TEMPERATURE (of comparable ductilities)



Test Data Courtesy of Thompson Ramo Wooldridge

New, advanced type, solid-fuel propellants . . . plus the need to achieve maximum range . . . demand a new look at tensile strength/weight ratios in rocket motor cases. Today's goal: hold rocket-case weight to *less than 10%* of propellant weight.

To achieve this goal, tensile strength/weight ratios of close to 1,000,000 are required in the rocket case. In this range, welded heat-treated steels develop severe embrittlement and high notch sensitivity when subjected to rocket case hoop stresses — largely ruling out their use. Titanium overcomes these disadvantages, plus giving *a weight saving of 25% to 38% over the best competitive steels!*

The Tapco Group of Thompson Ramo Wooldridge has carried out extensive development and testing, proving Mallory-Sharon 6Al-4V titanium alloy to be the most suitable material for this application.

It provides the necessary strength and ductility without embrittlement or distortion . . . can be readily welded and age hardened to give the welded strength/weight levels required.

For technical information on MST 6Al-4V or other titanium alloys, write to: Aircraft & Missile Development Dept., Mallory-Sharon Metals Corporation, Niles, Ohio.

MALLORY SHARON

MALLORY-SHARON METALS CORPORATION · NILES, OHIO

Integrated producer of Titanium · Zirconium · Special Metals

Fill in No. 12 on Subscriber Service Card.

missile market and product guide

editorial

Missile Support—a New U.S. Industry 11

missile market survey

How to do Business with the Defense Department 13
How to do Business with the Air Force 14
How to do Business with the Navy 16
How to do Business with the Army 18
How to do Business with NASA 20
What a Prime Seeks from a Sub 23
What a Sub Seeks from a Prime 25

missile catalog

Missile Frame, Warhead and Nose Cone 29
Propulsion Systems and Auxiliary Power Units 37
Ground Support Equipment 51
Checkout Equipment 63
Guidance Equipment 73
Test Equipment 83
Tracking and Telemetering Equipment 89
Materials and Metals 97

missile purchasing directory 111

missile product directory 187

index to advertisers 322

(Note: Throughout the issue, advertisers are identified by boldface listings.)

The MISSILE:

U. S. A. F. Northrop's SM-62 Snark, with a range of more than 6000 miles. Now operational, the Snark is America's first intercontinental guided missile. Powerplant is a Pratt & Whitney J-57 turbojet. Guidance is by a stellar-monitored inertial system.

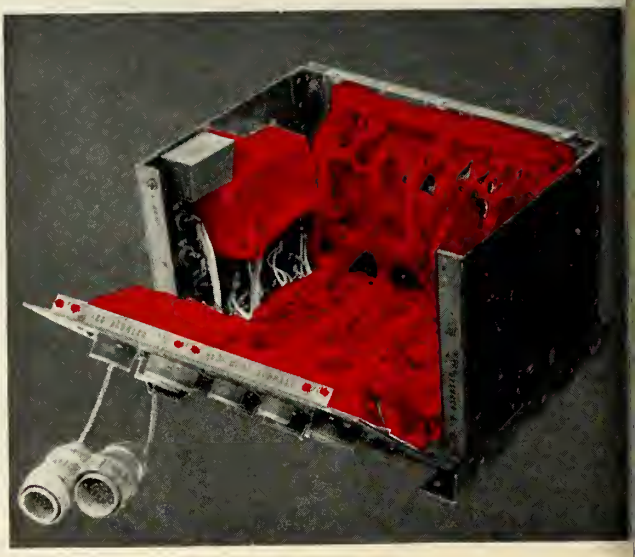


The MATERIAL:

SILASTIC
SILICONE RUBBER

In the Snark, panels containing resistors, capacitors, transistors and other electronic components are cushioned by Silastic*, the Dow Corning silicone rubber. Silastic protects against moisture, vibration damage, electrical leakage.

*T.M. REG. U.S. PAT. OFF.



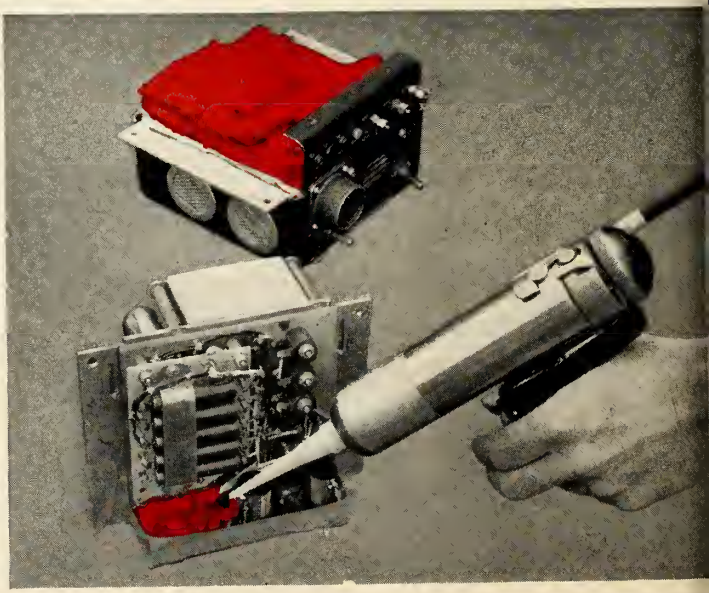
The METHOD:

Encapsulating with Silastic RTV, via calking gun. Silastic RTV vulcanizes completely at room temperature. When vulcanized, it has the characteristics typical of Silastic: resistance to extreme temperatures, moisture, ozone, corona. Electrical properties are excellent. Silastic RTV can be slit open for repair work and then re-sealed. Write for sample and technical data.

Address Dept. 916

first in silicones

Dow Corning
CORPORATION
MIDLAND, MICHIGAN



Fill in No. 15 on Subscriber Service Card.

Missile Support—a New U.S. Industry

Within the months ahead this country will see the development of an almost new segment of industry—one which will eventually run into billions of dollars. It is the construction of ballistic missile bases and the equipping of them with supporting hardware.

Involved to some extent will be the same companies which produce the missiles, the big primes which have traditionally been associated with the spacecraft and/or the aircraft business. But in addition to them, thousands of big and little companies to whom the missile and space industry a few months ago was as foreign, say, as a trip to Mars, will find themselves accidentally or intentionally concerned with producing or installing the thousand and one items which go to support the missiles of the very new future.

For the missile—and while this is intended primarily to treat of the big intercontinental ballistic types it also holds true for the smaller ballistic weapons and the air-breathers as well—is somewhat like the iceberg where cost visibility is concerned. Something like four-fifths is hidden. For example, a *Titan* ICBM may cost $2 million. The site to contain a squadron of nine *Titans* will cost $45 million, not including the personnel to man it.

The $45 million takes in the cost of a concrete blockhouse strong enough to withstand an accidental explosion; the cost of communications cables connecting with each launching pad—many-stranded cables which will snake through conduits at the cost of $800 a foot. It will include tons of concrete for handstand, miles of pipe for both liquids and gases; scores of pumps, hundreds of valves, generators, tubes and transistors, tons of steel in every form, aluminum and a dozen other metals, scores of chemicals. Heavy earth-moving equipment will be used, trucks, bulldozers, forklifts, lumber, lighting equipment—gauges and computers and every form of checkout equipment.

Some of the big ballistic missile launching pads will be hardened, that is, either sunk in holes or otherwise protected from possible enemy nuclear weapons. Our first ICBM, the *Atlas*, will be partially hardened, at some sites at least, probably to lie in a rough concrete-lined coffin with a sliding cover. From this "coffin" it will be raised and fired. The second liquid fuel ICBM, the *Titan*, will be lowered into holes in the ground, inverted silos, from which they will be raised to the surface and fired. The third ICBM, the second-generation, solid-fuel *Minuteman*, will also be housed in inverted silos from which it will be fired without elevating to the surface. A solid-fuel vehicle can be fired from the hole because it rises much more quickly in the initial firing stage and thus does not present the heat dissipation problem of the liquid-fuel missile.

The ICBM sites must also include living quarters for personnel, storage facilities for materials and for maintenance equipment. They must include, believe it or not, recreation facilities for crews who will be on constant alert 24 hours of every day.

None of the equipment needed for a missile site—and none of the skill—is new to American industry (with the exception of some of the more esoteric checkout and testing devices), but industry will be faced with a demand from the military services to come up with new techniques for both speed and lower costs.

How do you drill a hole 100 feet deep and 20 feet in diameter for the *Minuteman?* How do you line it with concrete, properly reinforced to withstand the shock of a near-miss nuclear explosion?

The services say: "Give us a new technique which will dig the holes in one day and line them with concrete in another—all at a cost of $50,000 and not $500,000." And they are talking about as many as a thousand holes for a thousand *Minutemen.*

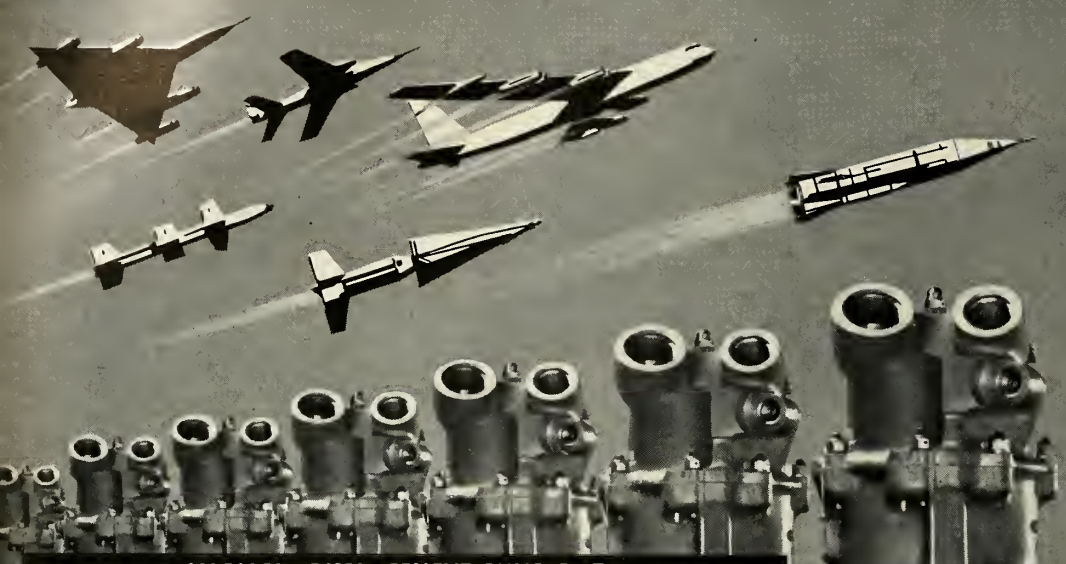
Which will be the companies to come up with new ideas in prefabrication, in miniaturization? Who will provide the shortcuts, the better, the faster and the cheaper way to do it?

There is no royal road to defense contracts and no magic formula for bidding. Uncle Sam is a tough customer and he wants and usually gets a full dollar's worth for every dollar he spends. He is as eager to find the little company with the bright idea or the special skill as he is to deal with the giant primes. Equally true is the fact that the big companies are always searching for the little man who has found a better way to do it. The price of missiles will come down as the skills of spacecraft advance—$100,000 for the *Minuteman,* for example. In parallel fashion, the cost of missile sites must lower, too, and it will be industry, big or little, which will bring that cost down through ingenuity while reaping a golden harvest as it happens.

Clarke Newlon

YOU ASKED FOR IT . . .

FOR MISSILE AND AIRCRAFT SYSTEMS . . .



VARIABLE DISPLACEMENT PUMP DATA

MODEL	DISPL. IN 3/REV.	RATED RPM	RATED GPM	MAX. RPM	ENVELOPE DIM. DIA.	ENVELOPE DIM. LENGTH
P175	1.750	4000	29.4	5000	5.750	8.320
P105	1.050	4000	17.3	6000	5.250	4.250
P56	.568	6000	13.9	8000	4.687	6.625
P16	.163	12000	7.9	16000	3.000	4.250
P11	.115	12000	5.5	16000	2.750	3.625
P064	.064	12000	3.1	18000	2.125	3.125
P044	.044	12000	2.1	18000	2.125	3.062

A NEW FAMILY OF BENDIX CONSTANT AND VARIABLE DISPLACEMENT HYDRAULIC PUMPS

SMALLER • LIGHTER • FEWER PARTS • SYMMETRICAL ENVELOPE • COMPACT • RUGGED DESIGN

INHERENT HIGH SPEED CAPABILITIES • SUPERIOR CONTAMINATION TOLERANCE • HIGH RELIABILITY

The rugged, simplified construction of Bendix® hydraulic pumps plus precision production and quality control experience provide pumps with increased reliability for missile and aircraft systems. Smaller envelopes permit interchangeability with existing installations and compact packaging for new applications. Thousands of hours of endurance, qualification and flight testing have proven the Bendix family of hydraulic pumps will exceed all existing customer and military requirements.

Pumps are furnished as separate components or as an integral part of complete sub-systems. Standard pumps are furnished with forged aluminum housings for temperatures up to 400°F. and pressures up to 4,000 psi. Previous qualifi cation of pumps for 550°F. assures you of high reliability fo lower temperatures and availability of proven pumps fo high temperature systems.

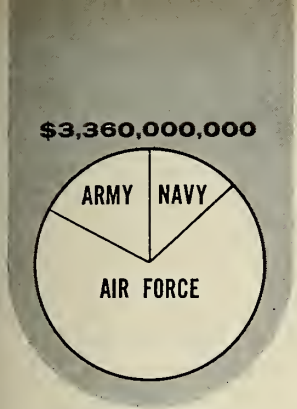
Advanced engineering, laboratory, precision manufac turing and complete service facilities are available fo producing and servicing Bendix hydraulic pumps. Thi assures you of a quality pump manufactured specifically fo your application.

All pumps are assembled and tested in a new air conditioned, humidity-controlled, dust-free area assurin contaminate-free pumps as delivered.

MAJOR PRODUCTS—aircraft and missile hydraulic pumps; hydraulic components and sub-systems; engine fuel pumps and fuel system components; precision bellows and bellows assemblies; thermostats and related sub-assemblies; and sub-contract manufacturing and brazing.

Hamilton Division
HAMILTON, OHIO

Bendix
AVIATION CORPORATION



Procurement & Production
Missiles, FY 1960

How To Do Business With the Defense Department

Outlined here are some helpful pointers for the average business man who wants to sell to the Department of Defense but doesn't know quite where to start . . .

TO THE AVERAGE business man hunting a contract from the Defense Department, the questions of whom to see, where to go and what to take with him are almost insoluble. Difficulties stem not only from the complexity of the Defense Department's procurement organization but also from changes which are almost constantly made in the techniques and rules of procurement.

As a starting point, the Defense Department, itself, buys nothing. It has a number of procurement agencies. The biggest, of course, are the Army, Navy and Air Force, with the Defense Department's Advanced Research Projects Agency likely to enter the field later. Each of these agencies themselves are subdivided with procurement responsibility decentralized throughout the country.

DOD's basic role in procurement is one of policymaking. It also decides how many dollars each of the services may spend and, in some cases, actually decides which weapon system may be bought and by whom.

Purchases are made either by formal advertising or by negotiation. For missiles, rockets, ground support equipment, and subsystems, normally a procedure called "competitive negotiation" is used. This means, generally, that contractors thought to be qualified are invited to submit competitive proposals which are evaluated. After evaluation, a contract is negotiated with the contractor whose proposal seems most nearly to meet the military requirement.

Rules governing both formal advertising and competitive negotiation are spelled out in great detail in the Armed Services Procurement Regulation, Army Procurement Procedure, Navy Procurement Directives and, Air Force Procurement Regulations and Instructions.

Most big manufacturers who do business with the agencies of the Defense Department on a regular basis maintain Washington organizations to handle the technical problems inherent in the complex procurement structure. It is the company which wants to come in for the first time or the small business firm which needs the most guidance.

All kinds of advice is available, particularly to small business concerns. To qualify, a concern must have less than 500 employees and cannot be dominant in its field of operation. A certificate from the Small Business Administration will be taken at face value by Defense Department procurement officers.

Each of the military departments has an active program to help small business to compete for defense procurement. In addition, some contracts may be set aside in whole or in part for the exclusive benefit of small business.

In the case of equal low bids submitted by a large and a small company, preference would generally be given to the small concern. However, if a big company agrees to perform the work in an area of substantial unemployment, it will receive a preference over a small concern which won't or can't produce in a labor surplus area. To bolster the small business program, Defense officials work with the Small Business Administration to screen procurement that can be set-aside for exclusive small business participation. However, there is more than a little question as to the effectiveness of the program.

Generally, Defense officials have expressed the belief that the most effective role which small business can play is in the subcontract structure. All major contractors maintain an active program which aims at establishing a qualified list or lists of subcontractors and suppliers. Many defense contracts specifically require that a specified percentage of a big contract be subcontracted and gradually, the military services are screening the subcontract structure to be sure that conditions are complied with.

For subcontracts, manufacturers are advised to apply directly to prime contractors. Names of the principal contractors can be obtained from a Commerce Department Synopsis of Bids published almost daily and from records maintained by the Defense Department.

In the research and development area, special opportunities are available to small concerns and nonprofit institutions. Here the yardstick is competence, which frequently has little to do with size. Special efforts are made both by the military departments and the Defense Department to find the right man or the right company for the job in the area of research and development. More details will be found in other articles in this section.

In general, a would-be contractor will find the following rules helpful:

(1) Don't come to Washington when you first decide you want military work.

(2) Analyze the capabilities of your company, including facilities know-how, available labor pool, management and finance.

(3) Visit the nearest procurement or contract administration office to your plant, taking with you your analysis of company capabilities.

(4) Visit prime contractors, taking an analysis or proposal with you, picking those prime contractors who are located close to your own plant.

(5) Study or have a competent lawyer study the procurement structure of the military departments to be sure that buying representatives are made aware of your company's capabilities.

(6) Don't sign a contract without competent advice.



PROCUREMENT & PRODUCTION
MISSILES, FY 1960

How To Do Business With the Air Force

The buying arm of the Air Force carries over one million items in inventory. Here is a rundown on where the would-be contractor should go and what he should do when seeking this business . . .

AIR MATERIEL COMMAND located at Dayton, Ohio, is the Air Force's buying, supply and maintenance arm. Its workload is decentralized to Air Materiel Areas, Centers and Depots. It buys new production weapons for inventory, provides spare parts and material to maintain equipment already in the hands of the troops and makes research and development contracts on orders from the Air Research and Development Command. Some idea of the scope of the job can be obtained from the fact that AMC carries more than 1,300,000 items in inventory.

Knowing that a requirement will exist for better tooling, a new material, or new electronic equipment, it makes manufacturing methods contracts with research organizations and with industry in an effort to assure the availability of equipment in production quantities and at practicable costs.

Air Materiel Command is headed by Lt. Gen. Samuel E. Anderson, Jr. His deputy is Lt. Gen. William F. McKee. It is divided into six directorates which now operate as staff offices. These are: Plans and Programs, Procurement and Production, Supply, Maintenance Engineering, Transportation and Services, and Personnel and Support Operations. There is a separate Quality Control office to improve reliability.

Major responsibility for procurement is vested in the Aeronautical Systems Center at Wright Patterson Air Force Base, Ohio, and the Ballistic Missiles Center, AF Unit Post Office, Los Angeles 45, Calif.

Aeronautical Systems Center is responsible for the purchase of complete missiles, other than ballistic, complete aircraft and aerial targets. In addition, it is responsible for the procurement of fire control systems, launchers, rocket and pyrotechnic weapons, warheads and explosives, photographic equipment, bombing and gunnery equipment, airborne radio and radar equipment, initial spares and ground support and tools/test equipment except for propulsion systems, research and development and service test of non-stock listed items. It buys, of course, many kinds of aircraft accessories and equipment.

Ballistic Missiles Center buys ballistic missiles, space vehicles and related equipment such as propulsion and guidance systems, ground support equipment, initial spares, tools, test equipment and the like. In the space field, Ballistic Missiles Center lets contracts on instructions from Advanced Research Projects Agency as well as the Air Force.

Electronic Defense Systems Division, 220 Church Street, New York City is responsible for the procurement of engineering management and other services for Air Defense Systems such as SAGE, DEW Line/White Alice (Alaska) and the new Ballistic Missile Early Warning Line.

The Air Materiel Areas have been designated Logistic Support Managers as well as weapon system managers to be sure positive supply support is provided to tactical units of first line weapons. This means:

Middletown Air Materiel Area, at Olmsted Air Force Base, Middletown, Pa. buys guided missile components support and rocket engine parts for the *Falcon* (GAR 1,2,3, and 4); *Sidewinder* (GAR 8); fuels, lubricants oils, waxes and corrosion preventative compounds; chemicals and chemical products; gases, compressed and liquified and gas cylinders; miscellaneous instruments (other than Government-Furnished Aircraft Equipment—GFAE) and laboratory equipment; electrical meters and maintenance parts; parachutes and aerial pickup and cargo tie-down equipment. It also provides for contractual maintenance and modification services for the support of commodities listed above and missiles and/or engines for which it has prime maintenance responsibility. It also buys structural components and aircraft engine parts for specified training, transport and liaison aircraft.

Mobile Air Materiel Area, Brookley AFB, Mobile, Ala., buys guided missile components for the SA-16 *Jupiter* intermediate range ballistic missile and aircraft components for the F-84 and F-105. It also provides for contractual maintenance and modification services for this missile.

Ogden Air Materiel Area, at Hill AFB, Ogden, Utah buys guided missile components, support and engine parts for the IM 99 *Bomarc*, SM-62 *Snark* and the SM-73 *Goose* (now cancelled). It also buys laboratory equipment biological surveillance and provides contractual maintenance and modification services for the listed missiles and/or engines. It also keeps parts for F-101 and other specified aircraft.

Oklahoma City Air Materiel Area, Tinker AFB, Oklahoma City, buys guided missile components, and support for the *Rascal* (GAM-63, now cancelled); *Hound Dog* (GAM-77) and *BullPup*, and provides maintenance and modification services for these missiles. It also buys parts and support for B-52, B-47, KC-135 and other aircraft.

Rome Air Materiel Area, Griffiss AFB, Rome, N.Y. is responsible for the purchase of the largest part of the Air Force's electronic, radio and radar

equipment procurement. Specifically, it buys ground radio, radar and navigational equipment, meteorological equipment, instruments (except airborne) and supplies; ground communications equipment, miscellaneous electric power and distribution equipment and supplies, lighting fixtures for airports, lighting fixtures and lamps (except airborne), and electric wire and cable.

Rome AMA buys the engineering and installation of ground electronics support equipment, facilities and systems (GEEIA). It also buys systems integration, development, service test and similar functions required for implementation and operation of Electronic Support Systems (ESSPOs).

San Bernardino Air Materiel Area, at Norton AFB, Calif., has been designated the support manager for ballistic missiles. As such, it buys guided missile components and support for the *Atlas, Titan* and *Thor* ballistic missiles and will, presumably, take on the job for *Minuteman* at a later date. It is also responsible for the support of the Q-2 target drone built by Ryan and the Q-4 drone built by Radioplane. It also buys parts and support for specified aircraft.

Warner Robins Air Materiel Area, Robins AFB, Macon, Ga., buys guided missile component support for the *Matador* (TM-61) and *Mace* (TM-76) and airframe structural components for the C-130 and B-57. Aircraft launching, landing and ground handling equipment; weapons, except Army Ordnance assigned items; bearings; metal working and woodworking machinery and equipment; maintenance and repair shop equipment (aircraft, motor vehicle and weapons); tires and tubes, except aircraft; gas turbines and jet engines, except aircraft; rescue and safety equipment. The AMA will provide contractual maintenance and modification services for support of commodities listed above and aircraft, bombing, gunnery and fire control systems and equipment and aircraft and missiles and/or engines for which the AMA has primary responsibilities.

Dayton AF Depot, Gentile AF Station, Dayton, Ohio, buys airborne radio, radar and navigational equipment and components, airborne communications equipment; electrical and electronic equipment, components; terminals; terminal boards, connectors, fuses, lightning arrestors, capacitors, resistors, switches, circuit breakers, tubes, relays, contactors, solenoids, insulators, knobs, pointers, dials and piezo electric crystals, laboratory and shop test inspection equipment and maintenance parts, measuring tools, inspection gages, and combination and miscellaneous instruments. Dayton does *not* buy any Government Furnished Aircraft Equipment (GFAE) in the way of airborne radio or airborne communications equipment.

There are two other air materiel areas and one depot. **Sacremento AMA** at McClellan AFB specializes in the purchase of airframe structural parts for aircraft including the F-100, F-104 and the upcoming F-108 among others. **San Antonio Air Materiel Area,** at Kelly AFB, Tex., buys airframe structural parts and engine parts for the B-58, the F-102 and has been designated the support manager for the B-70, chemical bomber and the WS-125A, nuclear-powered aircraft.

In outlining the decentralized procurement responsibility, Air Materiel Command notes that there is, in addition, a local purchase or base procurement program. This deals with the purchases of supplies and services required to support a specified installation. Most of the items bought are of a housekeeping nature.

Actually the would-be contractor or subcontractor doesn't have to go to the listed AMAs for help. Middletown AMA is responsible for five procurement districts, located at Boston, Newark, New York, Philadelphia and Rochester. In addition, there are eight Air Procurement offices, located at Hartford, Conn., Hackensack, N.J., and South Orange, N.J.; Stamford, Conn.; two in Pittsburgh, Pa., and one at Buffalo and Syracuse, N.Y. Finally AF has stationed at the plants of principal contractors representatives who can help. These are located at Bell Aircraft, Niagara Falls; Curtiss-Wright Wood-Ridge, N.J.; Fairchild Engine and Airplane at Hagerstown, Md., General Electric, Syracuse; Sperry Gyroscope, at Great Neck, L.I. and United Aircraft at Stamford, Conn.

How does the Air Force manage its vast buying program? It uses what it calls the Weapon System Integration concept. This means that an AF contract gives a strong prime contractor the basic responsibility to design, develop, produce and manage the total effort under the supervision of the Air Force.

However, this does not mean that subcontractors and suppliers are left out in the cold. AF usually requires that a specific part of the contract be subcontracted. It also wants to approve the subcontract structure.

Purpose is to be sure that the prime contractor does not keep in-house work which can be done more efficiently or economically on the outside.

Most of the prime contractors maintain active organizations which aim at building up and maintaining a strong subcontract structure. These involve in some cases as many as 23,000 subcontractors and suppliers, with 5,000-6,000 not being in any way unusual. A good point of contact for business is the prime contractors including: Boeing Airplane Co., Seattle, Wash.; North American Aviation, Canoga Park and Downey, Calif.; Lockheed Aircraft, Sunnyvale, Calif.; Aerojet General Corp., Nimbus, Calif.; Convair Division of General Dynamics at San Diego, Calif.; McDonnell Aircraft, St. Louis; Radio Corporation of America, Camden, N.J.; General Electric, Philadelphia, Pa., and Syracuse, N.Y.; Douglas Aircraft, Santa Monica, Calif.; Republic Aircraft, Farmingdale, L.I.; The Martin Company, Denver, Col., and Orlando, Fla.; Hughes Aircraft, Culver City, Calif., and Tucson, Ariz.

In one important area, Air Force does not handle its own work. Construction of missile bases, while planned for by the Air Force is handled by the Corps of Army Engineers acting as agent for the Air Force. Most of the contracts for construction of bases, many of which involve the installation of equipment, are handled on open bids invited by the District Engineer in which the installation will be located.

If you aren't interested in producing hardware but have a new idea, or a new way of doing something important for the AF, the Air Research and Development Command at Andrews AFB, just outside of Washington, D.C., frequently will talk business to private research groups, industrial concerns, regardless of size, and to nonprofit organizations.

ARDC is headed by a lieutenant general. There is a vice commander and an assistant vice commander. The office is divided into five main sections: Resources; Air Defense Systems Integration; Research; Ballistic Missiles, and Weapon Systems. Air Defense Systems Integration is located at Bedford, Mass. and the Ballistic Missiles Division is located at Inglewood, Calif. The other divisions are at Andrews AFB.

The resources office would probably be the first point of contact for a would-be contractor. It consists of: Directorate of Materiel; Directorate of Installations; Directorate of Procurement; Technical Services; Personnel; Operations; and Manpower and Organization. An Assistant Deputy Commander is charged with responsibility for contractual and technical services and would be helpful to the man with an idea.

The research engineering section would be another point of contact. It is the office which places most of the "pure" research contracts.



Procurement & Production, Missiles, FY 1960

How To Do Business With the Navy

Navy will spend over $6 billion in the next fiscal year. Here is a breakdown of those expenditures and tips to prime and subcontractors on how to obtain contracts . . .

FOR THE FISCAL YEAR 1959-60, the Navy plans procurement obligations totaling more than $6 billion. These contracts will involve everything the Navy needs from missiles, ships and planes to machined parts, food and clothing.

A breakdown of these planned expenditures shows the following major items:

Aircraft, $1.86 billion; ships, $1.7 billion; followed by various categories in the missile and rocket, and support systems areas—missiles, $716 million; electronics and communications, $318 million; construction, $266 million; miscellaneous procurement and production including target drones, machine tools etc., $96 million; production equipment and facilities, $26 million; and support vehicles, $30 million.

As with the Department of Defense and the other services, the two major approaches to selling to the Navy—whether it be hardware, supplies, equipment, missiles or support equipment, or research and development ability—are either as a prime contractor or as a subcontractor to a prime.

To obtain prime contracts, it is necessary to get on the bidders' lists for those items the company is qualified to produce. The Navy recommends reference to the booklet "How to Sell to Agencies Within the Department of Defense" which is available from the field offices of all the services. Major Navy field offices are the Inspectors of Naval Material located in 29 cities in all parts of the nation. The booklet covers both advertised and negotiated contracts.

If the interest is in the subcontract, it is necessary to get on the bidders' lists of the various primes. Lists of these primes also can be obtained from the Inspectors of Naval Material. The Navy recommends another booklet, "Selling to Navy Prime Contractors," NaVEXOS P-1030, as a source of information on procurement and production.

The third largest item in procurement obligations is for research and development work. Frequently such R&D contracts lead to production contracts.

These contracts usually are let by the interested bureau or office of the Navy on a competitive basis to the firm best qualified to do the work at the lowest cost. Detailed information may be found in two publications: "The Office of Naval Research Contract Research Program," which is available from the Chief of Naval Research, Department of the Navy, Washington 25, D.C.; and "Inventions Wanted by the Armed Forces," published by the National Inventors Council, Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

Another good source of information, the Navy says, is the Department of Commerce's "Daily Synopsis of U.S. Government Proposed Procurement, Sales and Contract Awards" which is available for a yearly subscription of $7.00 from the Commerce Department's Field Service, Administration Service Office, 433 West Van Buren St., Chicago 7, Ill.

During the past five years, approximately 20% of the Navy's domestic procurement dollar went directly to small business, with another 20% to small business in subcontracts. The Navy has a vigorous program to encourage small business—some 130 persons are primarily concerned with helping small business and are located in all major naval purchasing activities and in the Offices of the Inspectors of Naval Material.

One effective way to help small business is to set aside total procurements or parts of procurements exclusively for negotiation with small business. This is done generally when limiting of competition will not result in payment of unreasonable prices by the government.

In addition, the Navy Department in 1954, in cooperation with the Army, Air Force and other Federal agencies, developed the Industrial Assistance Program. Under this program, businessmen are advised of trends and needs of the services by means of procurement conferences, exhibits of items needed, and other activities to stimulate interest.

The coordination and direction of "material matters" in the Navy are the responsibility of the Assistant Secretary of the Navy (Material) assisted by the Chief of Naval Material. Under his guidance, the technical bureaus and offices are responsible for providing the Navy's needs.

Each of these offices or bureaus designs, procures, controls and maintains those segments of equipment coming under its particular cognizance.

This includes some 36,000 major end items such as ships, missiles, planes, communications devices etc., and more than 1,200,000 secondary supply items needed to support, operate and maintain the major equipment. This latter replenishable material includes 800,000 repair parts and 400,000 consumable and general supply items.

The Bureau of Aeronautics is charged with maintenance of superiority of the U.S. Navy in the air. In addition to the procurement of aircraft, BuAer is charged with procurement of the air-to-air and air-to-ground missiles. As with BuOrd, BuAer is interested in research and development work in its own field.

The Bureau of Ships is charged with design, building, conversion and altera-

tion of naval vessels, including the missile launching surface units and the submarines including *Polaris*.

The Bureau of Supplies and Accounts fills many needs throughout the Naval Service. The Bureau, through a network of more than 200 decentralized offices throughout the country, spends annually more than $2 billion to acquire more than a million items.

This procurement covers almost all categories of consumables, repair parts and technical items including electronics and special parts for guided missiles and support equipment including nuclear powered submarines for the *Polaris* missile system.

The Bureau is interested in expanding its procurement sources and encourages competition from both large and small business alike. It invites all qualified suppliers to have their names placed on the Navy's bidding lists. An information brochure can be obtained from the Bureau of Supplies and Accounts (Code OZ), Navy Department, Washington 25, D.C.

The Bureau of Yards & Docks has the responsibility for the construction and maintenance of the Navy's shore establishments. Also, through the Naval Civil Engineering Laboratory, Port Hueneme, Calif., the Bureau conducts broad research, development, testing and evaluation of methods, procedures, materials and equipment pertinent to its field of endeavor.

Civilian contractors interested in work for the Bureau, or inventors, researchers and others who wish to investigate possibilities or bid on work should contact one of the Naval District Public Works Offices located in various large cities.

The Bureau of Medicine & Surgery procures its supplies through a joint procurement agency—Military Medical Supply Agency, 84 Sands St., Brooklyn 1, N.Y.

The Office of Naval Research is responsible for sponsoring both basic and applied research. Its fields of interest to date include all the basic sciences such as physics, acoustics, chemistry, geophysics, electronics, mathematics, statistics, mechanics, systems analysis and others.

The Marine Corps., which is part of the Naval Establishment, through its Quartermaster General, procures electronics and engineering items, refrigeration and air conditioning equipment. Much of its procurement is carried out through contracting officers at the Marine Corps Supply Activity, 1100 South Broad St., Philadelphia, Pa.

The Navy's overall policy in procurement provides that research and development contracts be awarded on the basis of comparative technical ability in the specific science or technology involved in the work. Because of the exploratory nature of the work, and the uncertainties of successful accomplishment, cost-reimbursement contracts generally are used in this field.

Consequently, the award of such contracts normally is based on the comparative ability of the proposed contractors rather than on comparison of the estimated costs, since in cost-reimbursement contracts advance estimates of cost do provide a valid indication of the actual final costs.

So that there will not be unnecessary waste and cost involved, the Navy usually requests technical proposals only from firms which have been technically evaluated and believed qualified to do the work involved.

When applications are received, the Navy reviews the prospective contractor's management techniques, his compliance with the Department of Defense policies and thoroughly investigates the subcontracting plan.

Navy Purchasing Offices

Inspectors of Naval Material
50 7th St. NE
Atlanta 5, Ga.
Phone TRinity 6-3311 ext. 5593

Inspectors of Naval Material
401 Walter St.
Baltimore 2, Md.
Phone PLaza 2-7900 ext. 2-8460

Inspectors of Naval Material
495 Summer St., Post Office Box 2276
Boston 7, Mass.
Phone LIberty 2-5100

Inspectors of Naval Material
181 Middle St., Jayson Building
Bridgeport, Conn.
Phone FOrest 8-2567

Inspectors of Naval Material
740 Main St.
Buffalo 2, N.Y.
Phone Washington 4400-4406

Inspectors of Naval Material
RCA Building, Front and Cooper Sts.
Camden, N.J.
Phone WOodlawn 3-8690

Inspectors of Naval Material
800 1st Ave. NE., Box 1510
Cedar Rapids, Iowa
Phone EMpire 4-0165

Inspectors of Naval Material
608 South Dearborn St.
Chicago 5, Ill.
Phone HArrison 7-9300

Inspectors of Naval Material
230 East 9th St.
Cincinnati 2, Ohio
DUnbar 1-2200

Inspectors of Naval Material
Ferguson Building, 1783 East 11th St.
Cleveland 14, Ohio
Phone CHerry 1-7900

Inspectors of Naval Material
1114 Commerce St.
Dallas, Texas
Phone RIverside 8-561, ext. 311

Inspectors of Naval Material
310 East Jefferson Ave.
Detroit 26, Mich.
Phone WOodward 5-0714

Inspectors of Naval Material
3802 South Calhoun St.
Fort Wayne 6, Ind.
Phone HArrison 4231

Inspectors of Naval Material
605 Stewart Ave.
Garden City, Long Island, N.Y.

Inspectors of Naval Material
318 East 10th St.
Kansas City 6, Mo.
Phone BAltimore 1-700

Inspectors of Naval Material
1206 South Santee St.
Los Angeles 15, Calif.
Phone RIchmond 9-4711

Inspectors of Naval Material
783 North Water St.
Milwaukee 2, Wis.
Phone BRoadway 3-5901

Inspectors of Naval Material
U.S. Courthouse, 3rd St. and Marquette Ave. South
Minneapolis 1, Minn.
Phone FEderal 2-3244, Ext. 157-159

Inspectors of Naval Material
Naval Industrial Reserve Shipyard
Building 13, Port Newark
Newark 5, N.J.
Phone MItchell 3-5700

Inspectors of Naval Material
207 West 24th St.
New York 11, N.Y.
Phone WAtkins 4-5000

Inspectors of Naval Material
17 Brief Ave., Upper Darby, Pa.
Philadelphia, Pa.
Phone GRanite 4-4840

Inspectors of Naval Material
401 Old Post Office Building
Pittsburgh 19, Pa.
Phone EXpress 1-2560

Inspectors of Naval Material
10 North 8th St.
Reading, Pa.
Phone Franklin 4-5194

Inspectors of Naval Material
321 U.S. Customhouse (Old), 815 Olive St.
St. Louis 1, Mo.
Phone MAin 1-8100

Inspectors of Naval Material
Building 178, Treasure Island
San Francisco 19, Calif.
Phone EXbrook 2-3931

Inspectors of Naval Material
Post Office Box 1085
Schenectady 1, N.Y.
Phone DIckens 6-8476

Inspectors of Naval Material
2300 11th Ave. SW
Seattle 4, Wash.
Phone ELliott 8800

Inspectors of Naval Material
Post Office Building, Room 310
Springfield, Mass.
Phone REpublic 9-7391

Inspectors of Naval Material
428 South Warren St.
Syracuse 2, N.Y.
Phone GRanite 4-6861



PROCUREMENT & PRODUCTION, MISSILES, FY 1960

How To Do Business With the Army

This article show the businessman how he can get part of the Army missile dollar. Included also is a list of current Army missile and rocket systems and their prime contractors . . .

THERE ARE two basic ways for a businessman to get a part of the Army missile dollar. One way is get a contract to do certain research and development work, or as the prime contractor for a missile or system. The second approach—and the one through which the greater part of the business volume is channeled—is as a subcontractor to a prime or as a supplier of parts, components or services.

The prime contractor who gets a research and development contract, usually for an entire missile system, is responsible for the initial production of all system components including the missile, launching and handling equipment, guidance, documentation and test equipment. While the prime has the overall responsibility, in most cases the dollar volume of the subcontracted components far exceeds the value of the components manufactured directly by the prime contractor. This, naturally, depends on the capabilities of the prime and the scope of the entire system.

Selection of a Contractor

Selection of a contractor for production of a missile system or components is achieved through formal advertising and negotiation. Selection is based on a number of criteria including production capability, reliability, costs, quality of the company's commercial or military products, and specific production requirements for the particular item being considered.

Consequently, it is important that the Army know what each industrial firm can do. The overall responsibility for the Army missile program has been assigned to the U.S. Army Ordnance Missile Command, Redstone Arsenal, Alabama, under the jurisdiction of the Chief of U.S. Army Ordnance Corps. The Army Ordnance Missile Command (AOMC) maintains a source file on industrial firms.

Those interested in doing business with the Army should supply the following information: name and type of company; total number of employees including research scientists and development engineers or other technical personnel; plant space and equipment including laboratory equipment and other facilities for research and development work; security clearance if a "facility clearance" is held for Army, Navy or Air Force work; general information on engineering capability and commercial and defense products; financial statement and descriptive brochure or any other information which would help in determining the full capability of the company.

Regional points of contact are provided by the 11 Ordnance Districts (see listing). Each of these districts maintains lists of items to be procured. AOMC normally requests the Ordnance Districts to secure quotations when a supplier of missile items is to be selected. After evaluation and bids, AOMC will request the District to prepare a contract with the selected supplier.

While contract administration always is the responsibility of AOMC, under certain circumstances procurement may be allocated directly to the Districts for selection of suppliers and contractural action.

An interested contractor or supplier is given an opportunity to review such research and development drawings and specifications are obtained before submitting formal proposals or bids. This information can be had from the 11 District Offices. A security clearance may be required to obtain this information and details as to subcontracting possibilities. It is of prime importance that prospective Army contractors and suppliers maintain contact with the Ordnance District Offices.

By its very nature, the procurement of guided missile systems and the replenishment of spares, is different from procurement of other items. Frequently, urgency of the program will not permit normal competitive procedure until late in the program. The more information the District Office and AOMC has on a company, the better its opportunities for selection.

New Army Procedures

The Army welcomes ideas for new weapons and material items voluntarily generated by industry and civilian organizations. However, there have been cases where costly voluntary efforts resulted only in disappointment because the ideas were not sufficiently compatible with the factors which must be considered by the Army.

To assist prospective contractors the Ordnance Corps has published Order 7-58 which establishes some new procedures to aid in the availability of information as to what new items the Army would like to have developed. Any interested U.S. civilian organization which has a suitable R&D capability, has the necessary clearances and has signed the policy agreement form can now obtain information on what the Army wants.

The required Policy Agreement form may be obtained from the district offices. If the company already is working with Ordnance on an R&D type contract, queries may be submitted directly to the Ordnance Commodity Command or the Commodity Arsenal with which it has been dealing. This is because they already are familiar with the company's capability. Where such

work is not in progress, or the company wishes to expand into areas not covered by current contracts, the query should be submitted directly to the nearest Ordnance District Office. The District Office will then advise as to how to become a qualified organization and put the company in touch with the proper Commodity Command or Commodity Arsenals.

Normally, development requirements information will be released only from the Ordnance Commodity Commands and Arsenals. This may be done by means of interviews, group briefings, distribution of written documents, or by correspondence. However, for the present, it is anticipated that group briefings will be the principal method.

Inasmuch as a missile system in its final operation draws on practically every agency and corps of the Army, business opportunities in support of the missile program can be developed through other units, as well as the Ordnance Corps. For information as to the proper agency for R&D work, queries should be submitted to the Office of the Chief, Research and Development, Department of the Army, Washington 25, D.C., Attn.: Technical Liaison Office. This office maintains a list of items and activities with which each of the technical services and commands of the Army is concerned.

Such proposals should be complete and concise with full information on the proposing firm and a discussion of the proposed work in terms of objective and scope.

If the proposal is accepted, a contract may be negotiated between the organization and the apprpopriate agency. If it is not accepted, the government is not obligated in any way to reimburse the firm for costs it might have incurred in submitting the proposal or seeking the contract. Corps, and their fields of endeavor include:

Corps of Engineers—most of the support equipment for missile systems, rockets and satellite programs. This involves a variety of work such as: construction and maintenance equipment; launching towers; cover and concealment of weapons; electrical equipment such as generators and converters; fire-fighting equipment; industrial engines including turbines; industrial gases and compressors; infrared and night vision equipment; liquid fuels distribution; mapping, geodesy and surveying materials; nuclear power and heating plants; prefabricated buildings and other areas of interest.

Ordnance Corps—in addition to weapons, Ordnance has cognizance of fire control equipment and material; fuels and lubricants.

Quartermaster Corps—chemicals and plastics; environmental protection; individual clothing and equipment which should become more important with the development of nuclear power for missiles and the attendant hazards of radiation and decontamination; mechanical equipment; and test materials and techniques.

Signal Corps—avionics; electronic countermeasures; electronic data processing systems; infrared, ultraviolet, meteorological instrumentation; radar; radio and wire communications; radio direction finding; sound, and light and television.

Transportation Corps—air, marine, motor and rail transportation.

Chemical Corps—biological agents; chemical agents; incendiaries; protective equipment; screening agents; smokes, weapons.

Army Medical Service—all basic research in medical sciences.

For research in areas of personnel training, motivation and leadership, the Army has the Human Resources Research Office in Washington.

The current list of Army missile and rocket systems and their prime contractors include:

Corporal—Firestone Tire & Rubber Co. (missile and ground handling equipment), Gilfillan Brothers, Inc. (ground guidance equipment).

Hawk—Raytheon Manufacturing Co.

Jupiter—Army Ballistic Missile Agency (missile system) and Chrysler Corp. (missile fuselage and assembly and ground equipment).

Honest John—procurement responsibility for this rocket, with the exception of the fins and warhead compartments, has been transferred to the Commanding General, U.S. Army Ordnance Ammunition Command, Joliet, Ill. Ground equipment is under the authority of the Commanding General, U.S. Army Ordnance Weapons Command, Rock Island, Ill. Fins and warhead compartments are under Emerson Electric Mfg. Co., one of the prime contractors.

Lacrosse—Cornell Aeronautical Lab., and The Martin Company.

Nike—Western Electric Company; Goodyear Aircraft Company and Borg Warner Corp. (solid sustainer motor booster motor). Procurement of booster motor metal parts is the responsibility of the Commanding General Army Ordnance Ammunition Command, Joliet, Ill.

Pershing—The Martin Company.

Plato—Sylvania Electric Products, Inc.

Redstone—Army Ballistic Missile Agency and Chrysler Corp.

Sergeant—Jet Propulsion Laboratory (missile system) and Sperry Utah Engineering Lab. (all critical R&D components).

The Army has issued a statement which reads:

"It seems quite clear that a company which aspires to become an important factor in the guided missile industry in the role of a prime contractor should strive to attain a position of being able to assume full responsibility for system development and program management. The smaller company would do well to concentrate on superiority of individual components so that their reputation for reliability, superior performance, and better cost will lead prime contractors to their door."

The Ordnance Districts

Birmingham Ord. Dist.
2120 No. Seventh Ave.
Birmingham, Ala.
Birmingham 53-3421

Boston Ord. Dist.
Boston Army Base
Boston 10, Mass.
Liberty 2-6000

Chicago Ord. Dist.
209 W. Jackson Blvd.
Chicago 6, Ill.
Webster 9-6000

Cincinnati Ord. Dist.
Swift Bldg., 230 E. 9th St.
Cincinnati 2, Ohio
Dunbar 1-2200

Cleveland Ord. Dist.
Lincoln Bldg., 1367 E. 6th St.
Cleveland, Ohio
Tower 1-4960

Detroit Ord. Dist.
574 E. Woodbridge
Detroit 31, Mich.
Woodward 5-3720

Los Angeles Ord Dist.
55 S. Grand Ave.
Pasadena, Calif.
Ryan 1-8471

New York Ord. Dist.
770 Broadway
New York 3, N.Y.
Oregon 7-3030

Philadelphia Ord. Dist.
128 N. Broad St.
Philadelphia 2, Pa.
Locust 8-0400

St. Louis Ord Dist.
430 Goodfellow Blvd.
St. Louis 20, Mo.
Evergreen 2-8200

San Francisco Ord Dist.
1515 Clay Street
P.O. Box 1829
Oakland 12, Calif.
Twin Oaks 3-6330



Ernest Brackett
Director of Procurement and Supply

How To Do Business With NASA

National Aeronautics and Space Administration was added this year to the list of contracting agencies in the missile business. Outlined here are some of NASA's procurement procedures . . .

ANOTHER NAME has been added this year to the list of contracting agencies in the rockets and space development field. Under the National Aeronautics and Space Act of 1958, signed into law by the President July 29th last year, the charter and responsibilities of the National Advisory Committee on Aeronautics was expanded. NASA was given the overall responsibility for the nation's space program which the Act stated "should be devoted to peaceful purposes for the benefit of all mankind."

Generally speaking, NASA procurement follows the provisions of the Armed Services Procurement Regulations. This normally is by formal advertising for competitive bids where the supplies, materials, equipment or construction work can clearly be defined in drawings or specifications. However, in the case of research and development and other instances where such specification is not feasible, procurement is through negotiation with qualified firms.

The greater part of the procurement and contracting for services is carried through the field stations. However, any contract in excess of $25,000 must be countersigned by the NASA headquarters. All contracting negotiation and administration is performed via the field stations except in certain cases when the items or work sought does not fall specifically under the cognizance of one of the field stations.

NASA normally negotiates its own contracts with prime contractors. This is done directly with the contractor by NASA's own staff for contract negotiation and administration. A flexible procedure is employed which permits use of the services of the Department of Defense or other governmental agencies, as NASA sees fit. NASA's own technical direction, including project officer supervision, for all prime contracts is used except for standard hardware items more easily obtained by extension of already existing military contracts.

The actual level within the NASA organization responsible for the detailed technical direction and execution of the particular project negotiates with research and development contractors.

To the maximum extent possible, small business is given opportunity to participate in supplying NASA's supplies and services.

For actual procurement, NASA employs a decentralized system. This means that all equipment and supplies needed by a NASA field station are procured by the procurement officer at that station. Each of these procurement activities maintains its own bidders list, and should be contacted by those wishing to participate in NASA's procurement (see listing).

Advertising Procedures

In the case of purchases by formal advertising, strict adherence to a prescribed procedure is followed. At a specified time bids are opened and the bid most advantageous to the government is accepted. Upon award, the accepted bid becomes a legally binding contract.

When formal advertising does not meet the needs of NASA, procurement by negotiation is permitted. This method is when experimental, developmental or research work is involved or the urgency of the situation demands it. However, it is the policy of NASA to assure full and free competition as far as possible. Award in such cases is made in the best interest of the government considering price, delivery, quality of the product and other factors based on the origin proposals or negotiation.

NASA reminds would-be contra tors preparing their bids to watch fo special conditions relating to material packing, packaging and delivery whic may vary from the standard printe instructions. Any bid which does n conform to the requirements of th invitation for bids will be rejecte All bids may be rejected when reje tion is in the interest of the gover ment, or when the contracting offic does not consider the bids reasonab nor arrived at independently, or fee they are collusive or in bad faith.

Generally speaking, NASA em ploys the fixed-price contract for bot advertised and negotiated procuremen Certain variations of the fixed-pric contract is used for price redetermina tions where the performance of th contract may involve large contin gencies or uncertainties in costs.

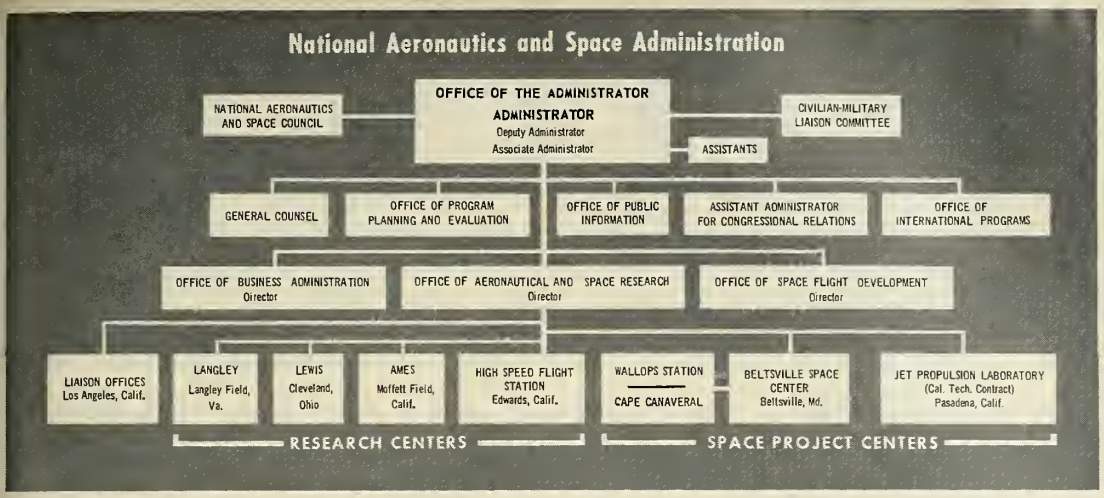
Cost-reimbursement contracts ar reserved for certain situations and ma be awarded with or without a fee. I emergencies, or under unusual circum stances requiring maximum reductio of procurement lead time, letter-of-in tent contracts enable the contractor t begin work pending negotiation an execution of the actual contract.

Cost - plus - percentage - of - cos contracts are prohibited by law.

Although contractors are expecte to be fully qualified and competent t carry out the contract including th financial requirements, when such wor will result in serious drain of the con tractor's working funds, the govern ment may provide financial assistance

In addition, the Small Business Ad ministration can grant loans to sma concerns for the financing of plan construction, equipment or for use a working capital.

NASA recognizes the increasin



e of quality control techniques by dustry and emphasizes the impornce of quality in all supplies and parts ed in the highly complex space vecles and equipment. Before materials e accepted, they are subject to inection for compliance with contract ecifications.

As with the military services, frently a facility clearance is required r NASA contracts. This is necessary henever access to classified matter is quired either by the contractor or his ployees. Subcontractors on classified jects should obtain a facility securi clearance via the prime contractor.

Most of the supplies purchased by ASA conform to the federal or mili y specifications on quality, size, perfmance etc., available from the Government Printing Office.

As with other government agencies, it's the policy with NASA to include in contracts involving employment of lor, a provision obligating the contctor not to discriminate against any employee or applicant for employnt because of race, religion, national gin, or color.

NASA points out that in research al development work especially, the competence of a firm is not always dermined by its size. Contracts for RD are awarded on a basis of highes competence in the specific branch oscience or technology required for successful execution of the project.

In addition, NASA each year lets a umber of research grants and contrts to educational institutions and nd-profit organizations. These contrts involve research of two general tys—supporting research and fundamtal research. Research proposals shld be submitted (10 copies will falitate evaluation) to the National Aonautics and Space Administration, 150 H. St., N.W., Washington 25, D.C. marked for the attention Research Grants and Contracts Office. All such contracts are handled by the NASA headquarters and not by any of the field stations.

While bona fide representatives are permissible, the "Covenant Against Contingent Fees" clause included in all NASA contracts is warranty by the contractor that he has not retained other parties in soliciting or securing the contract. Breach of this warranty may result in an annulment of the contract or recovery by the government of the amount of fee already paid. Employees or established commercial or selling agencies maintained by the contractor to secure new business can represent the firm.

List of products—A representative list of items and supplies procured by NASA follows:

Abrasives; Air Conditioning Equipment and Supplies; Aircraft Maintenance Equipment and Supplies; Building Materials; Castings; Chemicals; Chemical Laboratory Equipment and Supplies; Clothing, protective; Communications Equipment; Data Recording and Processing Equipment; Drafting and Illustrating Equipment and Supplies; Electrical Maintenance Shop Equipment and Supplies; Electrical Power Distribution Equipment and Supplies; Electronics Hardware and Supplies; Electronic Instrumentation Equipment; Electronic Test Equipment; Forgings; Foundry Supplies; Gases, compressed; Gases, liquefied; Hardware, all kinds; Janitorial Supplies; Lumber; Machine-shop Services; Materials Handling Equipment; Materials Testing Equipment; Mechanical Power Transmission Equipment; Metal Fabrication Services; Metal Finishing Equipment and Supplies; Metal Heat Treating Equipment and Supplies; Metals, ferrous; Metals, non-ferrous; Metals, precious; Metalworking Equipment and Supplies; Missile Structural Components; Office Equipment and Supplies; Offset Printing Equipment and Supplies; Oils and Greases; Paints; Painting Equipment and Supplies; Photographic Equipment and Supplies; Plastics Materials; Plastics-working Equipment and Supplies; Plumbing Supplies; Pressure Systems and Equipment; Pressure Vessels; Reproduction Equipment and Supplies; Safety Equipment and Supplies; Shop Furniture; Telemetry Equipment; Vacuum Systems and Equipment; Welding Equipment and Supplies; Weldments; Wind Tunnel Instrumentation Equipment and Supplies; Woodworking Equipment and Supplies.

Representatives of the Contracting Officer on Construction Projects

Mr. J. Cabell Messick
Chief, Engineering Services Division
Langley Research Center
Langley Field, Virginia

Mr. Charles A. Herrmann
Chief, Technical Services Division
Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Mr. Charles H. Harvey
Representative of the Contracting Officer
Ames Research Center
Moffett Field, California

Officials in Charge of Procurement of Supplies and Equipment

Mr. Sherwood L. Butler
Procurement Officer
Langley Research Center
Langley Field, Virginia

Mr. E. C. Braig
Procurement Officer
Lewis Research Center
21000 Brookpark Road
Cleveland 35, Ohio

Mr. Alvin S. Hertzog
Procurement Officer
Ames Research Center
Moffett Field, California

Mr. M. E. Bowling
Procurement Officer
NASA High Speed Flight Station
Box 273
Edwards, California



The representative from

'missiles and rockets' offers you the most exciting half hour of your week

In just thirty minutes, this man from Missiles and Rockets can reveal what's in a missile for you. Backed by information from the largest editorial staff exclusively serving the $7 Billion Missile Market, and by the m/r research department, he's tuned to the rapid change in the market . . . the overnight adjustments in manufacturing and marketing methods. New plants, new organizations, new techniques are appearing. Old materials are being used in *new* ways. If you are already active in the missile field, he can show you how to sell *more* in MISSILES AND ROCKETS—the main source of accurate information in the missile market. Don't wait for his call. Write, phone, or wire your nearest regional office and prepare yourself for the most exciting half hour of your week.

M/R

missiles and rockets

AMERICAN AVIATION PUBLICATIONS, INC.
World's Largest Aviation Publishers
1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

What a Prime Seeks from a Sub

A prime contractor official describes the weapon system concept and explains what a weapon system contractor expects from the suppliers . . .

by Rulon Nagely
Corporate Director, Material
North American Aviation, Inc.

THE RELATIONSHIP between a weapon system contractor, and his uppliers and subcontractors is perhaps ne of the most important elements in oday's defense picture.

A well-established, smooth work- ng relationship can lead to increased roduction efficiency and can save the overnment thousands upon thousands f dollars. On the other hand, poor co- rdination between the key organiza- ons can only result in wasted time nd effort, financial loss and, in ex- eme cases, perhaps could lead to the limination of the particular weapon ystem involved.

To fully understand the problems volved, it is important to first under- and the method of procurement hich is described as "the weapon sys- m concept." Historically, the various ilitary contractors, particularly those oing business with the Air Force or e Navy, were responsible only for e design and production of the pri- ary piece of equipment. In the case aircraft manufacturers, this was the rplane itself; the Government fur- shed such items as engines, wheels, akes, instruments, radar equipment, ros and so on.

Only occasionally was the contractor involved in the selection of these items.

The concerned government agency, in effect, acted as weapon system contractor, utilizing a number of subcontractors to furnish the necessary components which when assembled, became a finished, flyable airplane.

The system had certain advantages, not the least of which was that the prime manufacturer was absolved of the thousands of details—and the resultant headaches—that go with the procurement of the many pieces that make the whole.

Time for a Change

However, there were many more, and overriding, disadvantages. All too often the airplane manufacturer found that a vital equipment item would not work properly, or was incompatible with the balance of the system; making the necessary adjustments often delayed the whole program. Delivery schedules were not always as well planned as they should have been. Making major design changes while in the middle of a contract was very difficult and was often expensive because some completed hardware was no longer usable, but had to be paid for.

Where did the fault lie? In few instances could the responsibility be pinpointed to any one group, company or agency. Since there was no clear-cut line of responsibility, confusion and difficulties were unavoidable.

With the advent of the space age, it became increasingly obvious that the problems encountered through this procedure must be eliminated. The newer weapons then envisaged demanded the most exacting coordination and cooperation throughout the defense industry, and required a pooling of the most advanced scientific knowledge, the most specialized technologies, and the newest industrial skills.

The result: the so-called "weapon system concept."

Under this procedure, the prime contractor is held fully responsible for the success of the program, with only a very few, if any, items being furnished by the contracting agency. It is up to the contractor to find the proper equipment item for a given task, to see that delivery schedules are met, and that a high standard of quality, engineering and reliability is maintained. It is up to the contractor, also, to make certain that costs are held within prescribed limits and a very close cost control is



Rulon Nagely, Director of Material for North American Aviation, Inc., was promoted to his present position in 1951 from Purchasing Agent. He joined North American as Purchasing Agent in 1941.

Nagely first entered the aircraft industry in 1937 as purchasing agent for Vultee Aircraft Co., where he remained until 1941.

Nagely is Chairman of the Aerospace Industries Association's Materials Committee and is a member of the U.S. Air Force Advisory Group-Small Business.

maintained by the weapon system contractor.

In the case of today's complex weapons. these procedures involve far more than just selection and purchase; in many, if not most, instances the needed systems and subsystems are nonexistent. The contractor must first determine exactly what is required, he then must not only find the proper company to develop the item, but must also expend considerable effort of his own in assuring that the development process results in getting the right item on schedule and at a minimum expense.

North American Aviation is now weapon system contractor for two major weapon systems, the B-70 Valkyrie, intercontinental jet bomber, and the F-108 long-range jet interceptor. Both are designed for high altitude performance in the Mach-3 range. Under the latter two programs, the only items furnished by the Government are the engines; all other items, including fire-control flight control, mission and traffic control, electronic countermeasure and bombing-navigation systems, as well as other equipment that formerly would have been government-furnished equipment, are now North American's responsibility. We are charged with selecting, ordering and coordinating the manufacture of all the various components and subsystems which will go in to the B-70 and F-108. Moreover, we are also responsible for the ground-handling equipment, servicing equipment and everything else necessary to make the complete weapon system operate properly.

There should be no misunderstanding: the government is still deeply concerned with these programs and through the concerned weapon systems project offices keeps a close and constant watch over what we are doing. However, the responsibility is North American's.

Criticism of Procedure

There has been some criticism of the weapon system procedure, most of it on the basis that costs will increase and that small business will be squeezed out of the picture.

As to the first charge, we fully believe that is an unfounded fear. It is true that some of today's projects are staggeringly expensive as compared with World War II weapons; this is due to the increased complexity of the systems, not to the change in procurement procedures. Additionally, costs under the weapon systems concept can actually be determined and controlled because they are in one spot; previously, these costs were scattered over so many areas, and through so many agencies and companies, that it was almost impossible to determine and control the true and absolute cost of any single completed aircraft.

As to the second fear, we know that there is no basis for its existence. The small businessman will continue to play a vital role in the procurement picture and indeed, may even have increased opportunities for business. The business is still there, and the small businessman will get his share.

Changes in the System

The only basic change is that he will be dealing at a different level; in most instances, he will contact, or be contacted by, a prime contractor rather than a weapon system contractor.

The latter—whether one company or as in the case of some weapon systems, a group of related companies—will simply have moved up a rung on the ladder. The weapon system contractor will be handling most of the duties heretofore handled by the services, the major subcontractors will have replaced the prime contractors in certain procurement situations, and so on.

This means, of course, that the weapon system contractor will not have as much direct contact with the small business firm as has been customary in the past.

The size and scope of today's weapon systems demands that a greater portion of the business be subcontracted with major manufacturing concerns than in the past. It is doubtful that any one company in this country could handle as much as one-half the work involved in the design, development and production of a major modern weapon system.

For example, in the case of the B-70, we have named Boeing Airplane Co. as the subcontract for a wing section. This particular subcontract involves considerable engineering and design effort, as well as actual manufacture. It could not have been handled by a small concern and still have met design requirements and delivery schedules.

Boeing, in turn, will subcontract many of the items that will make up this section—and this is where small business will get its share of the program.

Other major subsystems are being handled in the same manner.

North American has taken several steps to insure that small business does, in fact, participate.

We require our suppliers, on eve purchase order or subcontract of $10(000 or more, to supply us with quarterly report on his small busine subcontracting; he in turn must inse a similar requirement in all of his pu chase orders and subcontracts in th amount.

We notify the regional office of tl Small Business Administration, as w as the Small Business Specialist of tl appropriate branch of the Armed Ser ices whenever a purchase order or su contract is let that appears to off opportunities for small business pa ticipation.

Each of our buyers is required make a "small business checklist" c each purchase, showing whether tl order went to large or small busines and if the former, whether small bus nesses were solicited and why they d not get the order.

Through these and other pr cedures, we are confident small bus ness will get its fair share of the wo on these weapon systems.

Approximately 80 per cent of tl work on the B-70 and F-108 will g to other companies, most of who would be prime contractors to the go ernment in a different situation. The companies will continue to let at lea the same amount of work to small concerns as they did in the past.

These procedures, while establishe by North American for specific pr grams, are essentially the same as wi be followed by other weapon syste contractors. The details may differ, b the basic philosophy will be the sam if for no other reason than the con plexity and size of the programs no being conducted.

Position of Contractor

It is readily apparent that tl weapon system contractor is placed in peculiarly vulnerable position. Holdir a tremendous responsibility for succe of an expensive program of great in portance to our defense picture, he at the same time cut off from dire contact with many of the people wh could increase costs or otherwis cripple the program.

The weapon system contractor mus therefore, be very demanding in h relationships with the immediate sul contractors and suppliers. He mu establish firm ground rules for oper tion, must make certain that all r quirements are met, and must be read to insist on competent performance o the part of both his own subcontracto and those companies on the third an

ourth tiers of effort.

The weapon system contractor must upervise and control the cost and the rogress of all work, and periodic reorts on these items from subconractors are a necessity.

Examination of these reports might ndicate inefficiencies or schedule slipage. In such a case, the contractor ust be prepared to take any steps ecessary to correct the situation.

uality Control

Quality control is extremely impornt, and here, too, the controller must vigilant. The subcontractor is, by rtue of his role, primarily responsible r high standards of workmanship. here quality is not up to par, the eapon system contractor must reserve e right to be arbitrary in demanding work or, if necessary, rejection. ithin the limits of sound working relationships, he must have the right to supervise the quality control procedures established by the other company.

And finally, the weapon system contractor must make certain that there is fast, clear, and accurate communication, not only with the subcontractor, but also between that organization and the others participating in the program. Red tape must be kept to a minimum, and decision-making must be prompt. This is a two-way street, and the weapon system manager has an equal responsibility to his subcontractors to provide fast and accurate information regarding changes of any kind.

The objectives of a particular weapon system program can only be met if this pattern is established at the beginning of the program and maintained to its completion. There must, naturally, be a certain amount of give-and-take on both sides, but essentially, the subcontractor must recognize that ultimate responsibility rests with the weapon system contractor, and that his demands must be met if the program is to succeed.

Working Relationship

This is the same businesslike relationship that should exist between two companies under any procurement system. The difference lies only in the size and complexity of today's weapon systems, and the increased responsibility that falls upon the weapon system contractor.

If these requirements are understood by all parties, and followed from the initial steps in contract negotiation, then there can be assurance that the government and the citizen will receive what is justifiably their due: a reliable, high-performance weapon system, delivered on time and at a minimum of cost.

★ ★ ★

What a Sub Seeks from a Prime

Profit is not the only thing the subcontractor seeks when he does business with a prime. Recognition of quality, courtesy, and fairness are major needs, says this defense industry expert . . .

by John Marschalk

THE NUMBER ONE thing a sub seeks from a prime is a chance to make a profit on quality work. Most primes recognize that a subcontractor has to make a profit to deliver a quality product and stay in business.

This means that *recognition of quality* is next to the top of the list of what a competent subcontractor wants. Years of operation with minimum rejection rates and prompt deliveries ought to mean more than lowest initial price, most qualified suppliers believe. And experienced buyers usually agree. With the heavy emphasis on reliability of supersonic weapons, this would seem to be the only way to buy. Even so, there are many do-good-to-small-business people who keep insisting that award to the lowest bidder (regardless of relative quality) is the "American way" to buy.

Competitive bidding on price alone may be completely satisfactory on common supply items like rope, nails and paper clips—where specifications can be fixed for a period of years. But the firms who work on the technical components of weapons think a low-price award is the certain way of assuring either default or poor quality.

I can think of no better word than "courtesy" for another want expressed time and again by small subcontractors with whom I've talked. They tell me that too many buyers take on a "power-of-God" attitude when dealing with representatives of smaller firms. It is human, I guess, to think of one's



John Marschalk, a public relations consultant, has specialized for the past fifteen years in the problems of industry dealing with Government. Until recently, he was executive director of Strategic Industries Association, a national trade group of small and independent firms in the defense supporting industry.

self as being pretty important when the control over several millions of dollars worth of purchasing is involved. The fellow from the small firm who wants to talk about an order for $3,000 is likely to seem relatively unimportant in the midst of such grandiose activities.

Here, again, the experienced buyer knows that the fellow from the small firm may have something to offer which can save both the prime and the Government millions of dollars and maybe thousands of lives. As the Director of Material for one large company told me recently, "A buyer has to know a little bit about a lot of things. The people he buys from need to know a great deal about just a few things. We try to teach our buyers to listen. They buy better that way."

The most common and costly discourtesy to a small firm representative is to keep him waiting for an hour or more after an appointment time. Frequently the small firm caller is either head of his company or close to it. Every hour he spends away from his plant is a costly deduction from management time. Yet it is his personal know-how which the buyer needs most. He is the one person who can readily interpret buyer needs in terms of his shop's capacity.

To make the small firm representative drive for an hour to the prime plant, park in a lot a half mile from the buying office, and then cool his heels for an hour-and-a-half before getting a three-minute brush-off from a self-important buyer, is about the poorest way to treat a fellow human being, let alone the waste involved.

Fair Return for Design

Finally, among the things small subcontractors want is a fair return for design effort. A common practice with some prime buying departments is to put out an "envelope" specification, asking several subs to submit a design for a component to do a certain job with size and weight limitations. Each sub is expected to submit his design for evaluation, plus a price proposal for doing the work.

When the engineers at the prime choose what they think is the best approach you expect them to negotiate with the firm that submitted the best design. Most companies do handle it that way. Some of them don't. Son take the winning design, copy it ar send it out for bids from other con panies. If the company that submitte the best design isn't low bidder, he ge not a dime for his work. Worse tha that, we know of a couple of class cases in which the prime people sai in effect, "Thanks for the idea; no we know enough to make this ou selves."

The top managements of eve prime we know have no patience wi that kind of practice. It can almo always be traced to that rare sma minded individual who congratulat himself on pulling a fast one. To g such practices stopped is one of t main hopes of thousands of small su pliers.

Adding it up, there are four maj needs on the part of most small su contractors:

1) A *chance* to make a fair profi
2) Recognition of quality over pri
3) Courtesy in handling contacts
4) Integrity in dealing

This is not much different fro what the large firms want for the selves.

Why Subcontractors Go Gray...

"We have lost money on our subcontracting for the past two years in a row. If it were not for our coupling sales, we would be out of business."

The man who told me this two months ago heads one of the most experienced and reliable small subcontract firms in New York State. As an individual, he has spent more than twenty-five years in defense manufacture. He normally employs about 125 people; his shop is rated A-1 on quality and reliability by many major prime contractors for whom he has been a supplier since World War II. Yet he has kept "alive" only through his sales—mostly commercial—of a small proprietary item.

Why has he taken orders at loss figures for the past two years? His answer is simple: "You owe something to your people; if it isn't *too* much of a loss, we'd rather keep them working."

Losses are less than fun for any businessman. But what really gets under this particular subcontractor's skin is the conviction that more than a few buyers with whom he deals enjoy the situation. He described the method used by one large company not far from his plant.

"They have a bidding system. When a job comes up, they send out bids. They claim all their bidders have been qualified to do the job, one no better than another. My company has the lowest rejection rate you can find, but we start out bidding against other outfits who have nowhere near our quality record. So we know we're going to have to shave to the bone to get close.

"So our engineers spend a couple of days analyzing the prints, working out production methods, preparing our bid. This costs a lot of money, in itself. Sometimes it can pay off, though. Sometimes we find a real good way to cut production cost, so the bid we send in is lower than we expected we could do. Maybe it even turns out we're the low bidder.

"But there's a hitch. They don't take the low bid. First thing they do is send it to their Cost Analysis boys. They try to find some holes in it. Maybe they call me on the phone and argue I figured too much for machine set-time or some other thing. Finally, I g a call from the buyer. Say I bid $2 apiece for each of twenty items. I tells me if I'll knock off $50 on ea piece, they will give me the job.

"I tell them to go hang. But y know what? They'll start calling t other bidders with the same pitch ur they find a sucker who will go alon

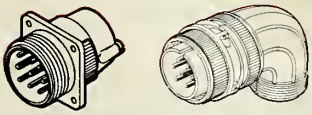
Although I heard the same sto from two other New York subco tractors with whom I visited, I'm p sonally convinced that this squee system isn't common practice. I have run into it in other parts of the coun and it may well be confined to t single prime about whom it was to In the only other case I know of p sonally, a contracting officer for one the military services bragged that had saved over a million dollars Uncle Sam in a single year by us this sort of system. When he was asl how many small companies had g broke as the result, he just shrug his shoulders.

—John Marsch

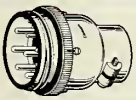
27,000 CANNON PLUG DESIGNS

FOR EVERY CONCEIVABLE APPLICATION

AIRCRAFT AND ELECTRONIC INSTRUMENTATIONS—MS, MS-A, MS-B, MS-E, MS-R SERIES, conforming to Specification MIL-C-5015D. Vibration-proof—Lightweight—Plugs are available with from 1 to 100 contacts. 15 different insert diameters and 260 contact layouts. 6 shell styles, MS 3100 to MS 3108 with all accessories. Environmental-Resisting MS-E and MS-R Series have interfacial sealing at mating faces and integral grommet seal at wire entry plus—grounding lugs and integral cable clamp.



GENERAL CIRCUITRY AND QUICK DISCONNECT—K, RK SERIES, with special acme thread. The all-purpose series with eight insert diameters available. Conduit and cable clamp entry types. 1 to 110 contacts. 10, 15, 30, 40, 60, 80, 115 and 200 amp. silver plated contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells.



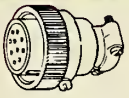
UNIT-PLUG-IN RACK/PANEL-DP, DPB, DPD, DPD2, DPD2R, DPJ, DPS SERIES, available with from 2 to 180 contacts in rectangular inserts. With and without shells; coaxial and high voltage contacts. Permit quick disconnect, interchange, replacement, testing, and inspection of assemblies and sub-assemblies.



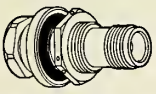
AUDIO AND LOW-LEVEL CIRCUITS—P, XLR, XK, O, UA, BRS SERIES, in many shell styles and insert layouts. Straight and 90° angles. Latch-lock types. Wall-mounting, panel, locknut mounting, and adapter receptacles, single and two-gang. 10 and 30 amp. contacts, coaxials.



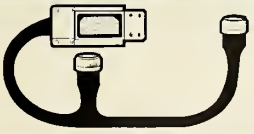
MINIATURE AND SUB-MINIATURE—D, US, DPA, DPX, AND K-MINIATURE SERIES, designed for amplifiers, miniature indicators, computer circuits, telemetering equipment, and general instrumentation of limited space requirements. Variety of shell styles, junction shells, and insert arrangements. Available with from 2 to 50 contacts, plus coaxials.



COAXIAL RF SERIES—available in a wide range of Series and types from sub-miniature to large cable applications. New Cannon adapters available for use with latest cable developments. Cannon's latest RF Plugs include aluminum versions designed for use where weight-saving is a critical design criteria.



GM AND PLUG HARNESS SYSTEMS—Cannon produces a wide range of GM Plugs to fit specific missile applications, ranging from straight umbilical dis-connects to stage-separation dis-connects. Cannon also produces Plug Harness Systems featuring MS or other specified plugs and cables as one unit, available with various contact types and sizes. From 8 to 140 contacts. Highest quality and proven reliability. Varied remote disconnect methods actuated by hydraulic, pneumatic, explosive, or manual means.



The **Cannon Electric Company** also has available a wide variety of plugs for Battery-Power, Fire-wall, Watertight, Printed Circuit, and other applications, as well as "Kwik-Term" Terminals and DC Solenoids.

FOR ADDITIONAL INFORMATION on the typical designs illustrated . . . other configurations for your specific applications . . . or the design, engineering and manufacture to your special needs . . . write to Cannon Electric Company—3208 Humboldt Street, Los Angeles 31, California. Please refer to Dept. 0000.

CANNON PLUGS

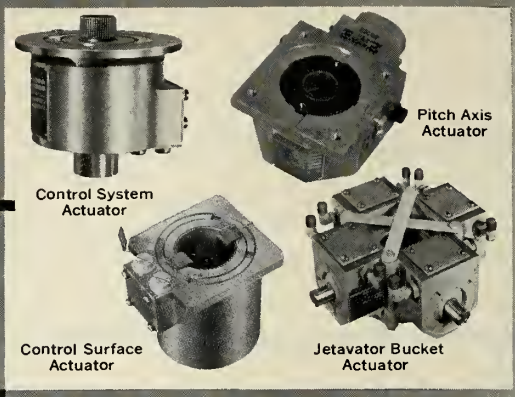
ARGEST FACILITY IN THE WORLD FOR PLUG RESEARCH-DEVELOPMENT-MANUFACTURE

ories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne, and Tokyo, Distributors and Representatives in the Principal Cities of the World.

HOUDAILLE...
your best source

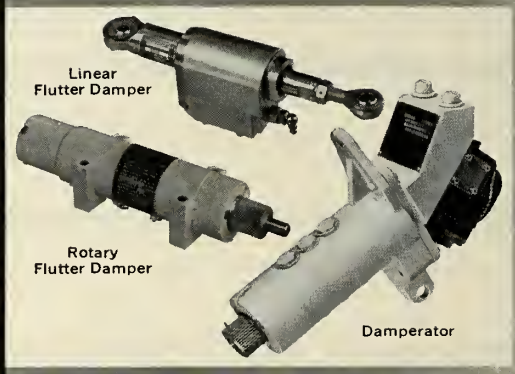
hydraulic and vibration control equipment

for airframe and missile applications



ROTARY ACTUATORS

Direct rotary torque output from 200 to 600,000 inch-pounds. Optional vibration damping may be incorporated. Broad range of designs and sizes, for hinge-line mounting.



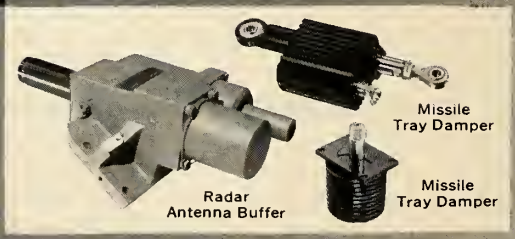
FLUTTER DAMPERS

Performance-proved by acceptance on leading high-performance aircraft and missiles. Linear and rotary types to meet any control surface application, any envelope requirement. New Damperator combines Flutter Damper and Rotary Actuator functions.



STEER AND SHIMMY DAMPERS

Constant-torque power steering units, combined with shimmy damping. May be mechanically or electrically controlled. Full 360° swivel optional. New Viscous Shimmy Dampers for limited-envelope applications.



SPECIALIZED DAMPERS AND BUFFERS

Hydraulic buffers, installed at limits of antenna travel, protect sensitive radar components from damage caused by over-travel. Specialized damping devices for missile handling equipment.

ONLY A SPECIALIST like Houdaille can meet your most exacting specifications for hydraulic or vibration-control applications . . . completely, economically. When *original* product designs are required, Houdaille engineers will evaluate your needs and develop the *right* component to solve any problem. Extensive precision manufacturing facilities assure delivery to meet your toughest schedules.

The items shown here are typical of recent Houdaille designs. Each is outstanding in quality, dependability and performance.

WRITE FOR TECHNICAL BULLETINS on any of above products you are interested in, or for engineering assistance, send details of your problem to

OVER 20 YEARS of specialized service to the aircraft industry.

Houdaille Industries inc.

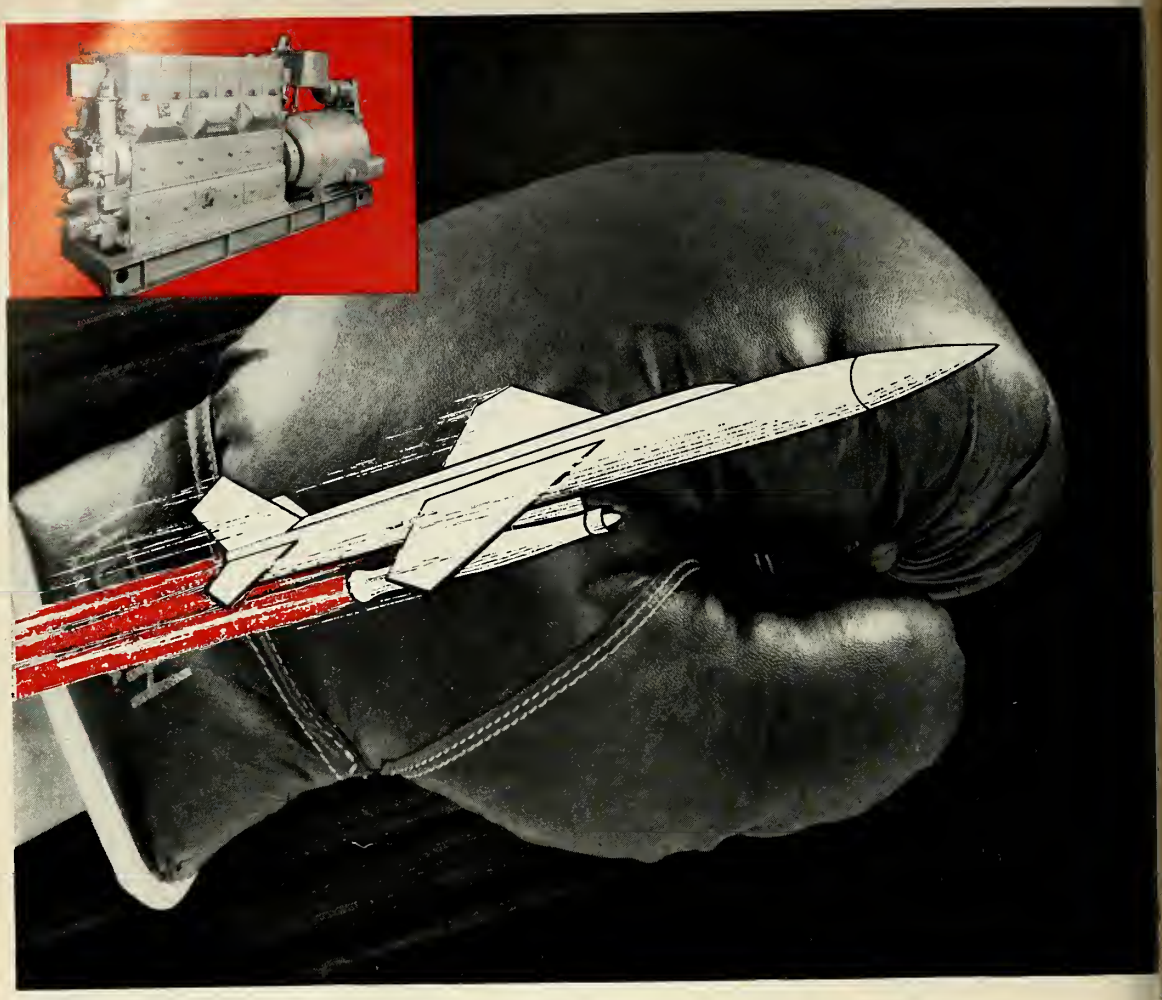
BUFFALO HYDRAULICS DIVISION
537 East Delavan Avenue • Buffalo 11, New York

Fill in No. 17 on Subscriber Service Card.

MISSILE FRAME, WARHEAD AND NOSE CONE

The frame is the skin and structure of the missile, including fins, if any. The warhead and nose cone contain the payload (nuclear, high explosive, or instruments in the case of research missiles) and the shell or cone that encases.





SUPERIOR ENGINES

develop KW... for missile KO!

The warhead carries a missile's big punch, but its fighter instinct is develope by earth-bound electric power. Without reliable ground power, there could be no missile launching, guidance and control, or communication . . . and no knock-out blow!

Already in the U. S. defense ring are dependable White Superior diesel engine generator sets at BOMARC, NIKE and other missile installations. At every round, they are ready with quick, easy starting and continuous, reliable operation. Precision construction takes Superior the limit, too, wit trouble-free performance, low maintenance and maximum fuel economy.

In the battle for space, Superiors are veterans, being installed on sections of SAGE, "DEW" line and the "Texas Towers." They will soon find important civilian sky duty also at many of the Federal Aviation Agency new air-traffic control stations. White can custom-engineer engines to meet your exact needs . . . offers experience with automatic, unattended and remotely controlled operation. If your requirements range from 215 to 2150 HP, or 150 to 1500 KW, get complete information now!

White Diesel

Superior ENGINES · ATLAS DIESEL ENGINES · White DIESEL

WHITE DIESEL ENGINE DIVISION

THE WHITE MOTOR COMPANY, *Plant and General Offices: Springfield, Ohio*

Fill in No. 18 on Subscriber Service Card.

New Products

• missle frame, warhead and nose cone

NEW FASTENERS MEET MISSILE PROGRAM DEMANDS

Huckbolt fasteners fabricated from igh alloy die steels and a variety of tainless steels are now available from Huck Manufacturing Co.

The new fastener specifications ave been developed primarily to meet ecent demands for miniaturized fas- ener designs for use in new missile rograms. The new materials permit se of smaller, lighter components with o sacrifice in strength. They are rec- mmended for use in elevated tempera- ure applications where unusually high trength is required.

Among the new Huckbolt pin ma- erials that may now be specified are AISI Types 321 and 431 stainless teels, A286 and 17-4 PH stainless teels, Vasco Jet 1000 alloy steel and Thermold J alloy steel. Huckbolt col- rs for these applications are of AISI ype 430 stainless steel, annealed.

Fastener strengths formerly achieved nly at room temperature are provided p to 900°F by some of these materials. n addition, fastener performance has



been satisfactory in certain applications at temperatures well beyond 900°F.

Huckbolt fasteners of both shear and tension types as well as Huckbolt stumps can now be obtained in the new materials for the full range of nominal pin diameters (5/32-in., 3/16-in., 1/4-in., 5/16-in. and 3/8-in.) Alloy steel fasteners are available with diffused cadmium-nickel alloy plate where required in accordance with A.M.S. 2416.

Fill in No. 100 on Subscriber Service Card.

loss-Cote Designed or Air-Space Usage

Hi-Brite Gloss-Cote is specifically esigned for use in military applica- ons and on private and commercial rcraft. The high-visibility colors are sed extensively on missiles for visual nd photographic tracking, on drone- rcraft and tow targets, on drogue utes for in-flight re-fueling opera- ons, and on private and commercial rplanes for improvement in the visi- lity of the aircraft against back- rounds of hazy sky, or dull green nd brown earth.

Fill in No. 101 on Subscriber Service Card.

lew Weldable Alloy olves Joining Problem

A new air-hardening, weldable and lly martensitic alloy has been devel- ped by The Carpenter Steel Co., to eet the need for a metal that can be ed for highly stressed parts at tem- ratures up to 1050°F where joining a problem.

The steel, known as Carpenter 404 loy, is designed to be free from weld acking without preheating or post- ating. Weldments can be readily cold rked after stress relieving or anneal- g.

The new alloy is recommended especially for applications such as steam turbine buckets, blades and bucket covers, as well as for "casting in" assemblies such as turbine diaphragms.

The new metal is essentially a 12%-chromium 1½% nickel composition having relatively high tensile strength and good ductility. It shows a marked improvement in weldability over stainless Type 410, and a more uniform structure and higher hardness than Type 405.

In the annealed condition, the steel is said to be easily blanked, drawn, formed or cold headed. Another advantage is its easy machineability in both the treated and annealed conditions.

Carpenter 404 alloy is made by the company's Mel-Trol process, a new quality control system with patented ingot design. Mel-Trol is used to minimize the causes of inconsistent centerline quality which so often causes erratic service in alloys of this type made by conventional methods.

The alloy offers resistance against a wide range of corrosives, including the atmosphere, fresh water, mine water, steam, carbonic acid, crude oil, gasoline, blood, perspiration, alcohol, ammonia, mercury, soap, sugar solutions and other reagents. It also has good resistance to scaling at elevated temperatures and can be used for continuous service up to about 1200°F.

Forms now available include forging billets; hot rolled bars and forgings, either annealed or heat treated; cold drawn and ground bars; wire and wire rods; and strip, both annealed and tempered.

Fill in No. 102 on Subscriber Service Card.

Subminiature Devices May Be Smallest Power Units

The engineering laboratories of Ferrotran Electronics Co. have recently developed a new subminiature series of their "Powertran" power supply units which may be the smallest power supply package ever developed. They are manufactured in a molded or in an encased form.

The molded unit which is made for mounting on a printed circuit board is approximately the size of a flashlight battery. A typical unit measures 1 3/8" x 1¾" x 1¼". (Photo shows relative size of unit compared to a power transistor.)



Four stock units which will give any fixed d-c output voltage in the range from 10-30 volts are available. The 10 volt unit, for example, operating from 115 volts, 60 cycles will supply 25 ma. of current. It is well-regulated, ripple-free, and short-circuit protected.

The device is ideal for transistor supply purposes, bias purposes, or reference voltage purposes.

This series of power supply units is the smallest in the "Powertran" series.

Stock units are as follows:

Model No.	*D.C. Output Volts*	*D.C. Output Current*	*% Reg.*	*% Ripple*
SM-10-A	10	25 ma.	2.3	0.5
SM-15-A	15	20	2.3	0.5
SM-20-A	20	20	2.5	0.5
SM-30-A	30	15	3.0	0.5

Encased units are 1 5/8" x 1¾" x 1½" and are available with transformer type terminals, multiple pin headers, or as plug-ins. (7-pins or 8-pins)

Molded units are 1 3/8" x 1¾" x 1¼" and are furnished with short pins for mounting into printed circuit boards. The units may be solder-dipped.

A far greater current than shown above can be drawn from the unit, without overheating, at a somewhat reduced output voltage.

Temporary short circuits may be placed across the output without damaging the unit.

Fill in No. 103 on Subscriber Service Card.

Environmental Testing

A complete environmental testing service for Electronic, Electrical, Electro-mechanical, Mechanical, Hydraulic and Pneumatic components, products and systems to all Government and Industrial specifications.

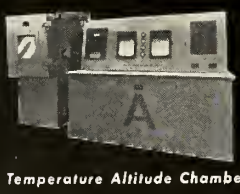
Stressing the Engineering Approach in Environmental, Qualification and Reliability Testing

TELEPHONE:
CApital 6-7407

Associated

Environmental Test Equipment

The quality line of Environmental Chambers and Test Equipment



Temperature Altitude Chamber

Descriptive Data Sheets Available on all test equipment

ASSOCIATED TESTING LABORATORIES, INC.
135 CLINTON ROAD
CALDWELL, NEW JERSEY
Telephone: CApital 6-7407

Fill in No. 43 on Subscriber Service Card.

Cross Index

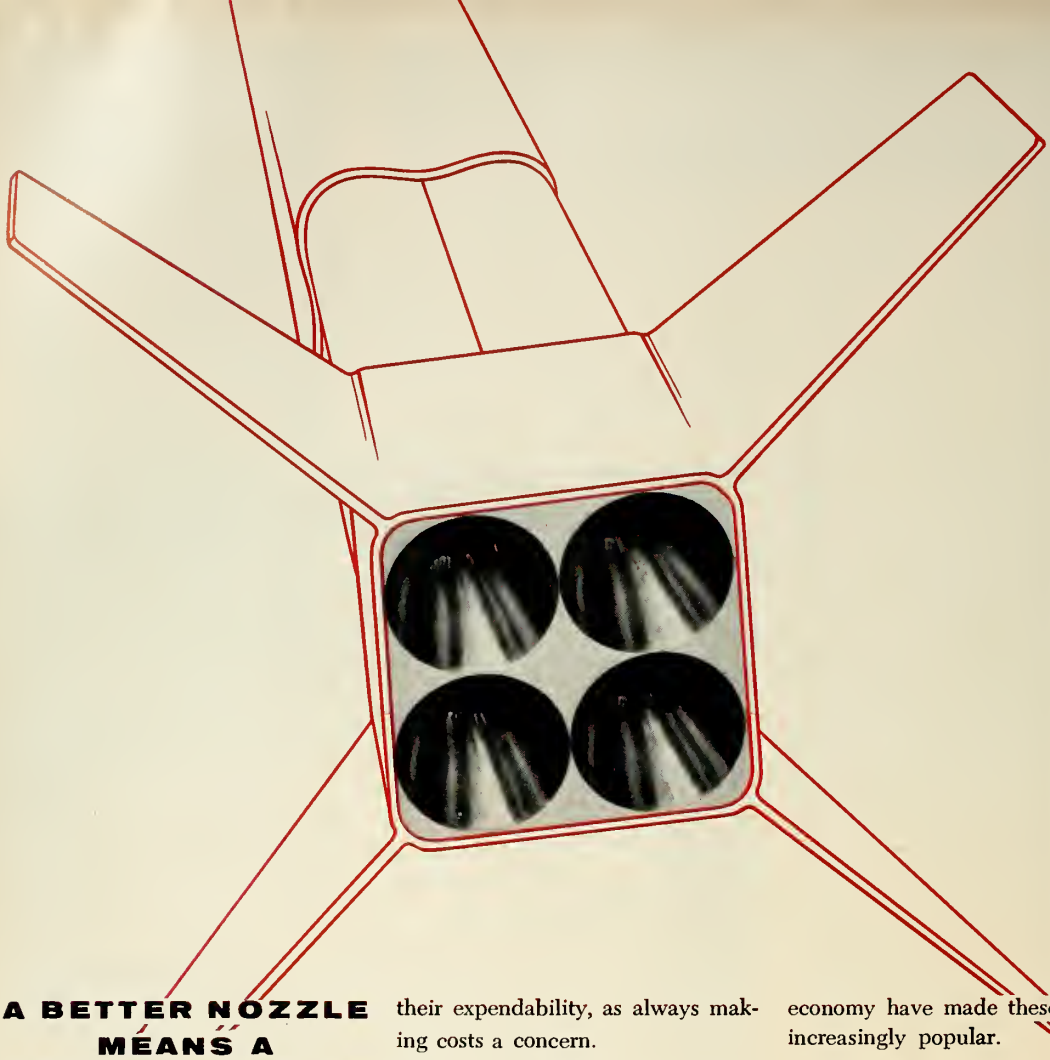
• *missile frame*

ADHESIVES, HIGH TEMPERATURE 188
ADHESIVES, METAL TO METAL 189
AIR CONDITIONING EQUIPMENT 189
AIR INLET SCREEN SUPPORTS 189
AIRBORNE LANDING SYSTEMS 189
ANALYZERS 192
Flight 192
Stress Surface 192
Vibration 192
BINDERS, LIQUID 198
BLISTERS 199
BOLTS, LOCK 200
BOLTS, TOGGLE OR EXPANSION 200
BONDING MATERIALS 200
BRACKETS, MOUNTING ... 201
BRAZING ALLOYS 201
CABLE 203
Clamps & Clips 203
CAPS, TUBE 206
CASTINGS 207
Centrifugal, Ferrous 207
Centrifugal, Non-Ferrous ... 207
Die, Ferrous 207
Die, Non-Ferrous 207
Precision, Ferrous 207
Precision, Non-Ferrous 207
Sand, Ferrous 207
Sand, Non-Ferrous 207
CEMENT 207
Asbestos 207
Pipe-Joint 207
Plastic 207
Rivet 207
Rubber-to-Metal 207
CERAMIC PARTS 208
CHASSIS, METAL 209
CLAMPS 210
Conduit 210
Harness 210
Hose 210
Mechanical Cable 210
Special 210
Tube 210
CLIPS 211
Conduit 211
Special 211
Spring 211
Tube 211
COMBUSTION CHAMBER COVERS 213
COMPUTERS, AIR DATA ... 216
CONDUITS 216
Ignition Wire 216
Metal 216
CONNECTORS 216
CONTROLS 217
Heat Treating 217
Materials Thickness 217
Strain 217
CONTROLS, SURFACE FINISH 220
CORDS 221
Patch 221
Retractile 221
Shock 221
DECALCOMANIAS 224
DIE CASTINGS 227
DIES 227
DOWELS 228
DROP FORGINGS 228
DUCTS, EXHAUST 229
DUCTS, FLEXIBLE & COMPRESSIBLE 229
DUCTS, NON-FLEXIBLE 229
EJECTION SYSTEMS 229
ELECTROPLATING EQUIPMENT 230
EMBEDDED ASSEMBLIES .. 230
EMBEDDED COMPONENTS . 230
EXTRUSIONS, METALLIC .. 232
EXTRUSIONS, NON-METALLIC 232
EYELETS 232
FASTENERS 233
Blind 233
Cowl 233
Self-Locking 233
Slide 233
Snap 233
FINDERS, VIEW 234
FINISHERS, PLASTIC 234
FINISHES 235
Crystal 235
Luminous Materials 235
Ripple 235
Wrinkle 235
FINS 235
FITTINGS, COAXIAL CABLE 235
FITTINGS, METALLIC 235
FITTINGS, NON-METALLIC . 235
FLUORESCENT COMPOUNDS, PHOSPHORS . 236
FLUX, BRAZING OR SOLDERING 236
FOIL, ALUMINUM 237
FOIL, LEAD 237
FORGINGS, FLAT DIE 237
FORGINGS, PRESS 237
FORGINGS, UPSET 237
FUEL LINES 237
GASKET PASTE & CEMENT 237
GASKETS, METALLIC 237
GASKETS, NON-METALLIC . 237
GRILLES, METAL 240
GRILLES, MOLDED PLASTIC 240
GROMMETS 240
GROMMETS, FIBRE 240
HOISTS, AIRBORNE 240
HYDRAULIC RESERVOIRS . 240
HYDRAULIC SYSTEMS & CONTROLS 240

NSULATING COMPOUNDS . 252
NSULATION PARTS 252
Ceramic 252
Insulating Sleeves 252
Rods 252
Sheets 252
Silicone Rubber 252
NSULATORS 253
AMINATES 256
ANDING GEAR ASSEMBLIES 256
ATCHES 256
ATCHES, BENCH 257
INERS 258
Can 258
OCKNUTS 259
ANIFOLDS 261
Air System 261
ETAL CLAD SHEETS 262
ETAL MACHINING 262
ETAL TREATING 263
ISSILE FRAMES 265
OLDERS, PLASTIC 266
AMEPLATES 269
AVIGATION DOMES 269
UTS, SELF-LOCKING 271
AINT, METALLIC 273
INS, TUBULAR 275
LASTICS FABRICATORS & FINISHERS 276
LATES, INSTRUCTION 276
LATES, METAL OR PLASTIC 276
LATES, PLASTIC LIGHTING 276
LATING, PRECIOUS METAL 276
LATING, TIN ZINC 277
EINFORCED PLASTICS 287
ESERVOIRS, HYDRAULIC SYSTEMS 289
ESERVOIRS, PNEUMATIC SYSTEMS 289
ETRACTING, MECHANISM UNITS 290
ETRACTORS, LANDING GEAR 290
INGS 290
Retainer 290
Scraper 290
Sealing 290
Shock Absober 290
Slip 290
Slip & Brush Assemblies 290
IVETS, BLIND 290
OCKETS 291
UDDERS 291
CREW, MACHINE PRODUCTS 291
CREWS, SELF-TAPPING ... 292
CREWS, SET 292
CREWS, STANDARD 292
EALERS, FUEL & OIL TANK 292
EALERS, NUCLEAR 292
EALERS, PROTECTIVE 292
EALING, SERVICE, HERMETIC 292
EALS 292
Carbon 292
Ceramic to Metal 292
Dust Excluder 292
Grease & Oil 292
Hermetic & Pressurized 292
Hydraulic 292
Insulating 292
Metal-to-Glass 292
Missile 292
Oil 292
Pipe Joint 292
Pump 292
Shaft 292
SEPARATION DEVICES 293
SHEET METAL PARTS 293
SHEETS, MOLYBDENUM ... 294
SHIELDING 294
Heat 294
Lead 294
Lead, Nuclear 294
Magnetic 294
Radiation 294
Radiation, Nuclear 294
Rubber 294
Sheet or Screen 294
Solid 295
SHIMS, LAMINATED 295
SHOCK ABSORBER CORD & RINGS 295
SHOCK ABSORBER LANDING GEAR 295
SHOCK MOUNTS 295
SILVER PASTE 296
SLEEVES, NON-METALLIC . 296
SLEEVES, TUBE 296
SLEEVING 296
SOLDER 296
SPACERS 297
SPRINGS 298
Hardware 298



Fill in No. 45 on Subscriber Service Card.

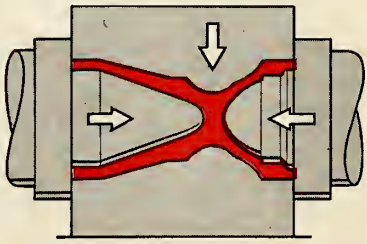


A BETTER NOZZLE MEANS A BETTER MISSILE

Nozzles for guided missiles are an important factor in performance and, of course, in cost. In the end result during their short-span service, they must produce proper thrust without disintegrating. In early production, despite their simple symmetrical shapes, they posed many knotty problems. Special alloys, thin sections, and close tolerances spelled trouble. So did their expendability, as always making costs a concern.



Today, after many years' production, we have delivered a staggering number of these problem pieces. The secret of our success has been our own unique Cameron forging



processes which have extended the scope of ferrous forgings far beyond traditional restrictions in shape, size and quality. Elimination of welds along with better grain structure, internal as well as external curvatures, and considerable machining economy have made these forgings increasingly popular.

Our forgings are available as forged rough machined, or finished machined, ready to save money in any phase of your operations. If you have a forging problem in components ranging from a few pounds to 8000 pounds, especially something for extreme service (high stress, high temperatures, etc.) we may have the answer. Special alloys are no problem because we produce our own steel with the most modern controls and tests from melt shop to delivery dock. Just call, write, or come by . . .

Cameron

IRON WORKS, INC.

SPECIAL PRODUCTS DIVISION

P. O. Box 1212
Houston 1, Texas

Fill in No. 19 on Subscriber Service Card.

. . cross index

Precision 298
SABILIZERS 298
SAMPED PARTS, TUBE 298
SPERSONIC EQUIPMENT . 300
SPPORTS, TUBE 300
TAILPIPES, JET ENGINE ... 302
TANKS 302
Auxiliary 302
Fuel 302
Liquid Nitrogen 302
Liquid Oxygen 302
Liquified Gas Storage 302
Oil 302
Self-Sealing 302
Transportation & Storage ... 302
TAPES 303
Asbestos 303
Coated & Impregnated 303
Electrical Insulation 303
Fabric 303
Friction 303
Heat Resistant 303
Plastic 303
Pressure Sensitive 303
Rubber, Natural & Synthetic 303
TINNING, HOT DIPPED 309
TRIM TABS 311
TUBING 312
Aluminum 312
Asbestos 312
Brass or Copper 312
Capillary 312
Ceramic 312
Fibre 312
Finned 312
Flexible Metal 312
Fused Quartz 312
Glass Fibre Insulation 312
Glass Precision 312
Metal & Alloy 312
Mica 312
Molybdenum 312
Monel 312
Nickel 312
Paper 312
Phenolic 312
Plastic 312
Precious Metal 312
Seamless 312
Silver 312
Steel 312
Steel, Stainless 312
Tantalum 312
Titanium 312
Tungsten 312
Woven or Knitted Wire 312
VARNISH 317
VESSELS 317
VIBRATION ABSORBERS ... 317
WASHERS 317
Brass 317
Ceramic 317
Felt 317
Fibre 317
Insulating 317
Lock 317
Metal 317
Mica 317
Plastic 317
Rubber 317
WATER INJECTION EQUIPMENT 318
WIRE 319
Aluminum 319
Cut & Stripped 319
Enameled 319
Fine Wire Specialties 319
Forms 319
Glass Insulated 319
Guy 319
Mesh 319
Metal Plated 319
Metal Shielded 319
Monel 319
Nickel Clad Copper 319
Phosphor Bronze 319
Plastic Insulated 319
Recording 319
Reels 319
Silicon Bronze 319
Silver Plated 319
Stainless Steel 319
Strippers, Mechanical 319
Tantalum 319
WIRE MARKING, SERVICE . 320
WIRE STRIPPERS 320

AIRCRAFT-TRAINED
MISSILE-MINDED

- 31 years experience in aircraft engine parts
- Headed fasteners in heat-resistant metals
- Laboratory-controlled hardened and ground precision parts
- Assemblies and sub-assemblies

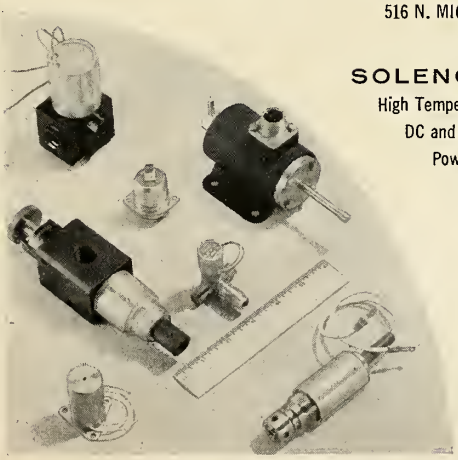
HMS
HARTFORD MACHINE SCREW CO.
Division of Standard Screw Co.
HARTFORD 2, CONNECTICUT

Fill in No. 46 on Subscriber Service Card.

VALVES • SOLENOIDS

Custom designed components for the severe environmental conditions of aircraft and missile operation.

Manufacturing Division of
KOONTZ WAGNER
ELECTRIC COMPANY INCORPORATED
516 N. MICHIGAN ST., SOUTH BEND, IND.



SOLENOIDS
High Temperature
DC and 400 cycle
Power and Miniature

VALVES
Manifold Mounting Oxygen
Propellant Air Deicing
High Pressure Miniature Fuel

Fill in No. 47 on Subscriber Service Card.



Designed especially for High Strength—High Temperature and liquid oxygen and other corrosive applications, Cherry Aircraft Lockbolts* are now available in austenitic A-286 Stainless Steel.

Available for the aircraft industry in a wide range of diameters, grip lengths and head styles in A-286 . . . Cherry Lockbolts are also produced in Alloy Steel and Aluminum.

Cherry Lockbolts are structural fasteners providing simplicity and speed of installation with uniform high tensile preloads.

Shop men like them.

For information on Cherry Aircraft Lockbolts, write Townsend Company, Cherry Rivet Division, P. O. Box 2157-Z, Santa Ana, California.

*Licensed under Huck patents RE22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049 and 2,754,703

CHERRY RIVET DIVISION

SANTA ANA, CALIFORNIA

Townsend Company

ESTABLISHED 1816 • NEW BRIGHTON, PA.

Fill in No. 20 on Subscriber Service Card.

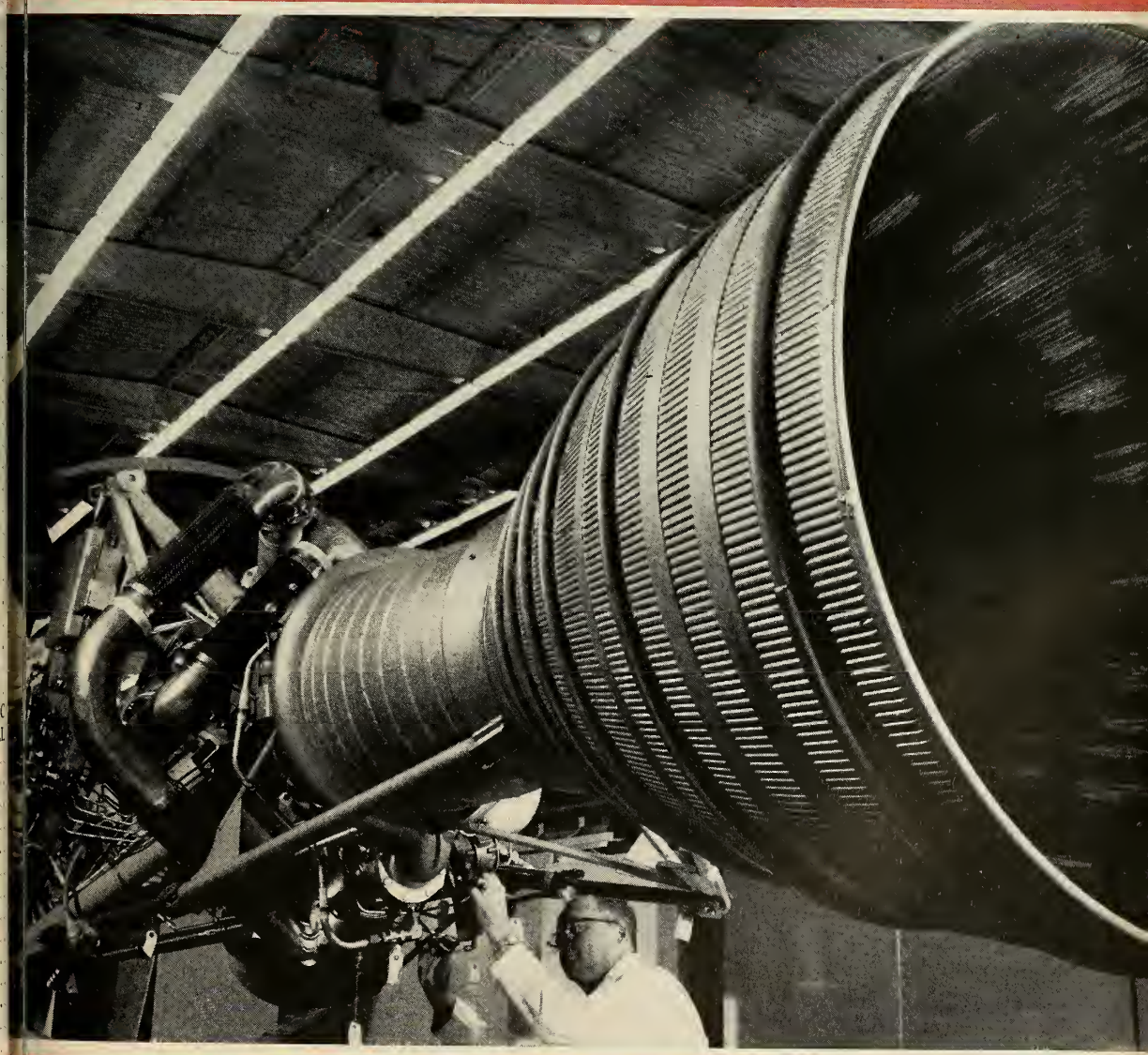
Cross Index

• warhead and nose cone

ACTUATORS 18
ADHESIVES, HIGH TEMPERATURE 18
ADHESIVES, METAL TO METAL 18
ALARM SYSTEMS 18
ANTENNAS 19
Radiation Test 19
ASSEMBLY SHIELD, NUCLEAR 19
BADGES, RADIATION 19
BOLTS, LOCK 20
BOLTS, TOGGLE OR EXPANSION 20
BONDING MATERIALS 20
BRAZING ALLOYS 20
CERAMIC PARTS 20
CONTROLS 21
Materials Thickness 21
DIE CASTINGS 22
DISSIPATORS, HEAT 22
DROP FORGINGS 22
ELECTROPLATING EQUIPMENT 23
EMBEDDED ASSEMBLIES .. 23
FINISHERS, PLASTIC 23
FINISHES 23
Luminous Materials 23
INSULATION PARTS 25
Insulating Sleeves 25
Rods 25
Sheets 25
Silicone Rubber 25
Stampings & Punchings 25
INSULATORS 25
INTERVALOMETERS 25
METAL CLAD SHEETS 26
METAL MACHINING 26
METAL TREATING 26
NUCLEAR 27
Shielding, Radiation 27
PARACHUTE HARDWARE .. 27
PARACHUTES 27
PLATES, METAL OR PLASTIC 27
PLATING, PRECIOUS METAL 27
RELEASE MECHANISMS ... 27
RINGS 27
Special 27
RIVETS, BLIND 27
RIVETS, EXPLOSIVE 27
SEPARATION DEVICES 27
SHIELDING 27
Heat 27
Lead 27
Magnetic 27
Radiation 27
Solid 27
SHIELDS, LEAD 27
SWITCHES 31
WASHERS 31
WATER INJECTION EQUIPMENT 31

PROPULSION SYSTEMS AND AUXILIARY POWER UNITS

These units include the power plant and its associated equipment; such as, tanks, pumps, blast chambers, nozzles, resonance rods and fuel. Propulsion systems are simple in solid rockets, complex in liquid rockets. Auxiliary power units consist either of hot gas turbines driving hydraulic pumps and generators, or of batteries supplying power for missile guidance and control systems.





giving the "breath of life" to solid propellants!

TRONA® ...first and foremost source of supply for **AMMONIUM PERCHLORATE**

Advances in solid propellant technology have depended on AMMONIUM PERCHLORATE from American Potash & Chemical Corporation since the very beginning. First in the field with this essential oxidant, AP&CC was for many years the only domestic producer of ordnance-grade NH_4ClO_4. Today, with a growing network of strategically located plants and increased technical knowledge, Trona still leads the industry. Supporting the big tonnage production of AMMONIUM PERCHLORATE at Henderson, Nevada is the new SODIUM CHLORATE plant at Aberdeen, Mississippi, making AP&CC the free world's largest producer of $NaClO_3$. If a guaranteed source for AMMONIUM PERCHLORATE and the very latest in technical developments, gained through years of experience in this field, are important to your process and products, contact your nearest AP&CC sales office today.

American Potash & Chemical Corporation

3000 WEST SIXTH STREET, LOS ANGELES 54, CALIFORNIA

99 PARK AVENUE, NEW YORK 16, NEW YORK

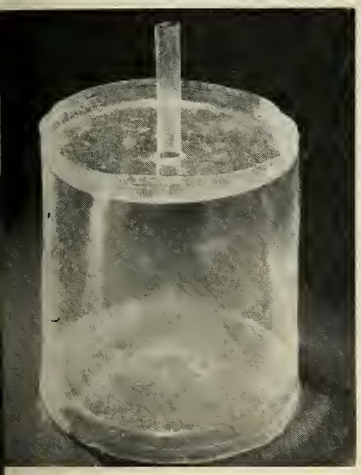
SALES OFFICES: Los Angeles • New York • San Francisco • Portland (Ore.) Chicago • Atlanta • Shreveport • Columbus (O.)

Fill in No. 21 on Subscriber Service Card.

New Products

• *propulsion systems*

KEL-F PLASTICS HAVE MISSILE APPLICATIONS



"Kel-F" polymers produced by Min-esota Mining and Mfg. Co. are noted r chemical inertness, low-tempera-re range, low "cold-flow" characteri-ics, all-round moldability, and easy achining.

Another useful property, especially r missiles and rockets, is the poly-ers' flexibility. Lip seals for rotating d reciprocating shaft seals and pro-ellant gate-valve seals must be flexi-e at temperatures from about –450 165°F. They also require spring-ack and dimensional stability to seal gainst low and high pressure, from 5 600 psi.

These qualities can be achieved by ecial heat treatment of "Kel-F" plas-cs to control physical properties. ensile strength of the plastics remains igh (up to 5800 psi at –300°F.), hile flexibility is maintained at these mperatures to withstand impulses and ycling as a seal from pressures of to 1000 psi.

Missile applications include:

Coil forms—Zero moisture absorp-on, good dielectric strength, and ex-llent dimensional stability make "Kel-" plastics an exceptional coil form aterial for missiles. Biggest problem solves is that it shows no effects om the extremely high temperatures ached by the wire wrapped around e form—temperatures that tend to ften and warp coil forms made of her materials.

Expellent bladders—Function of ese bladders is to store such highly rrosive liquids as LOX, WFNA, FNA, and 90% hydrogen peroxide the fuel chambers of missiles. Fabri-cated from plastic tubing and heat-sealed after loading, the bladders are usually employed as liners in stainless steel tanks. They range in diameter and length from ¼″ to 150″.

Gasket seals—Transfer-molded gasket seals, made of an elastomer O-ring mechanically-bonded to a square of anodized aluminum, are now being produced for nitric acid contacts in missiles. "Kel-F" polymers provide the only applicable elastomer that will withstand such contacts.

LOX lip seals—Chemical inertness and flexibility at the extremely low temperature of LOX are responsible for the wide use of "Kel-F" plastics in LOX lip seal applications. The material is first compression-molded, then post-formed and machined into seals of the desired shapes and sizes, with tolerances as close as plus or minus 1.5 mils with a 7 micro finish.

O-rings in rocket engines—Successful operation of a liquid rocket depends almost entirely on the proper functioning of its elastomeric parts. O-rings are used as shaft seals, gaskets, and valve seats. "Kel-F" elastomer was early applied in this area, mainly because of its resistance to WFNA.

Self-locking nuts—Inserts of "Kel-F" plastic prevent seepage of such strongly reactive missile fuel liquids as RFNA and WFNA past the internal bolt threads of self-locking nuts.

Sprays—"Kel-F" dispersion film, the most flexible of the polymers, is being used in many missile applications, chiefly diaphragms, as follows: the dispersion is sprayed on a metal form (which may be of any convolution or configuration); after baking, it is removed, yielding a component that is non-porous, tough and flexible.

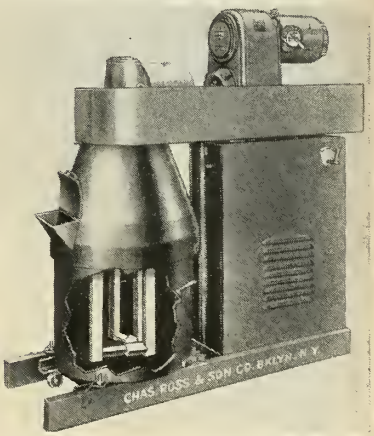
Structural-thermal use—Because of high compressive strength and wide temperature utility, "Kel-F" plastics are the main structural support and thermal barrier between the outer shell and the "internal package" in Vanguard satellites. Major concentrated load of the package is carried directly through a "Kel-F" plastic support to the main hub at the base of the structure.

Vent seals—A small device injection-molded from "Kel-F" plastics is used to prevent moisture or foreign material from entering small bleed holes in rocket engine components. The seal also acts as a low-pressure, small-volume relief valve.

Fill in No. 104 on Subscriber Service Card.

Machines Developed for Mixing Propellants

A complete new line of heavy duty double planetary change can mixers has been developed by Charles Ross & Son Co., Inc. for mixing solid propellants. The company, which also manufactures a line of horizontal type kneading machines for mixing propellants, has improved on the design of the vertical type changeable can mixer to incorporate many features designed specifically for propellant mixing.



The double planetary change can mixers are available in many sizes from 1 gallon Laboratory size to 200 gallon large production size, and all mixers are furnished with variable speed motor drives. Nonsparking materials are utilized, and, aside from versatility in operation and ease of clean out of the changeable can type mixers, mixers of this type eliminate stuffing boxes and bearing in the product zone.

The double planetary changeable can mixers are furnished with stainless steel stirrers and can, jacketed cans, and vacuum covers when required.

Fill in No. 105 on Subscriber Service Card.

Propellant Valve Has Dual Flow Control

For simultaneous flow control of liquid Oxygen and Fuel, Hydromatics Inc.'s provides zero leakage control of a 5/8″ LOX line and ½″ fuel line at pressure up to 100 psi and temperatures as low as –350°F.

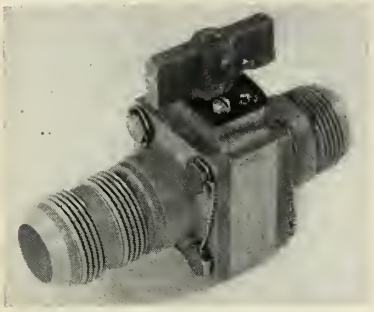
A single-acting, spring-return pressure actuator drives a precision mechanical linkage which controls both valves, thus insuring constant timing. The valves are extremely fast acting, with response times as short as 10 milliseconds. All dynamic sealing is double with a vent between seals for maximum safety. A sealed, rotary action snap switch permits remote observation of valve position. Valve flanges, available in standard or special styles, are removable and interchangeable.

Fill in No. 106 on Subscriber Service Card.

. . . new products

Koehler Ball Valves Have Missile Applications

An extensive line of KOEHLER/Dayton Ball Valves, Koehler Aircraft Products Co., is now available for missile in-flight and ground support applications.



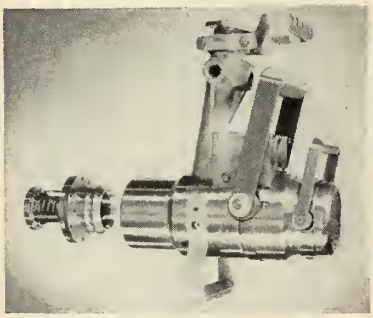
KOEHLER/Dayton Ball Valves are ideal for use with standard fuels and oils, high energy fuels, oridizers coolants and cryogenics. They combine simple design and rugged construction and as a result are among the lightest and smallest available.

When functioning as drain, selector, fill and flushing valves, this ball type design can be actuated by manual, mechanical or electrical means.

Fill in No. 107 on Subscriber Service Card.

Fuel Oxidizer Servicing Nozzle Designed

Missiles and ground servicing equipment require specially designed nozzles and adapters for fueling operations prior to countdown. Lear-Romec Division of Lear, Inc. has developed such a device for missiles embodying special design and materials, standardizing the equipment for filling oxidizer reservoirs and fuel tanks at missile bases.



Developed for dependability and safety in handling oxidants, the nozzle is fully capable of transferring any of the exotic fuels and oxidants except those requiring stoneware transmission equipment.

For "closed circuit" fueling operation, two nozzles are required to transfer propellant or oxidant from the supply source to missile and overflow venting from missile to source. Thru the three way locking action between the nozzle and its companion adapter (permanently mounted on supply source and missile) absolute leak and hazard-proof seal is effected.

Operation is satisfactory at temperatures ranging from –65 degrees to plus 140 degrees Fahrenheit, in accordance with the requirements of Military Test Specifications Mil-N-25556 (nozzle RR13110) and MIL-N-25555 (adapter RD13040).

Originally designed to accommodate fuming red nitric acid (HNO_3), only the purer and more advanced aluminum and stainless steels are used for their overall resistance qualities to the corrosive action of oxidants.

Fill in No. 108 on Subscriber Service Card.

Eckel Offers Miniature Three-Way Valve

Eckel Valve Co.'s Series BF42C is a miniature 3-way valve for small actuators and instrumentation systems. It operates to 70 psi—gases or liquids —with inherent minimum leakage. The current consumption is just 9 watts at 28V DC, and the valve is available either with electrical connectors or lead wires.



Because of the Eckel coaxial configuration, this new BF42C valve is only one-third the weight of previous "smallest" 3-way valves.

Fill in No. 109 on Subscriber Service Card.

Lox Pump Motor Delivers 60 gal/min.

Recently developed by the J. C. Carter Co. for pumping liquid oxygen of liquid nitrogen is an electric motor driven two stage centrifugal pump. Designed to deliver 60 gallons per minute against a 550 ft. head, this pump is particularly suited for installations where light-weight, compact design is important.

Fill in No. 110 on Subscriber Service Card.

New Concept Featured in Liquid Sensing

A new Liquid Sensor featuring simplicity and greater reliability is now being produced by the Pioneer-Central Division of Bendix. The new Sensor which was developed to supplement the fuel measurement and control systems and the airborne liquid and gaseous oxygen systems with which Bendix has been identified is expected to have wide application in many related and unrelated fields.



The Sensor provides a new means of sensing the existence or level of liquids even in the presence of gas or vapor. It is adaptable to a wide range of applications—from sensing the presence of liquid at a given level in tanks to the critical measurement and control of missile propellants. It will function in fluids with widely divergent characteristics including the liquified gases, hydrocarbon fuels, red fuming nitric acid, fluorides, hydrazine, water ink and viscous fluids such as molasses.

The Sensor is currently available in the form of a probe with built-in transistorized amplifier and relay or, for other applications, with the probe separated from the amplifier and relay. Both designs are adaptable to different configuration and to dimensional changes to conform to specific requirements.

Fill in No. 111 on Subscriber Service Card.

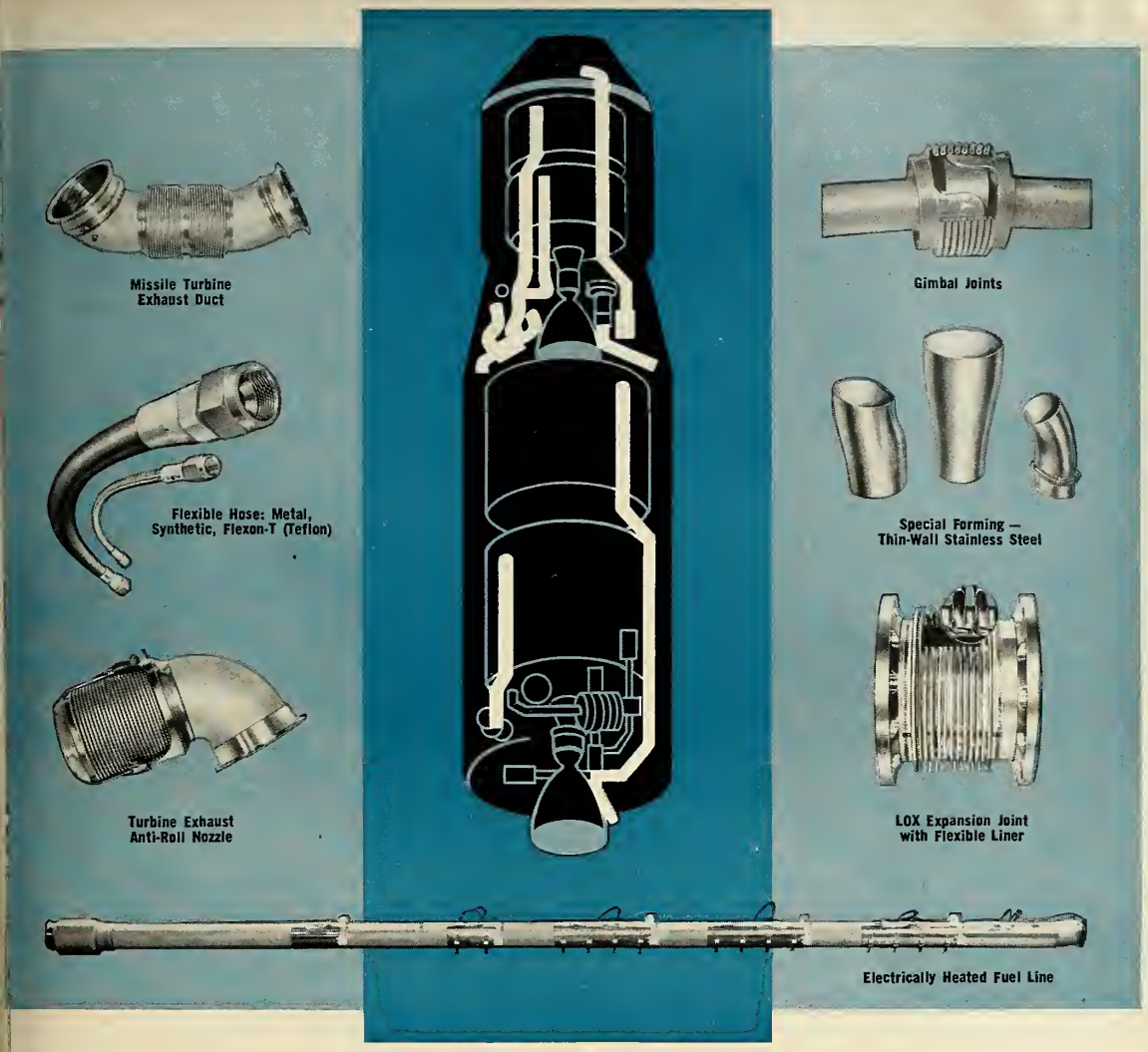
New Hydrogen Peroxide Nozzle Is Non-Corrosive

A new self-sealing, high flow rate hydrogen peroxide nozzle and adapter for servicing aircraft or missiles using hydrogen peroxide as an oxidizer has been announced by Flight Refueling Inc.

Safety requires the nozzle to be manually locked to the adapter before the internal valves can be actuated and collaterally, the internal valves must be completely closed before disengagement.

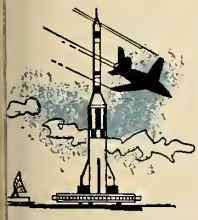
Another important feature is that working parts are fitted externally and do not come in contact with the fluid eliminating the possibility of corrosion.

Fill in No. 112 on Subscriber Service Card.



Propulsion piping system or individual components . . .

FLEXONICS ENGINEERING AND EXPERIENCE CAN SERVE YOU BEST

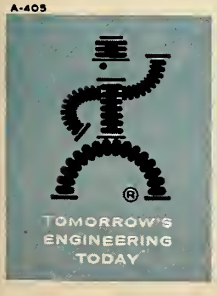


Flexonics has pioneered, for over half a century, in precision-forming thin metals into flexible carriers for a variety of media . . . and still leads. This special talent of Flexonics engineers and designers is available to you in the development and manufacture of LOX, fuel, hydraulic, pneumatic and turbo exhaust systems.

For the most authoritative product and design recommendations covering ducting systems, flexible connectors, bellows, metal hose, and Flexon T (Teflon)—contact your Flexonics Sales Engineer or write for Flexonics Aeronautical Engineering Manual.



A-405



Flexonics

AERONAUTICAL DIVISION

FLEXONICS CORPORATION • 1414 SOUTH THIRD AVENUE • MAYWOOD, ILLINOIS

Divisions

INDUSTRIAL HOSE • EXPANSION JOINT • BELLOWS • AERONAUTICAL • AUTOMOTIVE

Flexonics Research Laboratories, Elgin, Illinois

In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario

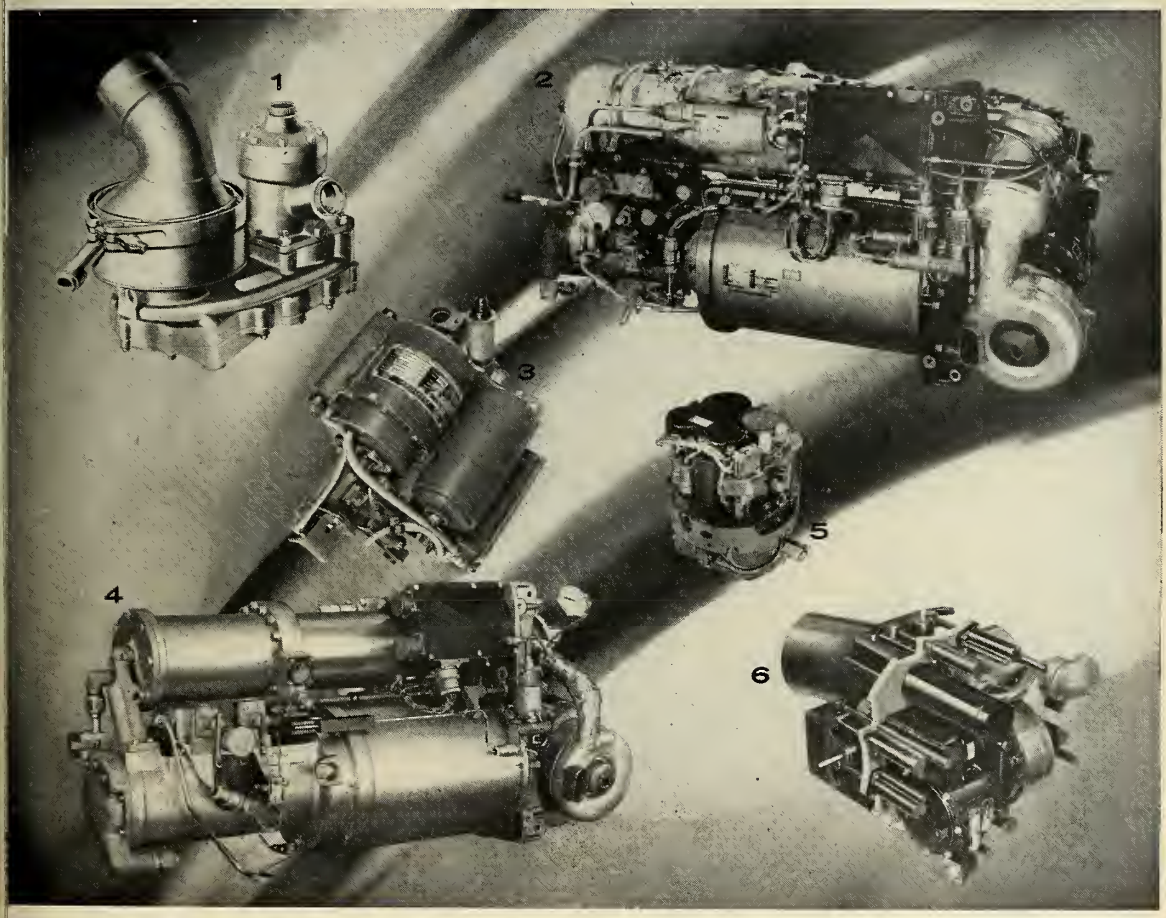
Fill in No. 22 on Subscriber Service Card.

Cross Index

• *propulsion systems*

ACCELERATORS, PARTICLE 187
ACTUATORS 188
Rotary 188
AFTERBURNERS 189
AFTERCOOLERS 189
AIR ADAPTERS 189
AIR INLET GUIDE VALVES 189
AIR INLET SCREEN SUPPORTS 189
ALARM SYSTEMS 189
ALARMS, AUTO 190
AMPLIDYNES 190
AMPLIFIERS 190
Compressor 190
ANALYZERS 192
Electro-Chemical 192
Engine 192
Gas 192
Ignition 192
Internal Combustion 192
Neutron Absorption 192
Spectrum 192
Vibration 193
ANGLE DRIVES 194
ANTENNAS 194
Radiation Test 194
ANTI-VIBRATION EQUIPMENT 195
ASSEMBLY SHIELD, NUCLEAR 195
BADGES, RADIATION 196
BAFFLES, AIR 196
BEARINGS 197
BELLOW ASSEMBLIES 198
BLADDERS, FUEL 198
BLADES 199
Compressor 199
Stator 199
Turbine 199
BLAST DEFLECTOR, PADS & TUBES 199
BLOWERS, MOTOR & GENERATOR 199
BLOWERS, SMALL 199
BOOSTERS, GAS PRESSURE 200
BOOSTERS, MISSILE, LIQUID FUELED 200
BOOSTERS, MISSILE, SOLID FUELED 200
BRAZING ALLOYS 201
BREATHERS, ENGINE 202
BUSHINGS, HERMETICALLY SEALED 202
BUSHINGS, METALLIC 202
BUSHINGS, NON METALLIC 202
CABLE 203
Ignition 203
CAPS, TUBE 206
CASTINGS 207
Centrifugal, Ferrous 207
Centrifugal, Non-Ferrous 207
Die, Ferrous 207
Die, Non-Ferrous 207
Precision, Ferrous 207
Precision, Non-Ferrous 207
CEMENT 207
Asbestos 207
Pipe-Joint 207
Rubber 207
CERAMIC PARTS 208
CERAMICS, HIGH TEMPERATURE 208
CHAIN, SMALL DRIVE 208
CHEMICALS, RADIOACTIVE 209
CLAMPS 210
Hose 210
Mechanical Cable 210
Special 210
Tube 210
CLEANERS, ULTRASONIC 211
CLIPS 211
Tube 211
CLUTCHES, MAGNETIC 211
CLUTCHES, MOTOR & GENERATOR 211
COILS, HIGH TEMPERATURE 212
COILS, IGNITION 212
COMBUSTION CHAMBER COVERS 213
COMBUSTION CHAMBERS 213
COMBUSTORS 213
COMPRESSOR ASSEMBLIES 214
COMPRESSOR ASSEMBLIES, AXIAL FLOW 214
COMPRESSOR ASSEMBLIES, CENTRIFUGAL FLOW 214
COMPRESSORS, GAS 214
CONDUITS 216
Fiber 216
Ignition Wire 216
Metal Flexible 216
Metal, Non-Flexible 216
CONES, EXHAUST 216
CONNECTORS, ELECTRICAL FIREWALL 216
CONNECTORS, PRESSURIZED 217
CONTROLS 217
Chemical 217
Combustion 217
Density 217
Dynamometer 217
Engine 217
Fire 217
Flame Failure 217
Fluid Conductivity 217
Fluid Flow 217
Fuel 217
Gas 217
Liquid Level 217
Machine Safety 217
Positioning 217
Power Level 217
Pressure 217
Reactor, Nuclear 217
Smoke Density 217
Speed 217
Strain 217
Turbidity 218
Vacuum 218
CONVERTERS 220
Liquid Oxygen 220
COOLANTS 221
COOLERS, OIL 221
CORES 221
Toroidal 221
COUPLINGS 222
Flexible 222
Hydraulic 222
Rigid 222
Shaft 222
Shaft, Reducers & Extensions 222
Shaft, Rigid & Flexible 222
Tube 222
CRYSTALS, SAPPHIRE 223
CYLINDERS 223
Air 223
Compressed Gas 223
Rocket Engine 223
DAMPERS, CONTROL 224
DAMPERS, PULSATION 224
DAMPERS, VIBRATION & SHIMMY 224
DETECTORS 225
Detonation 225
Flaw & Defect, Electronic 225
DIAPHRAGMS, JET ENGINE 226
DIAPHRAGMS, JET ENGINE NOZZLE 227
DIE CASTINGS 227
DIES 227
DIFFUSERS, GAS TURBINE ENGINE 227
DISCONNECTS, CONTROL SYSTEMS 22
DISCONNECTS, IGNITION SYSTEMS 22
DISSIPATORS, HEAT 22
DISTRIBUTORS, FUEL 22
DISTRIBUTORS, IGNITION 22
DRIVES 22
Torque Tube 22
DROP FORGINGS 22
DUCTS, EXHAUST 22
DUCTS, FLEXIBLE & COMPRESSIBLE 22
DUCTS, NON-FLEXIBLE 22
DYNAMOTORS 22
ELECTROPLATING EQUIPMENT 23
EMBEDDED ASSEMBLIES 23
ENGINE ACCESSORIES & COMPONENTS 23
ENGINE CONTROL SYSTEMS, AUTOMATIC 23
ENGINE CONTROLS, MECHANICAL & VACCUM 23
ENGINES 23
Auxiliary Jet 23
Auxiliary Rocket 23
Diesel 23
Gas Turbine 23
Nuclear Rocket 23
Nuclear Turbine 23
Pulse Jet 23
Ramjet 23
Rocket 23

DELIVERED—thousands of missile APUs



1. *Solid propellant—hydraulic output* 2. *Liquid propellant—hydraulic and electric output* 3. *Solid propellant—electric and mechanical drive output* 4. *Liquid propellant—hydraulic and electric output* 5. *Solid propellant—hydraulic and electric output* 6. *Solid propellant—hydraulic, electric and steering outputs*

AiResearch has designed, developed, manufactured and delivered thousands of missile accessory power units. Extremely reliable and lightweight, these various solid and liquid monopropellant APUs are completely self-sustaining within the missile system. Designed to minimum space and weight requirements, they are built to withstand high G loading and severe temperature extremes.

The several units pictured above provide hydraulic, electrical and/or steering surface control depending on the customer's requirement. Delivered horsepower ranges from 1.2 to 35 h.p. over hot gas operating durations from 30 seconds to 20 minutes. Electrical regulation is maintained as closely as ±½%. A significant advance in missile APUs is unit #6 pictured above. This package represents the first integrated hydraulic and electrical power unit providing a steering surface actuation system.

These tailored systems utilize the extensive hardware experience and complete laboratory, test and production facilities of AiResearch needed for quick and efficient quantity production of complex APU systems. AiResearch is the world's largest and most experienced manufacturer of lightweight turbomachinery—the key component of its APU systems. Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

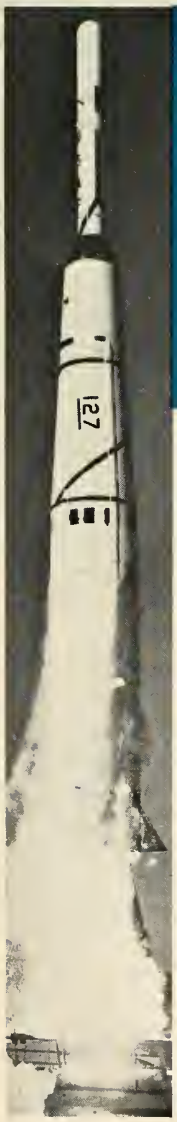
Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

Fill in No. 23 on Subscriber Service Card.

Engineers:

BECOME A PART OF CAPE CANAVERAL'S BIG MISSILE NEWS THROUGH ON-THE-SPOT PARTICIPATION WITH PAN AM



PAN AM

The Guided Missiles Range Division of Pan American World Airways has prime responsibility for management, operation and maintenance of the 5000-mile Atlantic Missile Range. This responsibility and the division's dynamic growth create unique opportunities for high level engineers, physicists and mathematicians in the pioneer arts of missile range management, operation, maintenance and test data collection and reduction.

Please address your resume in confidence to Mr. J. B. Appledorn, Director of Technical Employment, Pan American World Airways, Inc., Patrick Air Force Base, Florida, Dept. B-7.

Guided Missiles Range Division
Patrick Air Force Base, Florida

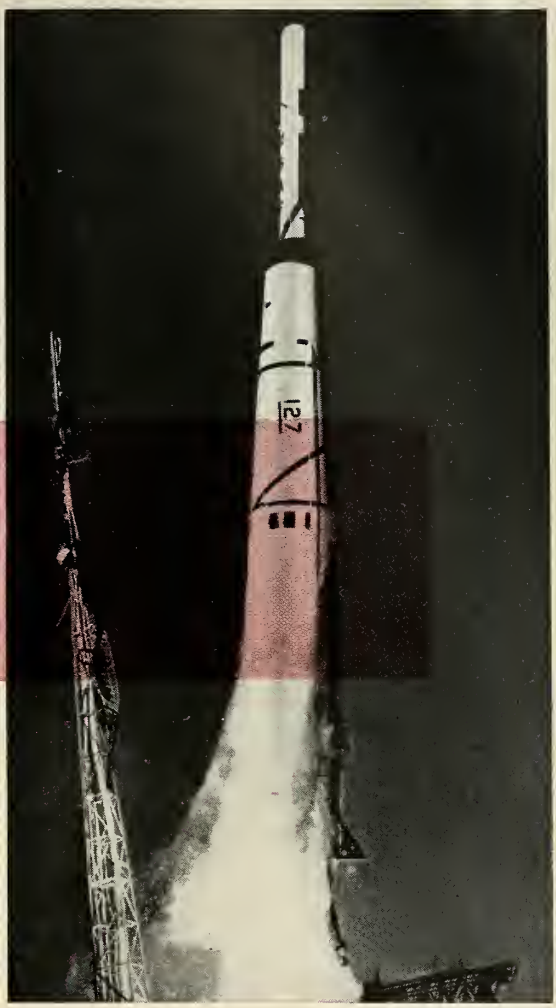
Fill in No. 24 on Subscriber Service Card.

. . . cross index

EXHAUST ASSEMBLIES 23
EXHAUST CONES, GAS TURBINE ENGINE 23
EXHAUST 23
EXTRUSIONS, METALLIC .. 23
EXTRUSIONS, NON-METALLIC 23
FABRICATORS, POWDERED METAL PARTS 23
FANS 23
FASTENERS 23
Blind 23
Cowl 23
Self-Locking 23
Slide 23
Snap 23
FEED SYSTEMS 23
FILTERS 23
Air 23
Detonation 23
Equalizer 23
Fuel & Oil 23
Line 23
Mechanical 23
Pneumatic System 23
FIRE 23
Detectors 23
FIRE WALLS 23
FITTINGS, COAXIAL CABLE 23
FITTINGS, METALLIC 23
FLAMEHOLDERS, RAM JET 23
FLUID METERING PUMP SYSTEMS 23
FLUID MOTORS 23
FLUIDS, HYDRAULIC OILS, COOLANTS, ETC. 23
FLYWHEELS 23
FUEL SYSTEMS & EQUIPMENT 23
Balancing Controls 23
Flow Dividers or Distributors 23
Injection Equipment 23
Lines 23
Mixture Controls, Automatic 23
Pressure Gauges 23
Pressure Warning Units 23
Pumps 23
Ratio Controllers 23
Strainers 23
FUELS, SOLID 23
GAS GENERATING DEVICES 23
GASES, NITROGEN 23
GASES, RARE 23
GASKET PASTE & CEMENT 2
GASKETS, METALLIC 2
GASKETS, NON-METALLIC . 2
GAUGES 2
Displacement Measuring 2
Fuel Pressure 2
Fuel Quantity 2
Hydraulic Pressure 2
Liquid Level 2
Manifold Pressure 2
Oil Level 2
Oil Pressure 2
Outside Air Temperature ... 2
Pressure 2
Quantity 2

NOW!

General Chemical offers Helpful Technical Data on ROCKET FUEL OXIDIZERS



- ✓ **Fuming Nitric Acid**
- ✓ **Liquid Fluorine**
- ✓ **Chlorine Trifluoride and other Halogen Fluorides**

To assist specialists working in the field of cket and missile propulsion, General Chemical now offers valuable set of product information bulletins packed with ysical and chemical data, tables and graphs. This infor- ation is based on General Chemical's extensive experience th these products as America's leading producer of lorine and fluorine-based chemicals, and one of the tion's primary producers of nitric and other mineral ids. The questions our customers ask most often about ese products are answered here.

re are the specific bulletins offered:

Nitric Acid, Fuming"—29 pages—Including detailed product description of both red and white fuming nitric acid, chemical and physical properties, corrosion data, directions for storage and handling.

luorine"—21 pages—Including extensive data on the chemical and physical properties of this most powerful oxidizing agent, a description of materials and equipment for handling gaseous and liquid fluorine, safety precautions.

hlorine Trifluoride"—35 pages—Including the chemical and physical properties of chlorine trifluoride and other halogen fluorides, recommended materials for use in halogen fluoride systems, directions for safe handling.

o available are bulletins on:

Handling Elemental Fluorine Gas In The Laboratory
Liquid Fluorine Unloading Procedure
Chlorine Trifluoride Vapor Pressures

ail coupon now for your free copy of any or all 6 of these valuable technical bulletins.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

GENERAL CHEMICAL DIVISION MI-59
ALLIED CHEMICAL CORPORATION
40 Rector Street, New York 6, N. Y.

Please send the following General Chemical Technical Bulletins:

- ☐ "Nitric Acid, Fuming" (PD-TA-70751)
- ☐ "Fluorine" (PD-TA-85413)
- ☐ "Handling Elemental Fluorine Gas In The Laboratory" (PD-TA-85413A)
- ☐ "Liquid Fluorine Unloading Procedure" (PD-TB-85411)
- ☐ "Chlorine Trifluoride" (TA-8532-2)
- ☐ "Chlorine Trifluoride Vapor Pressures" (DA-85321)

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

Fill In No. 25 on Subscriber Service Card.

AIRCRAFT - TRAINED
MISSILE - MINDED

31 years experience in aircraft engine parts

Headed fasteners in heat-resistant metals

Laboratory-controlled hardened and ground precision parts

Assemblies and sub-assemblies

HMS
HARTFORD MACHINE SCREW CO.
Division of Standard Screw Co.
HARTFORD 2, CONNECTICUT

Fill in No. 48 on Subscriber Service Card.



ASSURE THE SUCCESS OF YOUR SPACE AGE PRODUCTS WITH
Redel
Research and Development

- Propellant Studies — Solids, Liquids, Gases, and Hybrids
- Ignition Studies — Guns, Rockets, and Cartridge Actuated Devices
- Ballistic Studies — Interior and Applied
- Design and Development — Pyrotechnic, Explosive, Propellant, and Ballistically Activated Devices; Gas Generators
- High Performance Materials Studies
- Marketing Studies for Space Age Components, Devices and Products

Write for Brochure

Redel INCORPORATED
220 NO. ATCHISON ST., ANAHEIM, CALIFORNIA

Fill in No. 49 on Subscriber Service Card.

. . . cross index

GEAR ASSEMBLIES REDUCTION 239
GEARS, POWDERED METAL 240
GEARS, PRECISION 240
GEARS, RADIO & INSTRUMENT 240
GENERATORS 240
Electric AC 240
Electric DC 240
Engine Driven 240
Liquid Oxygen 240
Liquid Oxygen, Mobile 240
Tachometer 240
GENERATORS, ELECTRONIC 240
AM & FM 240
Microwave 240
Noise 240
Picture Signal 240
Pulse 240
Signal, AF 241
Signal, FM 241
Signal, RF 241
Signal, SHF 241
Signal, Single Sideband 241
Signal, Sweeping 241
Signal, Television Synchronizing 241
Signal, UHF, VHF 241
Square Wave 241
Ultrasonic 241
Variable Frequency 241
Waveform 241
GOVERNORS, MISSILE CONTROL 241
HARNESSES 245
HEADERS 245
HEAT TRANSFER CONTROL SYSTEMS 245
HEATER MUFFLER ASSEMBLIES 245
HEATERS 245
HOSE 246
Air 246
Flexible, Metalic 246
Flexible, Non-Metallic 246
Hydraulic 246
HYDRAULIC RESERVOIRS . 247
HYDRAULIC SYSTEMS & CONTROLS 247
IGNITION ASSEMBLIES 247
IGNITION SYSTEMS, AIRBORNE 247
IGNITION SYSTEMS, ELECTRONIC 247
IGNITION TUBE ASSEMBLIES 248
IMPELLERS 248
INDICATORS 248
Rate-of-Roll 248
Rate-of-Yaw 248
Recording Engine 248
Smoke & Combustion, Electronic 248
Sound Level 248
Specific Gravity 248
Strain 248
Temperature 248
Thrust 248
Torque 248
INJECTION SYSTEMS, FUEL 250
INJECTION SYSTEMS, WATER 250
INSULATIONS PARTS 252
Ceramic 252
Insulating Sleeves 252
Rods 252
Sheets 252
Silicone Rubber 252
Stampings & Punchings 252
INSULATORS 253
JET ENGINES 255
JOINT ASSEMBLIES 255
JOINTS 255
Ball 255
Swivel 255
Torsion 255
Universal 255
LINERS 258
Can 258
Combustion Chamber 258
Combustion Chamber, Gas Turbine Engine 258
Metal 258
Rocket Engine 258
LIQUID FUELS 259
LIQUID NITROGEN 259
LIQUID OXYGEN 259
LOCKNUTS 259
LOCKS 259
Hydraulic 259
Shaft 259
LUBRICATING DEVICES ... 259
LUBRICANTS 259
MAGNETOS & PARTS 260
MANIFOLDS 261
Air System 261
Fuel 261
Ignition 261
Intake & Exhaust 261
Nitrogen 261
Oxygen 261
Primer 261
MANIPULATORS, NUCLEAR 261
MASKS, APERTURE, TUBE . 261
METAL CLAD SHEETS 262
METAL MACHINING 262
MIDFRAME SECTIONS 265
MISSILE BOOSTERS 265
MONOPROPELLANTS 267
MOTORS 267
Clock 267
Control 267
MOUNTINGS, METALLIC .. 268
MOUNTINGS, NON-METALLIC 268
MOUNTINGS, VIBRATION & SHOCK 268
MOUNTS, ENGINE 268
MOUNTS, SHOCK 268
MOUNTS, THERMISTOR ... 268
MUFFLERS, JET ENGINE INTAKE & EXHAUST 268
MUFFS 268
MULTIMETERS 268
NOZZLE ASSEMBLIES 270
NOZZLE DIAPHRAGMS 270
NOZZLES 270
Exhaust 270

CONTROLS

FOR THE FULL SPECTRUM OF PROPULSION SYSTEMS



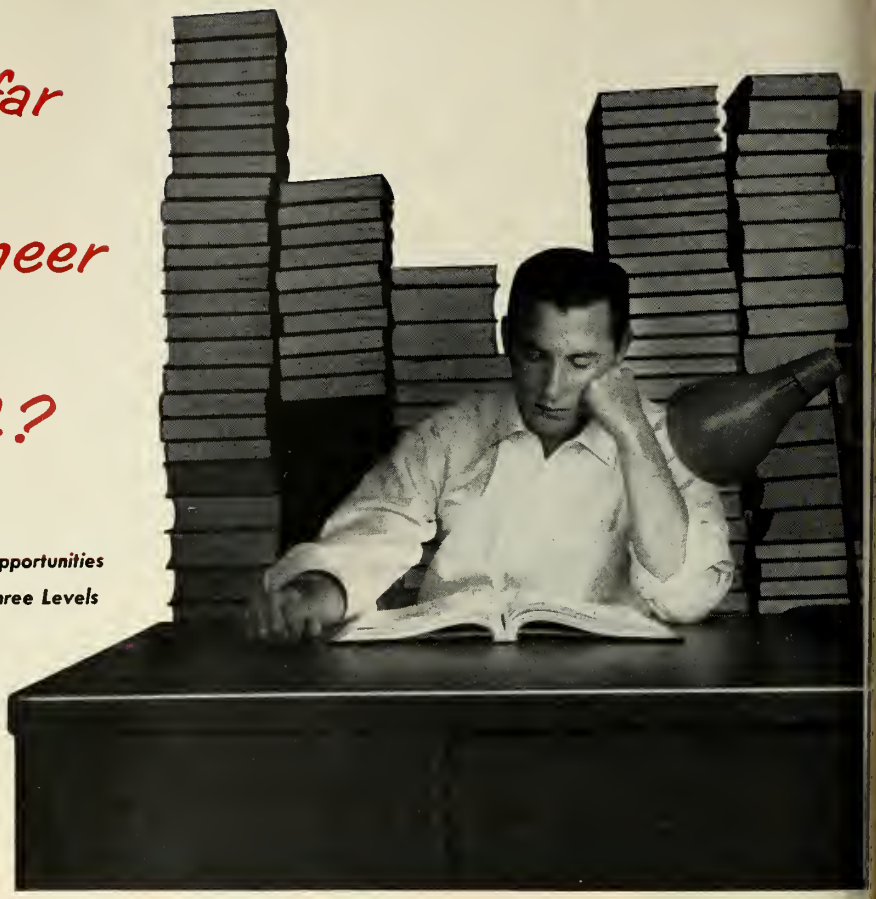
Bendix* has long been a leader in supplying controls and fuel systems for all types of aircraft engines. Today, Bendix is proving to be a natural for new challenges in related missile fields—on ram jets, rockets, nuclear power, and other advanced propulsion systems. So, when it comes to controls, remember that Bendix has the background—and is anxious to share it in solving your problems. *REG. U.S. PAT. OFF.

BENDIX PRODUCTS DIVISION **SOUTH BEND, IND.**

Bendix AVIATION CORPORATION

Fill in No. 26 on Subscriber Service Card.

How far can an engineer go at AC?



Special Advanced Education Opportunities Develop Career Potential on Three Levels

If you are a graduate engineer in the electronics, electrical or mechanical fields, or if you have an advanced degree in mathematics or physics, you can work on AC's famous AChiever inertial guidance system or a wide variety of other electro-mechanical, optical and infra-red devices. You can also prepare for promotion and enhance your professional status through AC's free comprehensive training programs—the finest "in house" programs available.

Program A—for recent graduate engineers—gives you a solid foundation in the theory and application of inertial guidance systems and servomechanisms. You attend classes three hours per day for four months, all on company time.

Program B—for experienced engineers—consists of upgrading studies in inertial guidance, servomechanisms, environmental problems, engineering math and physics, plus advanced state-of-the-art courses. Time? —during working hours or evenings.

Program C—for all engineering supervisors—involves management training developed by a team of AC executives and University of Chicago industrial relations experts. Sixty one-half-hour sessions give you a solid grounding in management techniques.

These thoroughly practical courses—taught by university professors or recognized AC specialists—constitute AC educational "extras." AC offers them in addition to their educational assistance programs for men who wish to study for advanced degrees in nearby universities.

AC invites you to compare these advanced training offerings with those of any other company. Get complete details today. Just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Dept. B, Box 746, South Milwaukee, Wisconsin.

INERTIAL GUIDANCE SYSTEMS • AFTERBURNER FUEL CONTROLS • BOMBING NAVIGATIONAL COMPUTERS GUN-BOMB-ROCKET SIGHTS • GYRO-ACCELEROMETERS GYROSCOPES • SPEED SENSITIVE SWITCHES • SPEED SENSORS • TORQUEMETERS • VIBACALL • SKYPHONE

AC SPARK PLUG
THE ELECTRONICS DIVISION
OF GENERAL MOTORS

Fill in No. 27 on Subscriber Service Card.

. . cross index

Exhaust, Metallic 270
UCLEAR 270
XIDIZERS 273
AINT, METALLIC 273
NS, TUBULAR 275
LATES, INSTRUCTION 276
LATES, METAL OR PLASTIC 276
LATING, PRECIOUS METAL 276
LATING, TIN ZINC 277
ROPELLANT CASES, SOLID ROCKET 281
ROPELLANT TANKS 281
ROPELLANTS, LIQUID ROCKET 281
ROPELLANTS, SOLID ROCKET 281
ROPULSION SYSTEMS 281
UMPS 281
Air 281
Alcohol 281
Booster 281
Combination Air & Hydraulic 281
Fuel 281
Hydraulic, Fixed Displacement 281
Hydrogen Peroxide 281
Liquid Nitrogen 281
Liquid Oxygen 281
Metering 281
Oil 281
Speed Density Metering 281
Transfer 281
Turbine 281
Vacuum 281
Water Injection 281
Wobble 281
ADIATORS, COOLANT 284
ADIATORS, ENGINE-COOLING 284
ADIATORS, OIL-COOLING . 284
EACTORS, SATURABLE ... 284
EDUCERS, SHAFT 286
EFRIGERATION EQUIPMENT, AIRBORNE 286
EGULATORS 287
Air Combustion 287
Air Pressure 287
Coolant 287
Demand Oxygen 287
Fuel Flow 287
Fuel Pressure 287
Hydraulic Pressure 287
Liquid Level 287
Manifold Pressure 287
Oil Cooler 287
Oil Pressure 287
Oil Pump Flow 287
Oil Temperature 287
Oxygen 287
Temperature 287
Vacuum Systems 287
Voltage Regulators & Stabilizers 287
Water Injection 287
ESERVOIRS, HYDRAULIC SYSTEMS 289
RESERVOIRS, PNEUMATIC SYSTEMS 289
RESTRICTORS, HYDRAULIC SYSTEMS 290
RINGS 290
Carbon Packing 290
Clamping 290
Collector 290
Expansion 290
Hydraulic Back-up 290
Oil Sealing 290
Retainer 290
Scraper 290
Sealing 290
Shock Absorber 290
Slip 290
Slip & Brush Assemblies ... 290
ROCKETS 291
ROD END BEARINGS 291
ROTATORS 291
ROTOR ASSEMBLIES, GAS TURBINE ENGINE 291
ROTOR CASTINGS 291
ROTORS 291
SCREW MACHINE PRODUCTS 291
SCREWS, SELF-TAPPING ... 292
SCREWS, SET 292
SCREWS, STANDARD 292
SEALERS, FUEL & OIL TANK 292
SEALERS, NUCLEAR 292
SEALERS, PROTECTIVE 292
SEALING, SERVICE, HERMETIC 292
SEALS 292
SHAFTS, FLEXIBLE 294
SHAFTS, RIGID 294
SHIELDING 294
Heat 294
Ignition 294
Lead 294
Lead, Nuclear 294
Magnetic 294
Radiation 294
Radiation, Nuclear 294
Solid 295
SHIMS, ADJUSTING 295
SILVER PASTE 296
SLEEVES, METALLIC 296
SLEEVES, NON-METALLIC . 296
SLEEVES, TUBE 296
SLEEVING 296
SLIP RING ASSEMBLIES ... 296
SOLDER 296
Aluminum 296
Indium 296
Lead-Tin 296
Platinum 296
SOLID ROCKET FUELS 297
SPACERS 297
SPRINGS 298
STACKS 298
STAMPED PARTS, TUBE ... 298
STARTERS, GAS TURBINE ENGINE 299
STARTERS, PNEUMATIC ... 299
STARTERS, ROCKET ENGINE 299
STARTING SYSTEMS & CONTROLS 299
SWITCHES 300
TAILPIPES, JET ENGINE 302
TANKS 302
Auxiliary 302
Auxiliary Drop 302
Fuel 302
Liquid Nitrogen 302
Liquid Oxygen 302
Liquified Gas Storage 302
Oil 302
Self-Sealing 302
Transportation & Storage ... 302
TAPES 303
Asbestos 303
Coated & Impregnated 303
Electrical Insulation 303
Fabric 303
Friction 303
Heat Resistant 303
Plastic 303
Pressure Sensitive 303
TEMPERATURE CONTROL SYSTEMS 303
THERMOCOUPLES 307
THRUST CHAMBERS 308
THRUST MEASURING INSTRUMENTS 308
TUBING 312
Aluminum 312
Asbestos 312
Brass or Copper 312
Capillary 312
Ceramic 312
Fibre 312
Finned 312
Flexible Metal 312
Fused Quartz 312
Glass Fibre Insulation 312
Glass, Precision 312
Metal & Alloy 312
Metal Hose, Flexible 312
Mica 312
Molybdenum 312
Monel 312
Nickel 312
Paper 312
Phenolic 312
Plastic 312
Precious Metal 312
Seamless 312
Silver 312
Steel 312
Steel, Stainless 312
Tantalum 312
Titanium 312
Tungsten 312
Varnished or Lacquered 312
Varnished Cambric Insulation 312
Woven or Knitted Wire 312
TUBULAR FABRICATIONS & ASSEMBLIES 313
TURBINE ASSEMBLIES 314
TURBINE SHAFTS 314
TURBINE WHEELS 314
TURBINES, AIR 314
TURBO FANS 314
TURBO JET ENGINES 314
TURBO PUMP 314
VACUUM SYSTEMS & CONTROLS 315
VACUUM UNITS 315

REGULATED DC POWER SUPPLIES

HI-VOLTAGE SERIES

Designed for powering airborne electronics equipment under the most adverse enviranmental conditions, Arnoux High Voltage DC Power Supplies assure the utmost in reliability. These magnetic-amplifier reguloted supplies ore available in the range of 108 to 450 volts DC, with current ratings from 50 ma to 800 mo. Other ratings are also available on speciol order.



Model 250 S 025

ARNOUX

Input Power: 115 volts, 400 cps

Regulation:	Input (Variation)	Output (% Rated)
Line Voltage:	± 10%	± 0.25
Line Frequency:	± 20 cps	± 0.1
Load Current:	20-100%	± 0.1
	0-100%	± 0.2

Ripple: Less thon 0.05% rms ot full lood.

Output Adjustment: 5% odjustment ovoilable on request ot slightly higher price.

Environmental: Meets specificotion MIL-E 5272A for acceleration, vibration, altitude, humidity and temperature operating at 20% to 100% roted lood.
Also meets MIL-I 6181 B.

Connector: AN-type connector.

Mounting: Stud-mounted.

(Write for Bulletin 200)

LO-VOLTAGE SERIES

Intended for use in precision airborne instrumentation systems, Arnaux Low-Voltage DC Power Supplies ore available in both single and dual output. Ranging fram 5 to 50 volts at currents up to 10 amperes, these rugged units are hermetically sealed.



Model 5 S 10

ARNOUX

Input Power: 115 volts, 400 cps

Regulation:	Input (Variation)	Output (% Rated)
Line Voltage:	± 15 volts	± 0.10
Line Frequency:	± 20 cps	± 0.15
Output Load:	20-100%	± 0.05
	0-100%	± 0.10

Temperature Stability: 0.5% per 100°F. (— 60°F. to + 160°F.)

Ripple: Less thon 0.1% rms ot full lood.

Output Adjustment: Screwdriver odjustment provides ± 0.5 volt chonge. Wider ronge of odjustment ovoilable on request.

Connector: Stondord AN-type connector, or hermetically seoled heoder on request.

Mounting: Stud-mounted.

Environmental: Meets specificotion MIL-E 5272A for occelerotion, vibration, oltitude, temperoture and humidity.

(Write for Bulletin 100)

Designers and Manufacturers of

PRECISION INSTRUMENTATION

ARNOUX CORPORATION

11924 WEST WASHINGTON BLVD. • LOS ANGELES 66, CALIFORNIA

Fill in No. 50 on Subscriber Service Card.

. . . cross index

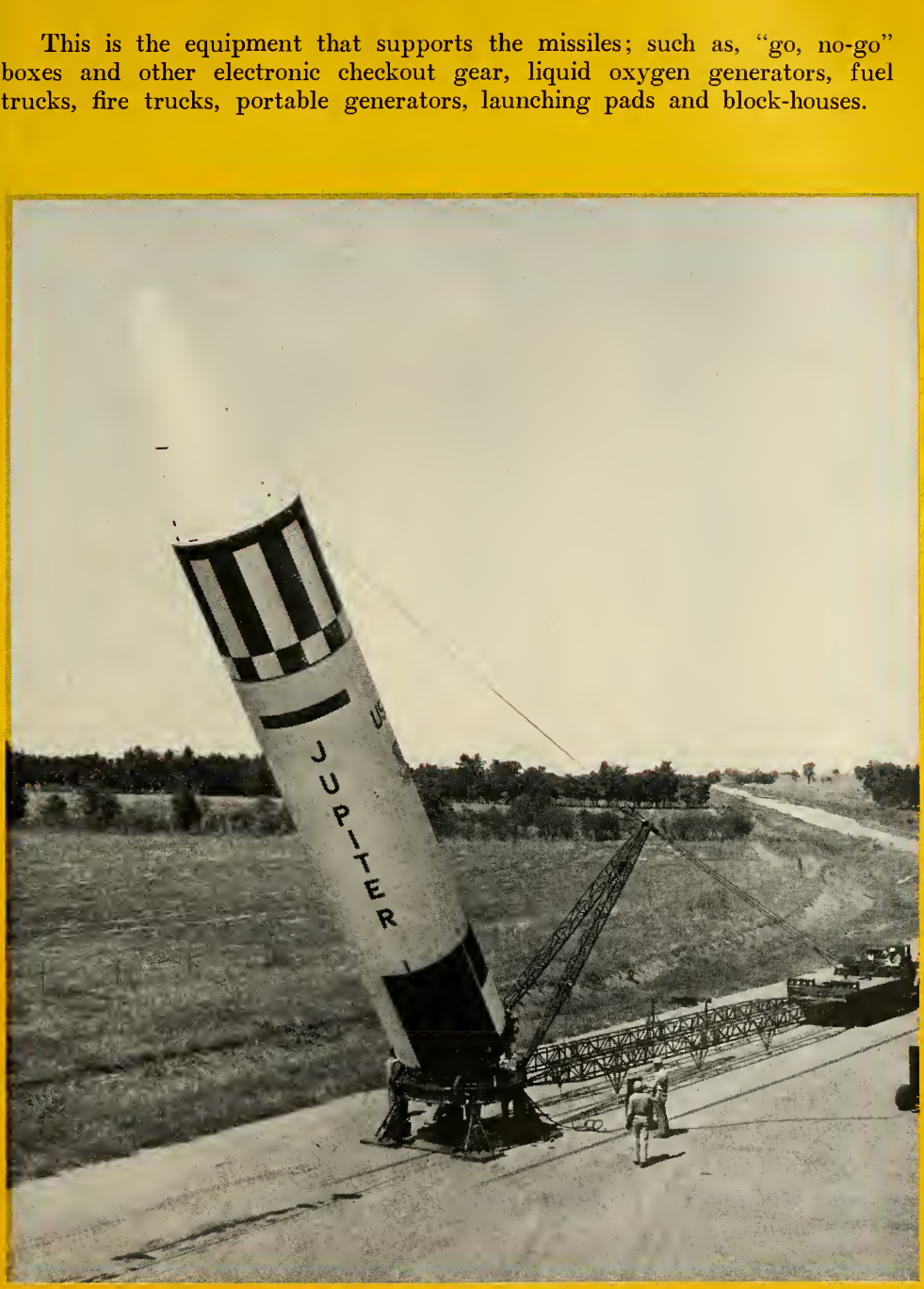
VALVE GUIDES 315
VALVE OPERATOR 315
VALVES 315
- Acid 315
- Acid Resistant 315
- Air 315
- Anti-Gravity 315
- Automatic Shutoff, Hydraulic 315
- Bleeder 315
- By-Pass 315
- Check & Check Relief 315
- Check-Hydraulic, Gas 315
- Control 315
- Diaphragm 315
- Dump 315
- Electronic Solenoid 315
- Engine Inlet 315
- Exhaust 315
- Float 315
- Globe 315
- Helium 315
- High Pressure Gas 315
- Hydraulic System 315
- Hydrogen 315
- Motor Operated 315
- Needle 315
- Plug 315
- Pneumatic 315
- Power Control 315
- Pressure Regulating 315
- Relief & By-Pass 315
- Restrictor 315
- Rocket Fuel 315
- Rotary 315
- Sequence 315
- Servo 315
- Shuttle Solenoid 315
- Strainer 315
- Suction Regulating 315
- Surge 315
- Thermostatic 315
- Throttling 315
- Transfer 315

VAPORIZERS, LIQUID OXYGEN 31
VIBRATION ABSORBERS ... 31
WASHERS 31
WATER INJECTION EQUIPMENT 31
WIRE 31
- Guy 31
- Mesh 31
- Metal Plated 31
- Metal Shielded 31
- Monel 31
- Nickel Clad Copper 31
- Phosphor Bronze 31
- Plastic Insulated 31
- Platinum 31
- Recording 31
- Reels 31
- Silicon Bronze 31
- Silver Plated 31
- Stainless Steel 31
- Tantalum 31
- Thermocouple 31
- Zirconium 31

WIRE STRIPPERS 32

GROUND SUPPORT EQUIPMENT

This is the equipment that supports the missiles; such as, "go, no-go" boxes and other electronic checkout gear, liquid oxygen generators, fuel trucks, fire trucks, portable generators, launching pads and block-houses.



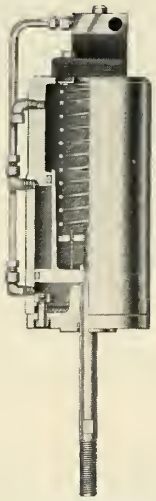
Annin OFFERS YOU MORE IN ACTUATORS

Your choice OF ADVANCED DESIGNS WITH MORE PRECISE POSITIONING AND DYNAMIC RESPONSE CHARACTERISTICS



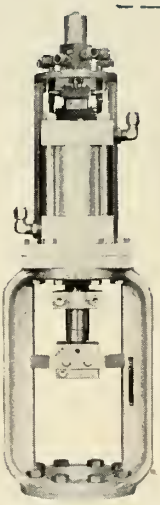
1542 & 1544 SERIES DOMOTOR POWERED ACTUATORS

Two types, "Direct Thrust" (illustrated) or "Lever" units are available for any application requiring accurate positioning in response to a pneumatic signal, such as butterfly valves, dampers, turbines and engine governors. Guaranteed positioning accuracy of better than 0.001" per inch of stroke over the complete range of piston travel is combined with a smooth operating action that provides an accurate, stable output force.



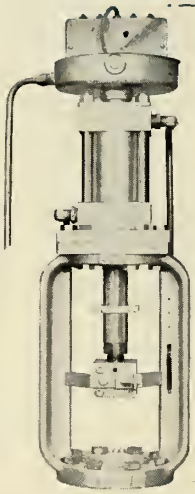
600 SERIES STROKE POSITIONING ACTUATORS

Offered primarily for the control of variable speed drives, rheostats, pumps and cams, as well as control valves, with strokes up to 6 inches and forces up to 2510 pounds of thrust. Compact and rugged, for easy mounting on existing equipment. May be operated from a standard 3-15 psi instrument signal, with a positional accuracy within 0.001" per inch of stroke.



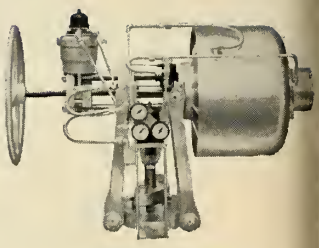
10,000 SERIES PNEUMATIC-HYDRAULIC ACTUATORS

For valves requiring strokes to 6 inches and thrusts to 100,000 lbs. Furnished on body assemblies where process conditions require very fine valve response, hi-speed and stability. Operate on 1500 psi oil supply system from any common instrument air signal.



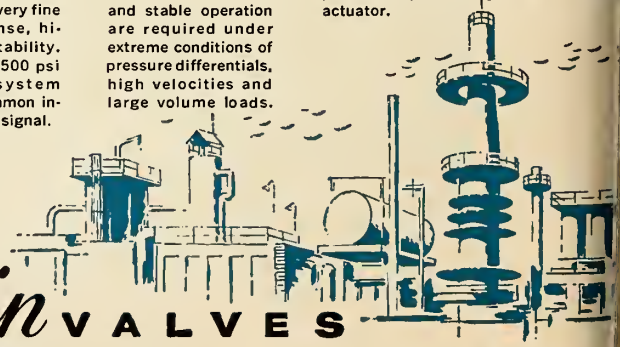
20,000 SERIES ELECTRO-HYDRAULIC ACTUATORS

Provide a means of converting an electrical signal to a powerful hydraulic positioning force, where high speed of response and stable operation are required under extreme conditions of pressure differentials, high velocities and large volume loads.



TOGGLE ACTUATORS

For process requirements where the unbalanced forces are extremely high, or where large through-puts are required. Three types are offered: pneumatic positioning, pneumatic on-off, and manual control, all embodying the toggle actuator; or a manual control arrangement can be combined with the pneumatic positioning or on-off toggle actuator.



Annin VALVES

THE ANNIN COMPANY
1040 S. Vail Avenue, Montebello, California

Write for Bulletin 1236-ST

Fill in No. 28 on Subscriber Service Card.

New Products

• ground support

EALED ELECTRIC COUNTER HAS ELECTRIC RESET

Durant Mfg. Co.'s new Model 5-E-9156-ER is a hermetically sealed lectric counter with electric reset, de-gned specifically for use on military nd other applications where adverse perating conditions are a factor. It is anufactured to meet MIL specifica-ons 5272-A and similar rugged ecfications.

Although especially designed for ich military applications as missile round support equipment and aircraft strumentation, Model YE-9156-ER ay also be used on industrial installa-ons where severe atmospheric condi-ons prevail, or where an explosion-roof unit is required.

Provision is made for mounting the unter to the front panel through four 32 threaded holes on the face of the unter. It is also equipped with four ounting lugs at the base for applica-ons where additional support is eeded, or for base installation. Com-ct in size and sturdy in construction, odel 5-YE-9156-ER is complete with Winchester hermatic seal connector



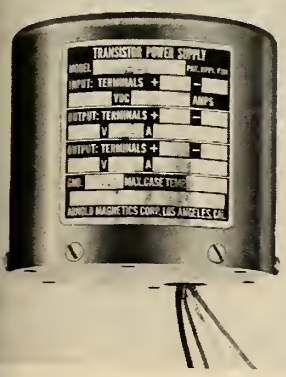
on the bottom for quick connection to the power source.

Case size—3½" wide x 1-7/8" deep x 3-7/16" high. Figures—3/16" high x 9/64" wide. White on black background, with wide window opening for maximum readability. Speeds —1500 CPM or 25 CPS standard, with maximum resetting time of 105 milliseconds. Voltage—28 V. DC—Other voltages available on special order. Finish—Gray color 36492 per federal standard 596 for military panels.

Fill in No. 113 on Subscriber Service Card.

Power Supply Produces DC to Square Wave

Arnold Magnetics Corp. has announced a transistorized power supply that will produce 400 cps single-phase, square wave power from a 28 volt DC line.



Unit delivers 50 VA of output power with a frequency and voltage regulation of ±1% for variations of input voltage of 5 volts. An output power of 115 volts, 400 cycles is standard, but any voltage between 6 or 1200 VRMS, and any frequency between 400 and 2000 cps, is available on request.

Protection against internal damage is provided by the use of an added circuit, which has the effect of rendering the power supply non-operative when the polarity is inadvertently reversed. Unit can withstand short circuit indefinitely, input voltage transients of 60 volts for 0.01 seconds, and 50 volts indefinitely at reduced power. Voltage drift is ±3% across a temperature range of from −55°C to +71°C.

Designated Model 591AC, unit is fully incapsulated and hermetically sealed, and meets the test specifications of MIL-E-5272B. Size is 3" OD x 3-3/16" high, and weight is 22 ounces.

Three standard terminations are available—A/N connector, wire-lead pigtail, and solder-lug terminals.

Fill in No. 114 on Subscriber Service Card.

Pneumatic Hose Has 24,000 Psi Burst Pressure

Aeroquip's Development-Engineering Center offers 678 Hose of Teflon for 6000 psi pneumatic systems and with a 24,000 psi burst pressure. 678 Hose is designed for the more severe requirements of missile pneumatic charging systems. The 4 to 1 safety factor of the hose provides greater safety to crews handling very high pressure air, helium, nitrogen, and other gases.



The hose has a Teflon tube with zero moisture absorption and an anti-adhesive surface to permit fast, easy purging and dehydration of hose lines and equipment. Spirally-wound stainless steel wire overlaying a stainless inner braid reinforces the hose, which has a stainless braided cover. Though constructed for use under rough handling, it retains flexibility making it easy to coil on reels. It is available in in -6 (3/8") and in -8 (½") sizes.

New segmented fittings for 678 Hose are reusable and incorporate a proven lip-seal for permanent leakproof performance. Designed concurrently with the 678 Hose is a lighter weight pneumatic hose for 3500 psi pneumatic systems. Designated 675 Hose, it features a Teflon tube and two-ply stainless steel wire braid reinforcement. With the exception of pressure requirements, it has the same characteristics of the 678 Hose and other Aeroquip Hoses of Teflon. It is available in sizes −4 (¼") to −12 (¾"), and fittings are of the reusable "super gem" type.

Fill in No. 115 on Subscriber Service Card.

FRI Float Switch To Close Circuits

The Flight Refueling, Inc. Model FS-2 Float Switch is ideal for use in any system where it is required to operate electrically actuated valves and



indicator light systems. It can be used for closing a circuit either by the rise or fall of a fluid level. Switches of this type can be used for both ground, aircraft and missile installations with the highest degree of reliability. A variety of float arm configurations are available to suit alternate requirements. Other float switches of this general type are available on special order for varying fluids and for special applications.

Fill in No. 116 on Subscriber Service Card.

I INSTRUMENTATION WIRING
C COMPLETE INSTALLATION
B BASE COMMUNICATION SYSTEM
M MISSILE GROUND SUPPORT SYSTEMS
BY
AMERICA'S
MOST COMPLETE
ELECTRICAL SERVICE

ETS-HOKIN & GALVAN

551 Mission Street, San Francisco, California
218 N. Avalon Boulevard, Wilmington, Calif.
2295 East Belt Street, San Diego, California
233 N. San Joaquin Street, Stockton, Calif.
484 Washington Street, Monterey, California

Fill in No. 1 on Subscriber Service Card.

HIGH STRENGTH FASTENERS

Hex head cap screws—low carbon, high carbon, stainless 304 or 316 in stock

Specials made to order in any alloy

Hardened and ground components to aircraft standards

31 years of aircraft engine experience and quality

HMS

HARTFORD MACHINE SCREW CO.
Division of Standard Screw Co.
HARTFORD 2, CONNECTICUT

Fill In No. 2 on Subscriber Service Card.

. . . new products

Monitoring Equipment Tracks Interference

The Mobile Interference Analysis Station assembled by Missileonics, Inc. of Melbourne, Fla., locate, track down, and record interference; and are able to eliminate any interfering radio signals by coordination with area frequency users. These signals may affect radio control of missile firings, or the telemetry signals from the missile.



The stations monitor radio signals in the frequencies from 1500 kilocycles to 10,000 megacycles. Advanced direction finding and field intensity equipment coupled with the ability of the stations to traverse cross-country roads, afford a quick means of locating the origin of any interfering radio signal. The stations are installed in specially designed truck vans constructed by Gramm Trailer Corp., Lima, O., and mounted on a heavy-duty Ford chassis, fitted with power steering and power brakes. Complete air conditioning and heating equipment are furnished, and independent gasoline-driven generators supply up to 7 KVA for operation of the electronic equipment.

Fill in No. 117 on Subscriber Service Card.

Pipe and Tube Connectors Offer Advantages

Meeting the high pressure, temperature and minimum weight requirements of the aircraft and missiles industry, Flight Refueling Inc.'s complete line of pipe and tube connectors offers many additional advantages. Positive grip and seal under conditions of angular misalignment, parallel axial offset and tube gaps assure a constant connection on beaded or flange type tubing.

One family of connectors provides for easy hand installation in hard-to-get-to places, where wrench movements are prohibited. Connectors are available in sizes from ¾" to 4½".

Fill in No. 118 on Subscriber Service Card.

Low-Cost Standards Used For Ground Support

New low-cost frequency standards which perform well in uncontrolled environments such as found in the operation of military ground support equipment and industrial applications, have been developed by The Gyrex Corp.

Resonant elements of the new Model TQ 60C units operate at their fundamental frequencies. This feature eliminates the need for auxiliary step-down circuitry, giving the instrument exceptionally high reliability. They can be operated or stored over a wide temperature range. Shock, vibration and atmospheric conditions normally found in connection with the operation of ground support equipment will not affect their operation. All units are hermetically sealed and qualify to MIL environment test specifications for ground support equipment.

Other advantages of the new Model TQ 60C units include simple transistorized circuitry and compact size.

Fill in No. 119 on Subscriber Service Card.

Miniature Accelerometer Is Developed

A new accelerometer measuring only 1" x 1" x 1¾" and weighing just three ounces, has been developed by Genisco, Inc., Los Angeles. A potentiometer-type pickoff is used.

The small size and light weight of the new instrument, designated Model GMA, makes it particularly suited for aircraft and missile fire and flight control systems and telemetering applications.



Range of the Model GMA is ± 0.5g to ± 100g's with natural frequencies of from 12 cps to 75 cps. Linearity is ± 1% of full scale for balanced range instruments. Damping is nominally 0.7 of critical at +75°F, provided by the shearing of silicone fluid between closely spaced moving surfaces. The instrument is temperature compensated and will operate to specifications between −20°F and +250°F.

It is able to withstand vibrational accelerations of 10g's, 10 to 20,000 cps, on any axis, and shock accelerations of 50g's for 7 ms duration on any axis.

Fill in No. 120 on Subscriber Service Card.

. . new products

ersatile Missile Check alve Is Lightweight

Flight Refueling Inc.'s Model CV-1 issile and aircraft check valves are ghtweight, reliable and extremely ver- tile. Standard beaded AND-10060 ype A) ends permit rapid in-line in- allation by using two pipe connectors. the interest of weight reduction,



tese check valves may be incorporated i o any long tube merely by expand- ig a small end section of the tube, tereby eliminating one pipe connector.

These operationally proved valves a positive sealing and feature low "acking" pressure and low pressure op. Design makes it practical for use vh most fluids and gases. The CV-1 is also available with threaded ends for s cial applications.

ll in No. 121 on Subscriber Service Card.

uminum Shelter Air Transportable

Gramm Trailer Corp. offers shelter o continuous ribs of extruded alumi- nm, located between end panels so e uipment can be supported properly ir any area. Longitudinal members are w ded to rib sections at the four cor- n s. Equipment can also be fastened tc hese members for support. The skid is ntegral with the bottom longitudinal m mbers for strength as well as simpli- ci of design. All inside dimensions are sc are so equipment may be mounted fl h against the wall. The inside may b ined with plywood, sheet aluminum, or perforated metal to suit individual re uirements. Hardware is flush m nted to minimize damage. Dutch d r comes equipped with flush frost b aking hardware as standard equip- m t.

This shelter is air transportable and ca be transported by C-119, or C124, he copter and M-35 truck.

l in No. 122 on Subscriber Service Card.

HARCO

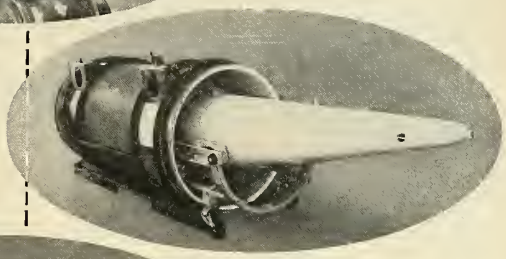
a PROVEN source

OF FIBERGLASS CONTAINERS AND INTEGRAL GROUND HANDLING TRAILERS



LOADED CONTAINERS
Measuring 18½' long, 4½' diameter and weighing up to 4800-pounds when loaded with in-flight refueling stores and integral trailer, can be stacked 3 high to conserve storage space.

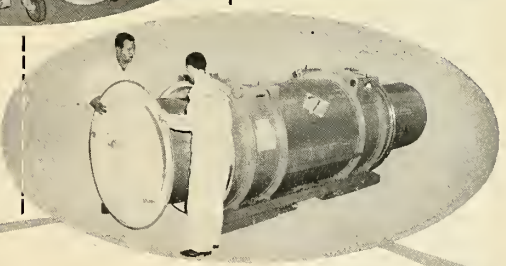
FAST UNLOADING OF REFUELING STORES
Less than 60-seconds required to remove end sections, through use of unique Vee-band clamps, greatly speeds unloading of stores on integral ground handling Harco trailer.



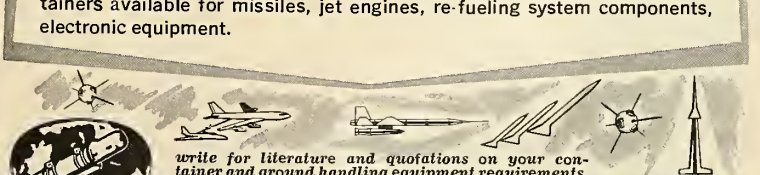


TRAILER IN PLACE FOR RETURN TO BASE
Harco Containers are a complete system for storage, transport and ground handling of critical stores; important part of system is Harco developed trailer which is returnable within container for re-loading.

END SECTIONS REVERSED FOR RETURN SHIPMENT
Overall length is reduced by half for empty-return shipment, conserving valuable shipping space. Use of fiberglass reduces container weight by 60%; is impervious to rust or corrosion; easily repaired in the field.



Harco Containers are the **only** fiberglass containers for storage, transport and handling of in-flight refueling stores approved by BuAer. Features include 60% reduction in weight, reversible end sections to cut return shipping size by ½, integral ground handling trailers for stores, 60-second availability of stores through use of quick release Vee-bands on end sections. Two years of field service prove their superiority. Other Harco Containers available for missiles, jet engines, re-fueling system components, electronic equipment.



write for literature and quotations on your container and ground handling equipment requirements.

EMPLOYMENT OPPORTUNITIES FOR TRAINED MECHANICS.

Harco Containers

A DIVISION OF HARBOR BOAT BUILDING CO.

258 CANNERY STREET, TERMINAL ISLAND, CALIFORNIA

Fill in No. 3 on Subscriber Service Card.

MAKE IT NEWAY

For Your Running Gear Requirements on Ground Handling and Support Equipment

Designers and Manufacturers of Running Gear Systems for

Missile Launchers
Missile Refuelers
Air-Borne Trailers
Ordnance Refuelers
Tank Retrievers

* * *

Air Suspension Systems

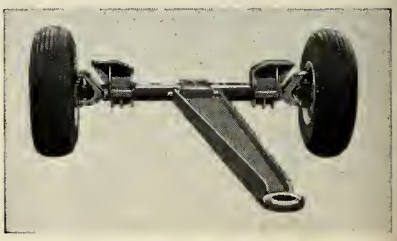
*

Spring Suspension Systems

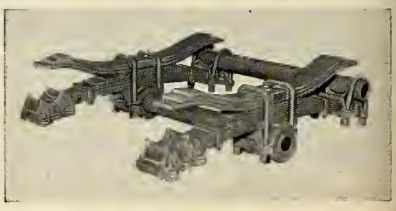
*

Walking Beam Systems

For Your Prototype Development Requirements Or Production Needs



L.O.X. Steering Suspension Assembly



Transerector Spring Suspension



100,000 lb. capacity Air Suspension

NEWAY EQUIPMENT COMPANY
MUSKEGON, MICHIGAN • U. S. A.

PRINTED IN U.S.A.

Fill in No. 29 on Subscriber Service Card.

Cross Index

• ground support

CCUMULATORS, HYDRAULIC 187
CTUATORS 188
Pneumatic 188
DAPTERS 188
Battery 188
Lamp Socket 188
MPLIFIERS 190
Industrial Sound 190
Microphone 190
Mixing Audio 190
Tone Control 190
NALYZERS 192
Cable 192
NTENNA TOWER LIGHTING 194
NTENNAS 194
Mobile Commercial 194
Mobile Communication 194
SSEMBLY EQUIPMENT, AUTOMATIC 195
UXILIARY POWER SOURCES 196
ALL JOINTS 196
ASES 197
ATTERIES 197
ATTERY BOXES, CRADLES, ETC. 197
ATTERY CHARGING & SERVICING EQUIPMENT 197
ATTERY SERVICING EQUIPMENT 197
EACONS, CRASH LOCATOR 197
EARINGS 197
Ball 197
Needle 197
Rod End 197
Roller 198
Roller Taper 198
Self Aligning 198
INS 198
LADDERS, FUEL 198
LADES 199
Hacksaw 199
OLT CARTRIDGES, EXPLOSIVE 200
OLTS, SPADE 200
OXES 200
OXES, STORAGE 201
RACKETS, HARDWARE ... 201
RAKE CONTROL UNITS .. 201
RAKE DRUM 201
RAKE LININGS 201
RAKES 201
Electrical 201
Magnetic 201
Mechanical 201
Pneumatic 201
RAKESHOES 201
REAK-AWAY MECHANISMS 201
UFFERS & GRINDERS 202
ULBS, TEMPERATURE RESISTANT 202
CABINET COVERING 203
CABINETS 203
Metal 203
Speaker 203
Wood 203
CABLE 203
Antenna Transmission 203
Bonding 203
Coaxial 203
Coaxial Flexible 203
Coaxial Rigid 203
Control 203
Delay 203
Disconnects 203
Electric 203
Flat Woven 203
Guards 203
Guillotines 203
Hangars 203
Markers 203
Mechanical 203
Microphone 203
Shielded 203
Splicers 203
Tensioners 203
Transmission Lines 203
Wire 203
CAMERA MOUNTS 205
CANS, HERMETICALLY SEALED 206
CARTRIDGES, STARTER ... 206
CASES 206
Instrument & Meter 206
Tubes 206
CASTERS 207
CATAPULTS 207
CEMENT, WOOD 207
CHAINS 208
CHAMBERS 208
Environmental 208
Ionization 208
Shielded Screen 208
Temperature & Humidity ... 208
Test 208
CHARGERS, BATTERY 208
CHEMICALS, TUBE 209
CHEMICALS, WIRE STRIPPER 209
CIRCUITS 210
Plug-In 210
CLAMPS 210
Conduit 210
Ground 210
Harness 210
Hose 210
Mechanical Cable 210
CLEANERS, CONTACT 210
CLIPS 211
Battery 211
Mechanical Cable 211
CLOTHS, GRILL 211
CLOTHS, SPEAKER GRILLE 211
CLUTCHES, MOTOR & GENERATOR 211
CODE & TAB MARKERS 211



Leading aircraft and missile builders use INVERTRON for accurate tests of subsonic to supersonic frequencies, at power outputs from milliwatts to kilowatts. It's silent and dependable!

- 3-Phase—250 VA to 3000 VA
- Two-Phase—80 VA to 1000 VA
- Single-Phase—160 VA to 2000 VA
- Output Frequencies—50 CPS to 3000 CPS
- Fixed or Variable Output, according to model
- Frequency Accuracy—0.5% to 0.001%
- Special Specifications to order

WRITE for Literature on Custom Instrumentation at Production Line Prices

BEHLMAN ENGINEERING COMPANY

2911 WINONA AVENUE

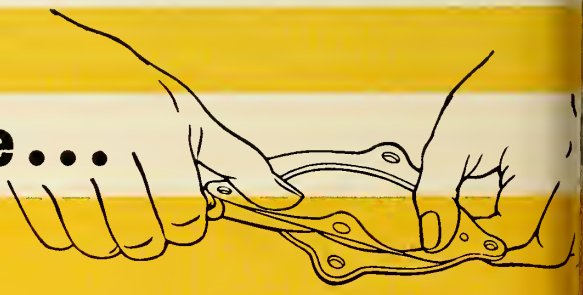
BURBANK, CALIFORNIA Victoria 9-4475

Fill In No. 30 on Subscriber Service Card.

. . . cross index

COIL DOPE 211
COIL FORMS 211
COIL WINDING MACHINES 212
COIL WIND MACHINES, TOROIDAL 212
COILS, HEATING 212
COILS, SPEAKER 212
COMMUNICATIONS SYSTEMS, COMMERCIAL .. 213
COMMUNICATIONS SYSTEMS, INTERCOM 213
COMPOUNDS, CLEANING .. 214
COMPRESSOR ASSEMBLIES, MOBILE 214
COMPRESSORS, AIR 214
COMPRESSORS, GAS 214
COMPRESSORS, PORTABLE . 214
CONDUITS 216
Electric 216
CONES, SPEAKER 216
CONNECTOR, OXYGEN EQUIPMENT 216
CONNECTORS 216
CONNECTORS, HIGH VOLTAGE 217
CONNECTORS, MICROPHONE 217
CONNECTORS, POWER 217
CONNECTORS, SKID & SLED 217
CONSOLES, AUDIO 217
CONSOLES, LIGHTING CONTROL 217
CONTAINERS 217
CONTROLLERS, REMOTE SOUND 217
CONTROLS 217
Chemical 217
Fire 217
Fluid Conductivity 217
Fluid Flow 217
Register Cutter 217
Sound System 217
Specific Gravity 217
Ventilating Control System .. 218
Volume 218
Volume & Tone 218
Weight 218
Welding 218
CONTROLS, GENERATOR .. 219
Illumination 219
Mechanical Overload 219
Mechanical Switch 219
Motor & Generator Communications 219
Motor & Generator, Industrial 219
Oxygen 219
X-Ray 219
CONVERTERS 220
AC-DC 220
DC-AC 220
FM Communications 220
Frequency, Measurement & Test 220
Frequency, Power Supplies .. 220
Liquid Oxygen 220
CORDS 22
Attachment 22
Dial Cords & Cables 22
Lacing 22
Line 22
Line Resistance 22
COUPLINGS 22
CRANES 22
CRYSTAL 22
CRYSTALS, RAW 22
CUTTERS 22
CYLINDERS 22
Air 22
Compressed Gas 22
Hydraulic 22
DEHUMIDIFIERS 22

Our Superiority Here . . .



LAMINUM®
the solid Shim that p-e-e-l-s for adjustment

Our superiority in the production of Laminated Shims of LAMINUM, to the most exacting specifications, results in numerous and profitable advantages. Manufacturers of aircraft, missiles and rockets, of motors and engines, of machine tools and similar precision-assembled equipment save time, cut costs and turn out better products with LAMINUM. Close-tolerance accuracy in fit and alignment is assured...with never a need for grinding counting, stacking nor miking. Laminated Shims of LAMINUM simply p-e-e-l for adjustment, with no dirt between layers—ever!

Brass with laminations of .002" or .003"

Mild Steel with laminations of .002" or .003"

Stainless Steel with laminations of .002" or .003"

Aluminum with laminations of .003" and NEW .002"

THE LAMINATED SHIM CO., INC.
Shim Headquarters since 1913

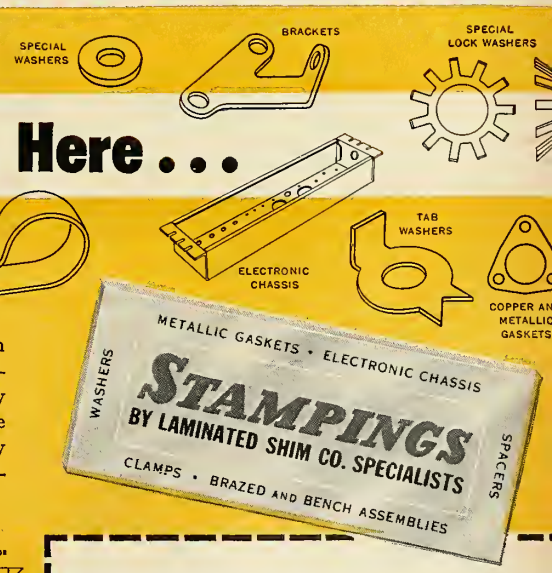
EAST COAST
Home Office and Plant
9304 Union Street
Glenbrook, Connecticut

WEST COAST
600 Sixteenth Street
Oakland 12, California

Please send, without obligation, detailed Engineering Data File on LAMINUM Shims that simply p-e-e-l for a perfect fit *right at the job.*

NAME _____ TITLE _____
COMPANY _____
STREET _____
CITY _____ ZONE ___ STATE _____

)EHYDRATING AGENTS .. 225
)EHYDRATOR PLUGS 225
)EHYDRATORS, AUTOMATIC 225
)EHYDRATORS, OXYGEN EQUIPMENT 225
)EMAGNETIZERS 225
)ESTRUCTORS 225
)ETECTION SYSTEMS 225
)ETECTORS 225
Explosive Gas 225
Smoke 225
)EVELOPERS, CHEMICAL .. 226
)IELECTRIC HEATING EQUIPMENT 227
ISCHARGE EQUIPMENT, LOW TEMPERATURE .. 227
ISCHARGERS, STATIC 227
OLLIES 228
OWELS 228
RAFTING EQUIPMENT .. 228
RAFTING PAPER 228
RILL PRESSES 228
RILL PRESSES, PRECISION 228
RILLS, ELECTRIC 228
RILLS, HAND 228
RILLS, TWIST 228
RIVES, HYDRAULIC 228
ELECTRIC POWER SYSTEMS 229
ELEMENTS, HEATING 230
ELEMENTS, HEATING CRYSTAL OVEN 230
ENCLOSURES, DUST 230
ENGINE STARTING SYSTEMS & CONTROLS, GAS TURBINE ENGINE 231
EXHAUST 232
Ducts 232
Heat Exchangers 232
Muffs 232
Stacks 232
Systems 232
EXHAUST ASSEMBLIES 232
FANS 233
FILES 233
FILM, MAGNETIC STRIPE .. 233
FILTERS 233
Air 233
Fuel & Oil 233
Hydraulic 233
Mechanical 233
Radio Range 233
Radio Tower Lighting 233
FINDERS, RANGE 234
FINDERS, VIEW 234
FIRE 235
Alarm Systems 235
Detectors 235
Extinguishing Systems 235
Protection Systems 235
FIRE STANDS, MISSILE 235
FIRING STAND ACCESSORIES 235
FUEL HANDLING EQUIPMENT 237
FURNACES 238
GAS GENERATING DEVICES 238
GASES, RARE 239
GEAR ASSEMBLIES REDUCTION 239
GEARS, POWDERED METAL 240
GEARS, PRECISION 240
GEARS, RADIO & INSTRUMENT 240
GENERATORS 240
Electric AC 240
Electric DC 240
Engine Driven 240
Liquid Oxygen 240
Liquid Oxygen, Mobile 240
GENERATORS, ELECTRONIC 240
AM & FM 240
Microwave 240
Noise 240



.Guarantees Superiority Here . . .

Actually, our famous Shims of LAMINUM are perfect precision STAMPINGS. Consequently, we have perfected our own special equipment and tooling, our own skills and techniques, unknown to ordinary stampings producers. Result: the unique ability to quickly produce precision STAMPINGS...in any contour, in any size...in any quantity "one to a million"...at the lowest possible unit cost. We have 3 exclusive Methods—pick the one that fits *you* best...

1. FOR A FEW PIECES

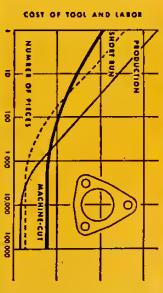
t Experimental
Pilot Stage
we use our
ACHINE CUT
ETHOD. No dies
eeded. Our spe-
al equipment,
us our unique
chniques, are
pplied to pro-
ce small quan-
ties at very low
st.

2. FOR SHORT RUNS

—we use our *low-cost*, SHORT RUN TOOLING METHOD. Our low cost tooling and simple dies, plus special presses, go to work to produce something more than "just a few." Quality is high—costs stay low.

3. FOR PRODUCTION RUNS

—we use our PRODUCTION RUN METHOD. Here is where our production tooling applies to great advantage, and when dies are needed, charges are moderate. The chart tells the story...top quality stampings at lowest possible unit cost.



ANY ONE OF THESE 3 METHODS WILL PRODUCE
AIRCRAFT-QUALITY STAMPINGS TO YOUR OWN RIGID STANDARDS

THE LAMINATED SHIM CO., INC.
—on most Bid Lists

EAST COAST
Home Office and Plant
9304 Union Street
Glenbrook, Connecticut

WEST COAST
600 Sixteenth Street
Oakland 12, California

Please send, without obligation, your 12-page booklet "Service in Stampings" which shows how to save time and cut costs.

NAME _____ TITLE _____
COMPANY _____
STREET _____
CITY _____ ZONE ____ STATE _____

Fill in No. 31 on Subscriber Service Card.



BRAID-LOK PERMANENTLY ATTACHED



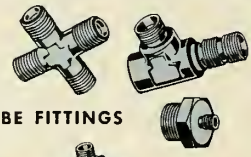


* "*super-gem*" DETACHABLE, RE-USABLE HOSE ASSEMBLIES OF TEFLON**

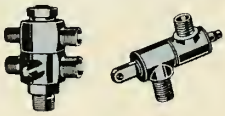


HOSE, END FITTINGS and ASSEMBLIES





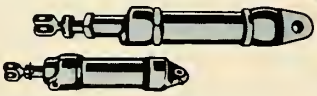
MS ER® FLARELESS TUBE FITTINGS



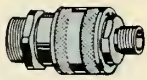
CLUSTER and SWIVEL FITTINGS



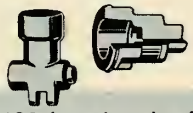
VALVES and BENT TUBE ASSEMBLIES



HYDRAULIC and PNEUMATIC CYLINDERS



QUICK-DISCONNECT, SELF-SEALING COUPLINGS



FORGINGS (cored and solid)

* "*super-gem*": Aeroquip Trademark
**TEFLON: Dupont Trademark

FOR AIRCRAFT and MISSILE HYDRAULICS and PNEUMATICS

Rely on WEATHERHEAD FITTINGS and COMPONENTS

Designed and engineered for lightweight, simplified configuration and dependability.

For quality and reliability where it counts, "specify WEATHERHEAD"

Write us today regarding your special requirements.

In Canada: St. Thomas, Ontario
Export Cable Address: WEATHCO, Cleveland

Thrusting Skyward
. . . beyond tomorrow

WEATHERHEAD AVIATION and MISSILE GROUP



WESTERN DIVISION
1736 Standard Avenue
GLENDALE, CALIFORNIA

SPECIAL PRODUCTS DIVISION
300 East 131st Street
CLEVELAND, OHIO

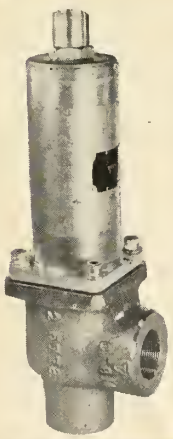
EASTERN AIRCRAFT PRODUCTS CORP.
229 River Street
ORANGE, NEW JERSEY

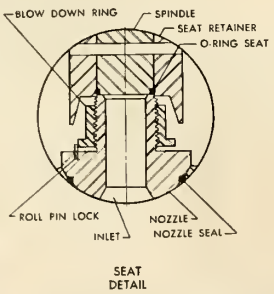
Fill in No. 32 on Subscriber Service Card.

Picture Signal 240
Pulse 240
Signal, AF 241
Signal, FM 241
Signal, RF 241
Signal, SHF 241
Signal, Single Sideband 241
Signal, Sweeping 241
Signal, Television Synchronizing 241
Square Wave 241
Ultrasonic 241
Variable Frequency 241
Waveform 241
GRID FRAMES 241
GRIDS 241
GROUND HANDLING EQUIPMENT, MISSILES . 242
GUN MOUNTS, TELEVISION 244
HAMMERS 244
HAND SETS 244
HANDLES 244
HANDLES, LEATHER 244
HEAT TRANSFER CONTROL SYSTEMS 245
HEAT TREATING SERVICE . 245
HEATER MUFFLER ASSEMBLIES 245
HEATERS 245
HEATING EQUIPMENT, FLEXIBLE 245
HINGES 246
HOISTS, GROUND 246
HOSE 246
Air 246
Assemblies, Flexible 246
Flexible, Metallic 246
Flexible, Non-Metallic 246
Hydraulic 246
HUMIDITY CONTROL SYSTEMS 246
IGNITERS, JET ENGINE 247
IGNITION ASSEMBLIES, SOLID ROCKETS 247
INDICATORS 248
Oxygen 248
Wind Direction 248
Wind Speed, Electronic 248
INDUCTION HEATING EQUIPMENT 249
INTERCOMMUNICATION SYSTEMS 253
INTERFERENCE EQUIPMENT, RF 254
INVERTERS 254
DC-AC 254
Measurement 254
Power Supply 254
Rectifier 254
ISOLATION UNITS 254
JACKS 254
JUMPERS, BONDING 255
KITS 255
Geiger Counter 255
Modification 255
Portable Lighting 255
Test Equipment 255
LACQUERS 256
LADDERS, FUELING 256
LAMINATORS, PLASTIC HIGH PRESSURE 256
LAMPS, INSPECTION 256
LAMPS, PROJECTION 256
LAUNCHERS, AIRBORNE ROCKET 257
LAUNCHERS, GROUND BASED MISSILES 257
LAUNCHING PLATFORMS . 257
LEADS, TEST 257
LENSES 257
LIGHT SUPPLIES 258
LIGHTING, COLD CATHODE 258
LIGHTING EQUIPMENT, EMERGENCY 258
LIGHTING EQUIPMENT, PRESET PANELS 258
LIGHTING EQUIPMENT, TOWER 258
LIGHTING ARRESTORS 258
LIGHTS 258
Arc 258
Flood 258
Fluorescent 258
Glow 258
Incandescent 258
Indicator 258
Spot 258
Stroboscopic Source 258
LIQUID LEVEL MEASURING DEVICES 259
LIQUID NITROGEN 259
LIQUID OXYGEN 259
LOCKS 259
Dial 259
General 259
Hydraulic 259
Shaft 259
LUGS 259
MACH LIMIT SWITCHES ... 260
MACHINES 260
Abrasive Cutting 260
Air Conditioning 260
Balancing 260
Bending 260
Blueprint 260
Capacitor Manufacturing ... 260
Cleaning 260
Coil Winding 260
Counting 260
Crystal Manufacturing & Finishing 260
Cutting 260
Diecasting 260
Electric Soldering 260
Electron Tube 260
Electronic Balancing 260
Electronic Transcribing 260
Engraving & Profiling 260
Forming 260
Glass Working 260
Hermetic Sealing 260
Impregnating 260
Lamination Stacking 260
Marking 260
Metal Forming 260
Modular & Automatic Assembly 260
Photocopy & Whiteprint 260
Plastic Press 260
Riveting 260
Shock Testing 260
Soldering 260
Tube Manufacturing 260
Wire Stripping 260
MAGNETIZERS & DEMAGNETIZERS 260
MATERIALS HANDLING EQUIPMENT 261
MEGAPHONES, ELECTRONIC 262
MICROPHONES 264
MISSILES, GROUND CHECK-OUT-EQUIPMENT 266
MOTORS 267
Hydraulic 267
Universal 267
NAILS, SPECIAL 269
NAVIGATION EQUIPMENT, GROUND 269
NEEDLES, DIAMOND 269
NEEDLES, METAL 269
NEEDLES, STEEL 269
NUCLEAR 270
Manipulators 270
Meters, Counting Rate 270
Meters, Dosimeter 270
Meters, Nuclear Radiation .. 270
Processors, Cataclystic Flow Rate 270
OPTICAL EQUIPMENT & SPECIALTIES 271
OVENS 272
Crystal 272
Environmental Testing 272
Infra-Red Drying 272
Temperature Controlled 272
OXYGEN APPARATUS & BREATHING EQUIPMENT 273
OXYGEN SYSTEMS & CONTROLS 273
PACK SETS 273
PACKAGING, ELECTRONIC EQUIPMENT, SERVICE ONLY 273
PACKAGING MATERIALS .. 273
PANELS 273
Wood & Plywood 273
PEDESTALS 274
PHOTOGRAPHIC EQUIPMENT 275
PHOTOGRAPHIC MATERIALS, SPECTROGRAPHIC INSTRUMENTS 275
PHOTOGRAPHIC MATERIALS, X-RAY FILMS 275
PICKUPS 275
Industrial 275
PLATFORMS, FIRING 276
PLIERS 277
PLYWOOD MANUFACTURERS 277
POTS, SOLDERING 278
POTS & TANKS, HEATING .. 278
POWER SOURCES, GROUND 278
Electric 278
Hydraulic 278
Mechanical 278
Pneumatic 278
Prime Movers 278

. . . cross index

POWER SUPPLIES 278
PRESSES, METAL FORMING 280
PRESSURIZATION UNITS .. 280
PROCESSING EQUIPMENT, MOTION PICTURE 281
PUBLIC ADDRESS SYSTEMS 281
PUMPS 281
Liquid Nitrogen 281
Liquid Oxygen 281
Metering 281
Oxygen Transfer 281
Pneumatic 281
Speed Density Metering 281
Transfer 281
Turbine 281
Vacuum 281
Water Injection 281
Wobble 281
RECTIFIER POWER UNITS . 286
REFRIGERATION EQUIPMENT, GROUND 286
REGULATORS 287
ROCKET LAUNCHING DEVICES 290
SAFETY EQUIPMENT 291
SAWS 291
SCALES, OSCILLOSCOPE ... 291
SCOOPS 291
SCREW DRIVERS 291
SEALS 292
SEPARATION DEVICES 293
SEPARATORS, OIL 293
SHELTERS, TRAILERS, VANS 294
SHIMS, LAMINATED 295
SHIPPING CONTAINERS ... 295
SIGNALLING DEVICES 295
SLIDES, INDUSTRIAL 296
SNIPS 296
SOLDER POTS 297
SOLDERING EQUIPMENT, PRINTED CIRCUIT 297
SOLDERING EQUIPMENT, ULTRASONIC 297
SOLDERING GUNS 297
SOLDERING IRONS 297
SOLDERING IRON STANDS . 297
SOLDERING IRON TIPS 297
SOLENOIDS 297
Control 297
SOUND SYSTEMS, COMPLETE 297
SPEAKERS 297
SPLICING EQUIPMENT 298
STARTERS 299
STARTERS, PNEUMATIC ... 299
STARTERS, ROCKET ENGINE 299
STARTING SYSTEMS & CONTROLS 299
STILLS & DEMINERALIZERS 299
STIMULATORS 299
STOOLS & BENCHES 299
STORAGE CONTAINERS 299
STORAGE UNITS 299
STRAINERS 299
STRIPS, GROUNDING 300
SWITCHES 300
TAILPIPES, JET ENGINE ... 302
TANKS 302
TENSIONS, COIL WINDING 304
THERMAL CONDITIONING EQUIPMENT 307
THERMAL CONDUCTIVITY CELLS 307
TOOLS 309
Pneumatic Assembly 309
Resistance Soldering 309
Thermal Soldering 309
Ultrasonic Soldering 309
Wire Wrapping 309
TOROIDS 309
TRACERS, SIGNAL 309
TRANSFER EQUIPMENT ... 310
TRANSFORMERS 310
Audio 310
Fly Back 310
Foil Wound 310
General 310
High Voltage Power Supply . 310
Instrument 310
Intermediate Frequency 310
Miniature 310
Power 310
TRANSMISSION LINE, WIRE & CABLE 311
TRANSMISSION LINES, MICROWAVE 31
TRANSMITTERS, PORTABLE & MOBILE RADIO-TELEPHONE 31
TRANSPORT UNITS 31
TRIPODS 31
TUBE PARTS 31
TURNTABLES, SOUND EQUIPMENT 31
TURRETS, CAMERA 31
VACUUM ALUMINIZERS ... 31
VACUUM SYSTEMS & CONTROLS 31
VACUUM UNITS 31
VALVE GUIDES 31
VALVE OPERATOR, ELECTRIC 3
VALVE OPERATOR, HYDRAULIC 3
VALVES 3
VAPORIZERS, LIQUID OXYGEN 3
VESSELS 3
VICES 3
VISCOMETERS 3
VOLTAGE SUPPLIERS, DECADE 3
VOLTMETERS 3
WAVEGUIDES, FLEXIBLE .. 3
WAVEGUIDES, RIGID 3
WELDERS, SPOT .....
WINDOWS, WAVEGUIDE ...
WIRE .....
WRENCHES .....
X-RAY EQUIPMENT, INDUSTRIAL .....
YOKES, DEFLECTION .....





SEAT DETAIL

Relief valve with replaceable O-ring seat

Bubble-tight operation up to set pressure is now possible with Anderson, Greenwood & Co.'s Type 3 Relief Valves. This new design uses replaceable O-ring seats to give perfect sealing and reseating qualities over a long dependable life — even on helium at 7000 psi. Write for catalog 151.

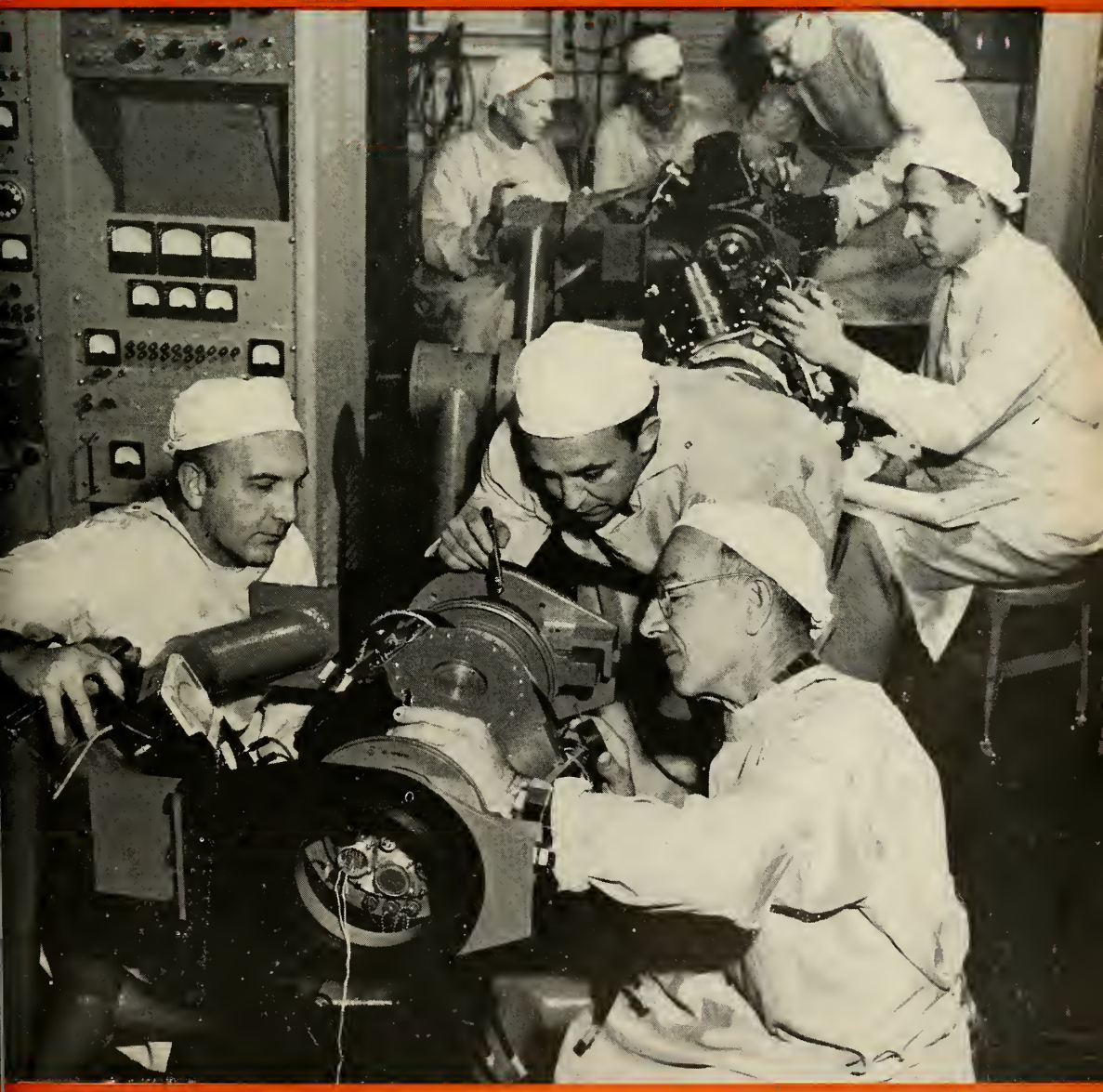
ANDERSON, GREENWOOD & CO.

1400 N. RICE AVE. BELLAIRE, TEXAS

Fill in No. 61 on Subscriber Service Card.

CHECKOUT EQUIPMENT

This equipment determines prior to launching whether all portions of the missile will or will not perform as intended. It is used to check out warhead, guidance, control and propulsion systems.





DESTINATION KNOWN

When a mighty "Thor" blasts off from Vandenberg Air Force Base it is checked out, launched and tracked by Packard Bell's ground support equipment and Missile Impact Prediction System.

ENGINEERING BEYOND THE EXPECTED

The Missile Impact Predictor is one-eighth the size and was built at one-tenth the cost of previous systems. Ground support equipment matches the reliability built into the "Thor." All combine to guarantee an effective weapon for retaliation or space exploration... destination known.

PACKARD BELL ELECTRONICS
Technical Products Division
12333 W. Olympic Blvd.
Los Angeles 64, Calif. · BR 2-2171

Fill in No. 33 on Subscriber Service Card.

New Products

• *checkout equipment*

CHART RECORDERS USE ADVANCED COMPONENTS

New circular chart recorder-controllers, with either electric or pneumatic controls, have been introduced by the Daystrom-Weston Industrial Division of Daystrom, Inc.

The new circular chart recorders employ advanced components, such as the division's recently developed D-Pak unit, and other improved mechanisms "to provide greater instrument reliability and service in process industries," according to the company.

All models of the new recorder-controllers feature the revolutionary D-Pak constant voltage supply unit which eliminates batteries, standard cells, and standardizing mechanisms in potentiometers; interchangeable slidewires, easy replaceable range standards, plug-in amplifiers, universal mountings, recessed indicator pointers to facilitate chart replacements; and rigidly supported scales on back of the plate assembly to permit easy calibration and indicator readings with the door open.

Pneumatic controls—in models 6836 potentiometer and 6856 Wheatstone bridge—are available as universal controller, proportional plus automatic reset, or proportional with automatic reset and derivative; proportional band adjustability—2 to 300 per cent. The proportional controller with reset, or reset and derivative, is recommended for more complex processes with high capacity or where appreciable transfer lag and/or dead-time is present.

Optional 4-position pneumatic transfer switch—automatic, manual, test, and service—provides complete control loop flexibility (supply air at 20 psig; controlled air at three to 15 psig). Piping of the "flip switch" also provides true bumpless transfer since gage accuracy is not a governing factor.

Electric controls—in models 6833 potentiometer and 6853 Wheatstone bridge—are available as contact type (two-position or three-position) and



proportioning control with 5, 10, or 20 per cent proportional band.

The control mechanism is directly coupled to the slidewire shaft, eliminating lag and backlash inherent with linkage and cams. According to division engineers, the unusual design of the control mechanism eliminates chatter due to vibration with even the narrowest differential and, being completely enclosed, insures long trouble-free performance under adverse atmospheric conditions.

The new null-balancing type circular chart recorders are designed for a-c operation only; 115 volts, 60 cycles; or 115 volts, 50 cycles as specified; accuracy of plus or minus 0.25 per cent of span, or .025 mv. Design features include 12-inch chart with full scale pen travel of 4-5/8 inches; 33.86-inch long, 320° concentric scale; large easily read numerals; many standard calibration ranges for potentiometer or Wheatstone bridge; full-scale response time of 5, 10, and 20 seconds; enclosed connection terminals; and standard chart speeds.

Fill in No. 123 on Subscriber Service Sord.

heta Instrument Makes ystem Error Bridge

With the Theta-Bridge the angular position of any synchro or resolver inaccessibly located within a complex system can be directly measured without any mechanical coupling. The only connection is via the electrical leads of the synchro or resolver. Loading of the system is avoided through use of very high impedance elements in Theta Instrument Corp.'s new device. It is also used to simulate a perfect synchro or resolver input to a system. Three dials display angular position digitally to three decimal places over a 360° range. The initial calibration to a particular system is accomplished without the necessity for mechanical rotation of any part of the system, and without the necessity for adjusting the system voltage excitation to an accurate level. Specifications: Accuracy, 10 sec. of arc. Readability, .001°. Size, 19 in. wide by 10½ in. high by 8 in. deep.

Fill in No. 124 on Subscriber Service Cord.

New Five-Channel Timer Has Low Contact Bounce

An extremely accurate, fixed position Interval Timer which limits contact bounce to within a range of 50 to 300 microseconds has been developed by Western Design & Manufacturing Corp., Santa Barbara, California, a division of U. S. Industries, Inc.

Currently utilized by two major aircraft companies in aircraft and missile systems checkout under severe environmental conditions, this compact electromechanical device is designed to provide highly accurate switching operations at precise time intervals for electrical circuits. Timing cycles may be as short as a second or as long as several hours.

With up to five independent channels available in the standard unit, events may be sequenced simultaneously or in a series, or in a combination of both. On special order, the number of channels may be increased to 10 as the synchronous motor has ample torque to handle the increased operating load.

The Western Design Timer, in addition to the synchronous motor, consists of a unique cam and positive action contact arrangement in which one set of contacts makes the circuit and the other set breaks the circuit. This action sharply defines the start or finish of any pulse and is accomplished by the use of abrupt discontinuities on the cam surfaces which permit the tripping points to be set precisely. The speed of contact operation is independent of the speed of rotation of the cams.

This unique design reduces duration of contact bounce to an absolute minimum. Total contact bounce on the circuit make and break is so slight it can be measured in microseconds, less than 300 microseconds on make, and less than 50 microseconds on break in production line units.

Contacts are designed for a load current of at least 0.5 amperes and are capable of operating satisfactorily with higher currents depending on the type of circuits and duty cycle required.

Because of the synchronous drive motors, the tolerance of the timing pulses is held to ±1/5 of one percent or ±10 milliseconds whichever is greater. These tolerances are relative to a 60 cycle or 400 cycle time base accuracy.

A variable speed drive may be used so that one channel of the output pulses of the timer may be fed back into a closed loop servo system which will automatically synchronize the timer function with an external process.

The Interval Timer is supplied to operate at various input voltages on 60 cps and 400 cps alternating current lines or on direct current. Diminutive in size, the units are 5 inches long, with a 2.2 inch diameter and weigh as little as 1.5 lbs.

Fill in No. 125 on Subscriber Service Cord.

ACK
RADIO SUPPLY COMPANY
distributor of electronics to industry offers you all these
Texas Instruments
SEMICONDUCTORS
Philco
SEMICONDUCTORS
Motorola
SEMICONDUCTORS
the industry's widest lines off-the-shelf at factory prices for same day or overnight delivery
SEMICONDUCTOR CENTER OF THE SOUTH
ACK RADIO SUPPLY COMPANY
3101 Fourth Ave., So.
Birmingham 5, Alabama
FAirfax 2-0588
★
331 Luckie St., N.W.
Atlanta 13, Georgia
JAckson 4-8477
Fill in No. 4 on Subscriber Service Card.

Transistorized Tachometer Goes on Market

To fill the need in industry for a moderately priced indicating instrument suitable for numerous applications, Kahn and Co. has developed and put on the market their Transi-Tach Transistorized Tachometer.

The Transi-Tach is available in three basic models—for 19″ rack panel mounting, as a portable unit, or with remote indicator. All models are self-powered by a 9-volt battery, but can also be used with 115 volts, 60 cycle AC.

The Transi-Tach indicates the speed of rotating shafts through the use of a magnetic or other speed pickup. RPM is read directly on a large meter scale which can be calibrated in any speed range desired with as many as 120 linear scale divisions. Speeds up to 60,000 rpm can be accurately measured. Zero suppression can be built into the scale to enable scale expansion within a desired speed range.

Since it is essentially a frequency meter, the Transi-Tach can be supplied as such for the measurement of audio or ultrasonic frequencies. It may also be adapted for use in conjunction with any transducer which converts flows, pressures or other physical forces into electrical signals of variable frequencies. Accuracy is plus or minus 2% of full scale of the meter reading. The proper transducer for each application can be supplied by Kahn and Company. Complete information is contained in illustrated bulletin which is available from Kahn and Company, Inc.

Fill in No. 126 on Subscriber Service Card.

Manometer Model TA Has 25 Tubes

Dynametrics Model TA Tiltable Manometer, Dynametrics Corp., is designed for operation as either a standard vertical manometer or a slant tube manometer at any selected angle from 11° to 90°. This mobile, backlighted unit has 25 tubes mounted in a rigid box frame. The frame is balanced in precision line-bored pivots on the mobile stand, and has a manual-locking adjustment to fix the frame at any desired angle between vertical and 11° of horizontal. Slanting the bank increases the sensitivity of fluid height indication over smaller ranges and permits a more accurate pressure measurement. Zero register is accurate on all tubes even at the greatest tilt angle. When used as a standard vertical unit, the Model TA retains all the favorable characteristics of the Dynametrics multibank and multitube manometers.

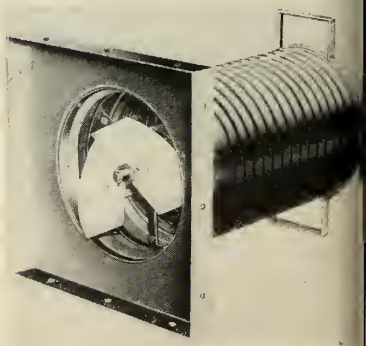
All tubes are manifolded to a single, manually adjustable reservoir. A vernier is provided for fine adjustment at angles near the horizontal. To reduce the quantity of fluid necessary, the pyrex tubes have a smaller than standard bore. The accurate co-planar scale sheet is backlighted for photography and is graduated in inches and tenths of inches. The stand is mounted on 4 swivel casters for mobility and has built-in leveling jacks and level indicator for precise set up after locating.

As in all other Dynametrics manometers, the Model TA can be equipped, at slight extra cost, with a metric scale, check valves, or other standard accessories. One model of this unit is standard: TA-25-60 (25 tubes 60″ scale height).

Fill in No. 127 on Subscriber Service Card.

Sun Electric Improves Electric Power Absorber

An improved version of their versatile Electric Power Absorber is announced by Sun Electric Corporation. The unit is used extensively in aircraft and missile testing systems applications. It is compact and has a low weight factor in relation to power absorbtion and heat dissipation. 10 to 15 KW capacity is claimed for AC use and up to 450 amperes at 30 volts DC.



New features include a front mounting panel for stacking units to conserve space. Mounting panel is one 13 inches square, overall length approximately 18 inches and weight 15 to 20 pounds depending on capacity.

A low temperature coefficient resistance ribbon within a slotted housing is cooled by ambient air drawn through a cooling tube by an internal mounted fan and motor. The motor may be operated as a part of the load or from an independent power source.

The unit is easily wired and is fully protected against overload. Infinite variable loading within the range of each unit can be achieved by the addition of a carbon pile or similar variable resistor.

Fill in No. 128 on Subscriber Service Card.

ELECTRO SNAP

Creators of over 6,000 Precision Switches and Controls

presents . . .

A new panel concept that promises to revolutionize monitoring or control of Missiles and Rockets

the astromatic panel concept

"THE MOST EFFICIENT LINK BETWEEN MIND AND MACHINES"

Consider These Obvious Advantages in Your Designing

- ★ OFFERS INSTANT VISUAL CONTROL WITH EXTREME ACCURACY
- ★ REDUCES HUMAN ERROR TO AN IMPROBABILITY
- ★ PROVIDES SIMPLIFICATION OF THE MOST COMPLEX OPERATION
- ★ ALLOWS REMARKABLE CONSERVATION OF VITAL SPACE
- ★ WITHSTANDS EXTREME LIMITS OF TESTING SPECIFICATIONS
- ★ APPLICATION POSSIBILITIES AS UNLIMITED AS THE IMAGINATION



Study the following specifications with your project in mind . . . .

ASTROMATIC DIVISION
Electrosnap Corporation
4218 West Lake Street, Chicago 24, Illinois

the astromatic panel concept by ELECTROSNAP

Ready now for tomorrow's higher control requirements



This new concept in panel techniques combines the latest advances in scientific, technological and psychological achievements to insure the highest possible degree of efficiency and accuracy in control or monitoring of equipment.

HUMAN FACTOR ENGINEERED for highest efficiency with extreme accuracy



100% FLUSH PANEL . . . Eliminates protruding hardware . . . unless specified by human engineering requirements. Switching functions may be recessed, flush, or over-flush.



TRI-COLOR LIGHTS . . . Each light module contains 3 separate bulbs and circuits to permit triple indications such as GO, NO-GO and CAUTION signalling.



CONCENTRATED GROUPING OF CONTROLS . . . Multiple function of TRI-LITE controls permits high component density, saving from two to four times space required by ordinary panel. Permits instant visual recognition and action by operator, minimizing time-loss found in larger panels.



VERSATILE SWITCHING . . . The switching and indicating techniques are specifically designed for maximum compatibility with this advanced panel. Momentary, positive feel and alternate action switching is available.



LIMITLESS COLOR COMBINATIONS . . . The unique combination of TRILITES plus multi-color photo printing of panel allows unlimited color guidance, distinctly identifiable even by color blind.



SCHEMATIC DIAGRAMMING . . . Photo color printing of panel surface permits visual schematic diagramming. Increases speed and efficiency of operators and recognition of system indications. Reduces indoctrination period for operator training. Eliminates the written word.

PRECISION ENGINEERED

. . . Meets or exceeds most exacting specifications



SHOCK AND ABUSE TOLERANT . . . Laminated Fiberglas panel resists chipping, shattering, crazing. Coefficient of expansion identical to aluminum sub-assemblies eliminates buckling under stress or extreme cold or heat conditions.



LASTING LEGIBILITY . . . Exclusive process imbues color into Fiberglas . . . resists wear-off of legend and diagramming. Vivid colors actually photoprinted—will not chip or scratch off. Meets all requirements of MIL-P-7788 for Aircraft Cockpit Panel.



QUICK LAMP REPLACEMENT . . . Front panel hinged for quick access to components below, permitting 10-second bulb change if necessary.

EASY TO ALTER . . . During prototyping legend and schematic diagramming can be easily changed to visualize any new findings. Components under panel may be relocated.

VERSATILITY OF DESIGN . . . The module concept of construction makes the Astromatic panel technique extremely versatile. WHATEVER ACTION YOU DESIRE TO VISUALIZE, ASTROMATIC CAN SUBMIT A PANEL DESIGN TO SURPASS YOUR EXPECTATIONS.

MAIL COUPON BELOW FOR ADDITIONAL TECHNICAL INFORMATION . . . OR PHONE ROBERT PROVART, TECHNICAL DIRECTOR COLLECT, VAN BUREN 6-3100

Astromatic Division, Electrosnap Corporation
4218 W. Lake Street, Chicago 24, Illinois

Gentlemen: ☐ Have your Design Engineer call for an appointment.
☐ Please count me in on any Symposium held in my area.

Name_____ **Title**_____

Company_____

Address_____

City_____ **Zone**____ **State**_____

ASTROMATIC DIVISION
Electrosnap Corporation
4218 W. Lake Street, Chicago 24, Illinois
VAn Buren 6-3100, TWX CG-1400

Cross Index
• checkout equipment

CCELEROMETERS 187
DAPTERS 188
Lamp Socket 188
Phase 188
LARM SYSTEMS 189
LARMS, AUTO 190
MMETERS 190
MPLIFIERS 190
Audio Subminiatures 190
Booster 190
Cathode Followers 190
Data Recording 190
Decade, Audio 190
Differential 190
Direct Current 190
Microphone 190
Monitoring RF 190
Operational 190
Oscilloscope 190
Peak Limiting 190
Power 190
Power, Special Service 190
Stabilizing 190
Strain Gage 190
Wideband, Audio 190
Wideband, RF 190
ANALYSIS EQUIPMENT, ELECTRO-CHEMICAL .. 192
ANALYZERS 192
Antenna Pattern 192
Audio Amplifier 192
Cable 192
Coincidence 192
Crystal 192
Dimensional 192
Distortion 192
Electro-Chemical 192
Engine 192
Frequency 192
Ignition 192
Intermodulation 192
Magnetic 192
Microwave 192
Neutron Absorption 192
Noise 192
Phase 192
Spectrum 192
Spectrum, Nuclear 192
Transducer 192
Transistor 192
Ultrasonic 192
ANEMOMETERS 193
ANODES, METAL 193
ANTI-VIBRATION EQUIPMENT 195
BAROGRAPHS 197
BELTS, DIAL DRIVE 198
BEZELS 198
BINDING POSTS 198
BREADBOARD KITS, ELECTRONIC 201
BRIDGES 202
CABINETS 203
Temperature Test 203
CABLE 203
Solid Dielectric 203
CABLE ASSEMBLIES, THERMOCOUPLES 205
CALIBRATORS 205
Crystal 205
Frequency 205
Radar Devices 205
Radar Range 205
Sweep 205
Voltage 205
UHF 205
VSWR 205
CHECKER, CABLE 209
CLIPS 211
Test 211
CLOCKS, TIME 211
COILS, HIGH TEMPERATURE 212
COLLIMATORS 212
COLORIMETERS 213
COMPARATORS, AUTOMATIC RESISTANCE 213
CONNECTORS 216
Rack & Panel 216
CONTROLS 217
Conductivity 217
Humidity 217
Inspection 217
CONTROLS, ALARM SYSTEM 219
COUNTERS 221
Geiger 221

A NEW REPRINT

MISSILES AND ROCKETS

Now available

Vol. 1, 1956
Paper bound $20.00

Vol. 3, No. 1, Jan. 1958
Paper bound 4.00

Vol. 3, No. 2, Feb. 1958
Paper bound 4.00

Reprinted with the permission of the original publisher

Please address orders to

Johnson Reprint Corporation
111 Fifth Avenue
New York 3, New York

SIGHTED:



Missiles and Rockets Classified Page

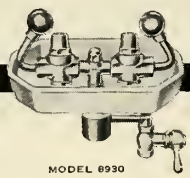
Quick results are yours when you buy, sell, or seek employment through the classified page of MISSILES AND ROCKETS Magazine. Reach about 30,000 top missile and rocket men. Send your message today to

MISSILES & ROCKETS
1001 Vermont Avenue, N.W., Washington 5, D. C.

. . . cross index

Impulse 221
Mechanical 221
DELAY LINES 225
Measurement & Test 225
DENSITOMETERS, ELECTRONIC 225
DETECTION SYSTEMS 225
DETECTORS 225
Crack 225
Detonation 225
Explosive Gas 225
Flaw & Defect, Electronic .. 225
Impedance 225
Leak 225
Metal, Electronic 225
Monoxide 225
Null 225
Null, RF 225
Radiation 225
Radiation, Nuclear 225
Resistance 225
Vibration 225
Water Leak 225
DIAGNOSTIC EQUIPMENT COMPUTER 226
DIAL CRYSTALS 226
DIALS, COMPLETE 226
DIALS, INSTRUMENT 226
FILTERS 233
Measurement 233
FLOWMETERS, MASS RATE 236
GAUGES 239
Compression 239
Differential Pressure 239
Strain 239
Suction 239
Tension 239
Thickness, Electronic 239
Torque Pressure 239
Ultrasonic Thickness 239
GAUSSMETERS 239
HYDROMETERS 246
INDICATORS 248
Capacitor Leakage 248
Data Display 248
Detonation Indicators & Meters 248
Deviation 248
Dew Point 248
Dielectric Constant 248
Dive Angle 248
Engine Synchronizer 248
Film Thickness 248
Fluid Conductivity 248
Fluid Flow, Electronic 248
Frequency 248
Fuel Flow Rate 248
Fuel Mixture 248
Liquid Level, Electronics 248
Pressure 248
Pulse Timer Riser 248
Radiation 248
Radiation, Nuclear 248
Recording Engine 248
Remote 248
Timing 248
Vacuum 248
Vibration 248
Volume 248
Weight 248
Wind Direction 248
INDUCTANCE SPECIALTIES, MEASUREMENT 249
INSPECTION EQUIPMENT .. 250
Fluorescent 250
Lighting 250
Magnetic 250
Optical 250
X-Ray 250
MACHMETERS 260







LOOK TO HAWS FOR SAFETY

EYE WASH / EYE-FACE WASH / DRENCH SHOWER



Only HAWS provides a complete line of eye-wash and drench shower units — performance-proven models to serve virtually any industrial and laboratory need! Instant water irrigation washes harmful irritants from exposed areas for immediate first aid before medical help arrives — or as a routine precautionary measure. HAWS will supply the equipment that best fits your operation!

Model 8600: Fiberglass Decontamination Booth; Model 8930: Basic eye-wash fountain; Model 8950: Portable eye-wash fountain; Model 8933: Basic eye- and face-wash fountain; Model 8650: Walk-through decontamination shower; Model 8935: Drench shower with eye-wash combination.

Write for illustrated literature today!

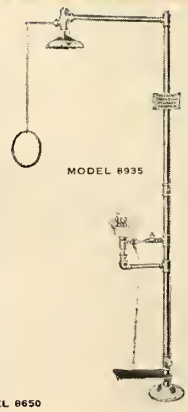
HAWS OUR 50th YEAR 1909 - 1959

HAWS DRINKING FAUCET CO.

1443 Fourth Street
Berkeley 10, California

EXPORT DEPT:
19 Columbus Avenue
San Francisco 11, California, U.S.A.





Fill in No. 52 on Subscriber Service Card.

MAGNETIC ANALYSIS EQUIPMENT 260
MANOMETERS 261
MEASURING EQUIPMENT, PRESSURE 261
MEASURING EQUIPMENT, VIBRATION 261
MEASURING EQUIPMENT, VSWR 262
MEGOHMETERS, VACUUM TUBE 262
METERS 263
Ammeter 263
Ammeter RF 263
Attenuation 263
Audio 263
Capacitance 263
Conductance 263
Counting Rate 263
Counting Rate, Nuclear 263
D Arsonval 263
Decibel 263
Deflection 263
Deviation 263
Distortion & Noise 263
Dosimeter 263
Dosimeter, Nuclear 263
Elapsed Time 263
Electrometer 263
Electronic Micrometer 263
Events-Per-Unit-Time 263
Flow 263
Flutter 263
Flux 263
FM Deviation 263
Footcandle 263
Frequency 263
Galvanometer 263
Grid Dip 263
Impedance 263
Industrial 263
Infrared 263
Intermodulation 263
Kilovolt 263
Kilowatt 263
Light 263
Megohm 263
Microfrarad 263
Microvolt 263
Microwave 263
Milliampere 263
Millivolt 263
Modulation 263
Moisture, Electronic 263
Multimeter 263
Multiplier 263
Noise, Electrical Measurement 263
Ohm 263
Output, Electrical Measurement 263
Output, RF 263
Panel 263
Ph Meters, Recorders & Comparators 263
Phase 263
Photoelectric Reflection 263

SS 10



SS 11



The Guided Missiles Manufactured in Mass Production by NORD-AVIATION.

NORD AVIATION

2 A 18, RUE BERANGER
CHATILLON-SS-BAGNEUX
SEINE
TÉLÉPH. ALÉSIA 57-40

Fill in No. 53 on Subscriber Service Card.

Balcrank counter balanced

Best quality, fine grain cast iron.
Rim and handles polished to high luster.
Center hole and hub faces true with rim,
all to close tolerances to eliminate wobble.

HAND WHEELS

Handles are revolving, solid or omitted. Available in standard sizes 4" to 12" dia. with plating, broaching or other machining to your specification.



machine HANDLES

Revolving handles turn on HARDENED steel spindle with permanent graphite grease lubrication permitting FASTER, EASIER adjustment by user. Machined from quality BAR STEEL ground and POLISHED to a smooth, high luster. Soft shank ends for assembly. Wide range of standard sizes in both revolving and solid types.

also
• balanced cranks
• compound rests
• clamping levers

Specialists for half a century in supplying industry . . . BALCRANK has the "know how" for producing these accessory items of finest quality and high precision. Let BALCRANK "handle" your job . . . You can free machines and manpower for saleable production — and cut costs, too. Choose from many types and sizes for immediate shipment.

Machine Tool Division
BALCRANK INC.
13 Disney Street
Cincinnati 9, Ohio
U.S.A.

READY NOW! Our NEW 1959 Catalog No. 1, Just off the press WRITE TODAY!

Fill in No. 54 on Subscriber Service Card.

. . . cross index

Power Output 263
Pressure 263
Pyrometer 263
Q 263
Radiation, Nuclear 263
Rate 263
Ratio 263
Recording 263
RF Power 263
Snap Around 263
Sound Level 263
Spectral 263
Standing Wave Radio 263
Tachometer 263
Tension 263
Thermocouple 263
Thermometer 263
Thrust 263
Time 263
Torque 263
Ultra-Violet 263
Vacuum Tube Volt 263
Vibrating Reed 263
Vibration 263
Viscosity, Electronic 263
Volt-Ohm, Electronic 263
Watt 263
Watt-Hour 263
Wave 263

MICROMETERS, ELECTRONIC 264

MICRO-OHMMETERS 264

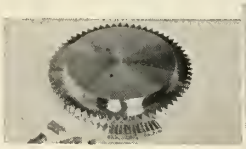
MIRRORS, INSPECTION 265

MIRRORS, SPECIAL PURPOSE 265

NUCLEAR 270
Analyzers, Coincidence 270
Analyzers, Neutron Absorption 270
Analyzers, Spectrum 270
Assemblies, Shield 270
Badges, Radiation 270
Counters 270
Crystals 270
Detectors 270
Indicators, Radiation 270
Meters, Dosimeter 270
Meters, Nuclear Radiation .. 270
Tubes, Scintillation 270
Tubes, Geiger Counter 270

PHASEMETERS 275
PICKUPS 275
Pressure 275
Temperature 275

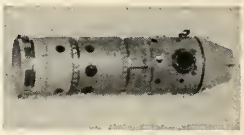
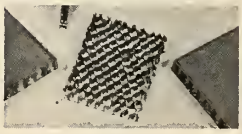
POTENTIOMETERS 278
Absolute Pressure 278
Differential Pressure 278
PRESSURE INSTRUMENTS .. 280
PYROMETERS, OPTICAL ... 282
PYROMETERS, RADIATION . 282
PYROMETERS, RESISTANCE 282
SWITCHES 300
TACHOMETERS, ELECTRONIC 302
TIMERS 308
Automatic Cycle 308
Automatic Reset 308
Automatic Sequence 308
Clock Radio 308
Counting 308
Cycle 308
Hour Counting 308
Impulse 308
Interval 308
Motor Operated 308
Percentage 308
Sequence 308
Thermal 308
Welding, Electronic 308
WARNING UNITS, FUEL PRESSURE 312
WARNING UNITS, TEMPERATURE 312


Furnace Braze Stainless Alloys

To eliminate problems of distortion, stress, oxidation, and porous welds

The advantages of stainless alloy brazing in dry hydrogen or vacuum environment furnaces are many. And the use of brazing for high-temperature service parts is growing just as fast as potential users learn to design for it. We offer technical design assistance to further the acceptance of this modern joining technique. Ten years of pioneering this field, plus operating three stainless processing plants, plus manufacturing our own Nicrobraz® brazing alloys, fully qualifies us to give initial guidance to your design crew in planning brazed stainless components. Call TWinbrook 3-3800 in Detroit, or write to find out how we might help you.


STAINLESS PROCESSING DIVISION
WALL COLMONOY CORPORATION
19345 John R Street • Detroit 3, Michigan
There are Wall Colmonoy furnace plants in Detroit, Michigan; Morrisville, Pennsylvania; and Montebello, California

Fill in No. 51 on Subscriber Service Card.

Now Available

NUCLEAR EXPLOSIONS IN SPACE

by Prof. S. Fred Singer

the story behind
Project ARGUS

Reprints of this exclusive M/R report are now available due to repeated requests.

A series of four illustrated articles combined, this important M/R special contains scientific explanations of:

* **project ARGUS**
* **creation of an artificial particle belt**
* **effect on manned space vehicles and nuclear warheads**
* **effects on radar and long-range communications**
* **scientific techniques for detecting such explosions**

50 cents per copy
(bulk rates on request from publisher)

missiles and rockets
1001 Vermont Ave., N.W.
Washington, D.C.

GUIDANCE EQUIPMENT

Guidance equipment (electronic, inertial, optical) determines where the missile is relative to where it should be in order to hit its target, and subsequently issues corrective instructions to the missile control system. Guidance equipment also includes the control system that makes the missile change its direction of flight: the fins, hydraulic, electrical or mechanical circuitries, actuators, jetavators, jets, and so on.



For MISSILES
ROCKETS
SPACECRAFT
AIRCRAFT

the A. W. HAYDON COMPANY

offers a complete line of

TIMING DEVICES

ALTERNATING AND DIRECT CURRENT

Tough & Tiny
Sub-Miniatures
Rugged & Reliable
Electronics
Time-Proven
Electro-mechanicals

PRECISION TIMING MOTORS

Repeat Cycle Timers
Time Delay Relays
Stop Clocks
Intervalometers
Coding Devices

ELECTRO-MECHANICAL AND ELECTRONIC TIMING DEVICES

REPEAT CYCLE TIMERS

— 3″ long (Typical)
— 6½ ounces basic
— 1-8 switches (Standard)
— Cycle Time 5 sec. to 90 Min.
— Loads to 5 Amperes

Write for Bulletin AWH RC-301



SUB-MINIATURE ELECTRO-MECHANICAL TIMING DEVICES

Features
Hermetically Sealed Housings
¼ Size
— ½ Weight of Standard Designs
1 x 2 Cross-Section
DC, 60 or 400 CPS
Meet MIL-E-5272A

TIME DELAY RELAY

— 3″ long (Typica
— 7½ ounces bas
— 1-3 switches (Standard
— Time Dela
— 25 Sec. to 3 Hou
— Loads to 5 Amper

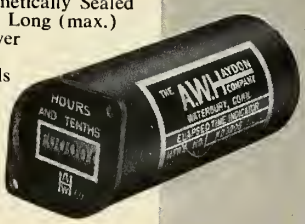
Write for Bulle AWH TD-5



ELAPSED TIME INDICATORS

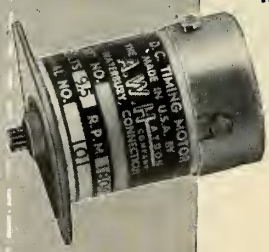
— Sub-Miniature — Hermetically Sealed
— 1¼″ Diameter — 2⅞″ Long (max.)
— 3 Watts maximum power
— Digital or Dial Type
— 60 cps & 400 cps models cataloged
— DC Models Available
— Meet MIL-E-5272A MIL-M-7793B

Write for Bulletin AWH ET-602 describes 400 cps models
AWH ET-603 describes 60 cps models



MINIATURE TIMING MOTOR

— Compact — High Performan
— 60 or 400 Cycle A
— 15/16″ Diameter — 1 7/32″ lo
— Direct Curre
— 13/16″ Diameter — 1 11/32″ lo
— Submit problem stateme with motor requirements f recommendatio



ELECTRONIC TIME DELAY RELAYS

Miniature Series

— 1 7/16″ x 1 21/32″ x 2½″ long
— 1-4 SPDT contacts
— Loads to 10 Amperes
— Weight — only 6 ounces
— 5½ Watts maximum power

Write for Bulletin AWH TD-503



Features
Hermetically Sealed Housings
Variety of Circuits
Temperature to 250°F
Vibration to 2000 cps, 15 g
Meet MIL-E-5272A
Unique Transistorized RC Time Constant network
Time Delays 50 MS to 120 sec.

Sub-Miniature Serie

— 31/32″ x 1 3/1 x 2″ long (max
— 1-2 SPDT contac
— Loads to 8 Amper
— Weight only 3 ounc
— 4 Watts maximum pow

Write for Bulle AWH TD-5



ALSO AVAILABLE

A Complete Line of timing devices and instruments for Military, Commercial & Industrial Applications

Write for specific literature or complete catalog.

The **A.W. HAYDON *Company***

231A NORTH ELM STREET, WATERBURY 20, CONNECTICUT

CUSTOM DESIGN & MANUFACTURE OF ELECTRONIC AND ELECTRO-MECHANICAL TIMING DEVICES

Fill in No. 35 on Subscriber Service Card.

New Products

• *guidance equipment*

AGNETIC AMPLIFIER IS SMALL UNIT

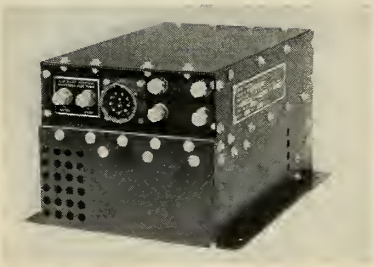
A new Variable Output Magnetic mplifier for aircraft and missile use as been developed by the Vap-Air eronautical Products Division of apor Heating Corporation, Chicago, . It is said to be the smallest in size d weight of any unit of this type ailable. It has an output of from to 2000 watts.

The Variable Output Magnetic Amifier can be used in many aircraft d missile systems including windield temperature control, heater conol, and motor speed control.

The advantage of the Variable Outt Magnetic Amplifier over the on- type is the modulating output, minating power surges in the airaft or missile electrical system.

It also replaces three units normally ed in a system; the temperature ntroller, power contactor, and the nsformer.

Combining the functions of these its into a single control eliminates, extra AN Connectors and harness tie them together, 2) moving elecal contacts in the control box and ntactor, and 3) installing three units.



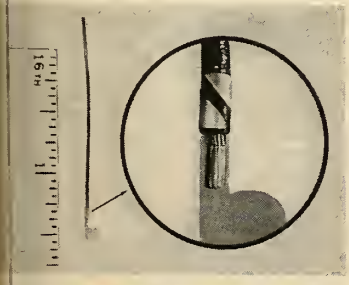
The controller also offers fail-safe features which will shut the controller off in the event of loss of power, pick-up short, or pickup open.

In addition, the Variable Output Magnetic Amplifier has the ruggedness which is characteristic of mag-amps. The unit meets the requirements of MIL-E-5272A, is adjustable over a wide range, has the built-in reliability which mag-amps offer, and features extreme accuracy and repeatability of operation in ambients of minus 65° to 200°F.

Fill in No. 129 on Subscriber Service Cord.

iniature Terminals Are esistant Welded

A new process has been developed b Manger Electric Co. to meet the t minating requirements of subminiae electronic assemblies. No longer ited to ready made terminals, terations can now be designed to fit assembly. These terminals can be surely welded to wire as small as W.G. #32.



Close tolerances are maintained and h flex life is assured. Engineering se ice is available to assist with any sp ial terminating problems relating to all types of electrical terminations.

l in No. 130 on Subscriber Service Cord.

Mouse Tails Eliminate Clamps

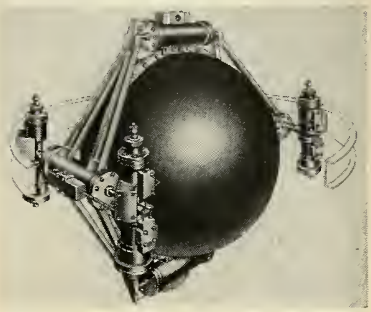
The electronic package for Boeing Airplane Co.'s IM-99 *Bomarc* interceptor missile utilizes a recently-developed "mouse tail" for securing wire bundles to the chassis. These "mouse tails" produced by Rubber Teck, Inc., are made of a tough rubber compound. They are available in lengths from 1 to 4 inches, and are tapered at each end. They are installed easily by passing one tapered end through a hole in the chassis, looping the shank over the wire bundle and inserting the other tapered end through an adjacent hole. When clinched up tight and the tension relieved, expansion of the rubber holds the "mouse tail" firmly in place.

A series of laboratory shake tests has proved that these "mouse tails" will hold firm under all environmental conditions expected during the missile's flight. Use of mouse tails eliminates the need for clamps or waxed string ties. As a result, both weight and a considerable amount of manufacturing time are saved. Rubber Teck has been chosen to be the licensee for their manufacture.

Fill in No. 131 on Subscriber Service Cord.

Isolation System Protects Delicate Units

Walter Kidde & Co., Inc.'s pneumatic vibration isolation system protects delicate units such as missile controls, aircraft components, and sled test instrumentation subjected to large and rapid "g" load changes. The isolation system accomplishes this by maintaining its desired low natural frequency while limiting relative displacement at various load conditions. The system consists of three independent sets of servo-controlled gas springs, each set absorbing a component of the vibrational and acceleration loadings along one of three mutually perpendicular axes.

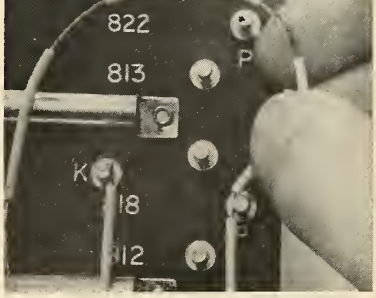


Fill in No. 132 on Subscriber Service Cord.

Centerstripped Leads Permit Fast Assembly

Manger Electric Co. offers centerstripping as one of its custom wire processing services. The firm has developed equipment which removes the insulation from stranded or solid conductors of any gauge.

The stripped portion may be any length from a minimum of 1/8" and may be located at either regular or irregular intervals throughout the length of the wire. Leads can be cut, end-stripped, and counter-stripped as required, or they can be supplied in a continuous coil.



Centerstripping is of particular interest to manufacturers of products where multiple banks of electrical components have common terminating points. One continuous centerstripped wire can be used in place of two or more single leads.

Fill in No. 133 on Subscriber Service Cord.

Circuit Breaker Weighs Only 2.1 Oz.

A hermetically-sealed circuit breaker of less than matchbox size has been developed by Heinemann Electric Co. of Trenton, New Jersey.

Called Model SM3, it is the first of Heinemann's SM series of sub-miniature breakers to go into production. The SM series is aimed at applications where small size and light weight are demanded, and where stable performance under varying conditions of shock, vibration, and ambient temperature is vital.

A series-overload breaker, the SM3 is designed for operation at 110 volts at either 60 or 400 cycles, or for 50 volts DC. It is available in ratings from 50 milliamps to 10 amperes. A choice of two time delay curves is offered, for fast or slow overload response, and the breaker is also available with instantaneous-trip response.

Since the SM3 combines magnetic actuation with hydraulic time delay, its current capacity and must-trip points are free from ambient temperature



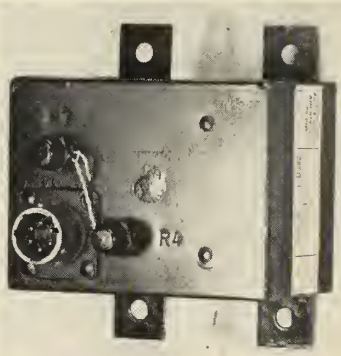
effects. The breaker will maintain its 125-percent must-trip point from –65° to +125° Centigrade. No de-rating is necessary for temperature or vibration. The rugged, hermetically sealed construction assures dependable operation under severe environmental conditions.

Fill in No. 134 on Subscriber Service Card.

Magnetic Amplifier Is New On-Off Type

Vap-Air Division, Vapor Heating Corp., offers a new On-Off Type Magnetic Amplifier Controller that is claimed to be the smallest and lightest unit of its type on the market today. Encapsulated in epoxy, it can stand extreme shock and vibration, yet is smaller than a pack of cigarettes.

The controller has many applications in the aircraft and missile field, among them, windshield temperature control, heater control and overheat warning.



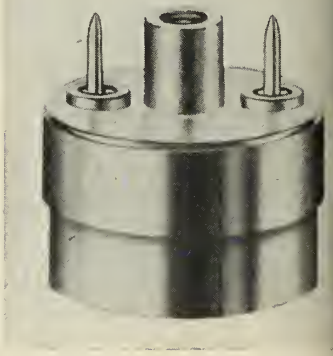
Ruggedness and reliability are characteristics of magnetic amplifiers. Other features of this unit are adjustability ± 25°F. of control point, accuracy, and repeatability of operation in ambients of minus 65° to 200°F. The amplifier meets requirements of MIL-E-5272A.

There are several built-in-fail-safe features which will shut the unit off in case of 1) loss of power, 2) partial or full pickup short, and 3) pickup open.

Fill in No. 135 on Subscriber Service Card.

Bimetal Thermal Switch Weighs ½ Ounce

Weighing ½ ounce, Control Products, Inc.'s "Button" switch is a high-temperature bimetal thermal switch which can be supplied with contacts for either close-on-rise or close-on-fall in temperature. The switch can be supplied calibrated at a maximum of 600°F or down to a minimum of –20°F with a possible close temperature tolerance of 2°F under laboratory conditions. Temperature differential and repeatability for a given switch is about 1°F. An overshoot to 800°F or undershoot to –100°F can be tolerated.



The switch can be mounted by lugs soft soldered directly to, or recessed into the surface to be controlled, thus giving precise surface temperature measurement for applications such as aircraft and airborne electric equipment. It is available with single-wire or two-wire construction.

Hermetically sealed (metal-to-glass) it will meet the shock and vibration requirements of MIL-E-5272A Procedure I. The lower portion of the switch is ¾" in diameter and the upper portion is 25/32" to permit seating the unit in a recessed mounting. The overall height is ¾" including the glass seals and bushing.

Fill in No. 136 on Subscriber Service Card.

Price Electric Improves Crystal-Can Style Relay

Price Electric Corp., Frederick, Md. has announced a design improvement in its Style 6 Crystal-Can-size relay to improve reliability. An internal bracket has been added to support the relay mechanism and position it relative to the header, reinforcing the can in this function.

This design change has not affected the basic simplicity of the design, which does not require an armature hinge pin and thus eliminates the need for precision fitting of the armature hinge. The new bracket is said to improve uniformity and reliability of performance in vibration, shock, contact life and other environmental exposures.

Fill in No. 137 on Subscriber Service Card.

AIRCRAFT - TRAINED
MISSILE - MINDED

31 years experience in aircraft engine parts

Headed fasteners in heat-resistant metals

Laboratory-controlled hardened and ground precision parts

Assemblies and sub-assemblies

HMS
HARTFORD MACHINE SCREW CO.
Division of Standard Screw Co.
HARTFORD 2, CONNECTICUT

Fill in No. S on Subscriber Service Card.

Cross Index

• *guidance equipment*

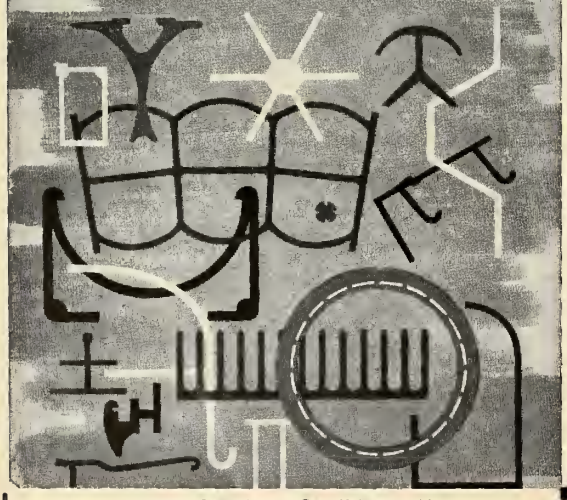
BSORBERS 187
CCUMULATORS 187
CTUATORS 188
Hydraulic 188
Linear 188
Pneumatic 188
Rotary 188
DAPTERS 188
Battery 188
DHESIVES, METAL TO METAL 189
IR CONDITIONING EQUIPMENT 189
LARMS, AUTO 190
LNICO 190
LTERNATORS 190
LTIMETERS, RADIO & RADAR 190
MPLIDYNES 190
MPLIFIERS 190
Antenna 190
Control 190
Cuing 190
Encapsulated 190
Integrating 190
Line, Audio 190
Magnetic 190
Microwave 190
Mixing, RF 190
Noise-Suppressing 190
Operational 190
Photocell 190
Power 190
Printed Circuit 190
Servo 190
Transistor 190
Ultrasonic 190
Vibration Pickup 190
NALYZERS 192
Circuit 192
Differential 192
Phase 192
Servo 192
Transducer 192
Transistor 192
NODES, GRAPHITE 193
NTENNA FEED SYSTEMS . 193
NTENNA FITTINGS & ACCESSORIES 194
NTENNA TUNING UNITS . 194
NTENNAS 194
Direction Finding 194
NTENUATORS 195
Audio 195
Microwave 195
Precision 195
RF & IF 195
NTITUDE 196
UTOMATIC PILOT CONTROL VALVES 196
UTOMATIC PILOTS, ELECTRONIC 196
AUTOMATIC PILOTS, HYDRAULIC 196
BALL LATCHES 197
BASES 197
Transistor 197
BATTERIES 197
Atomic 197
Mercury 197
Nickel Alkaline 197
Nickel-Cadmium 197
Nuclear 197
Silver 197
Silver Zinc 197
Transistor 197
BEARINGS 197
Ball Miniature 197
Jewel 197
Needle 197
Oiless 197
Rod End 197
Roller 198
Roller Taper 198
Self Aligning 198
Special Purpose 198
BELLOWS 198
BINDING POSTS 198
BRIDGES 202
Impedance 202
Inductance 202
Megohm 202
RF 202
Resistance 202
Self-Balancing 202
Standing Wave 202
Synchro 202
BRUSHES, MOTOR 202
BUSHINGS 202
CALLING SYSTEMS, SELECTIVE, NAVIGATION 205
CAPACITOR SPECIALTIES MEASUREMENT 206
CAPACITORS 206
Ceramic 206
Ceramic Trimmer 206
Composition 206
Decade 206
Electrolytic 206
Feed-Through 206
Fixed 206
Gas-Filled 206
Glass 206
Hermetically Sealed 206
High Temperature 206
High Voltage 206
Industrial 206
Mica 206
Miniature 206
Mylar Dielectric 206
Neutralizing 206
Oil 206
Piston 206
Plastic 206
Plastic Dielectric 206
Plug-In 206
Polystyrene Insulated 206
Porcelain 206
Precision 206
Pressure Types 206
Printed Circuit 206
Receiver Tuning 206
Silicone-Filled 206
Silvered Mica 206
Standard 206
Tantalum 206
Teflon, Dielectric 206
Temperature Compensated ... 206
Transmitter Tuning 206
Transmitting 206
Vacuum Types 206
Variable 206
CASINGS 207
CROMATOGRAPHS 209
CHRONOGRAPHS 209
CHRONOMETERS 209
CHRONOSCOPES 209
CIRCUITS 210
Computer, Logic 210
Plated 210
Plug-In 210
CIRCUITS-PRINTED, STAMPED, ETCHED 210
CLINOMETERS 211
CLIPS 211
Alligator 211
Crystal Diode 211
COIL ASSEMBLIES 211
COILS 212
AF Choke 212
Booster 212
Choke 212
Filter Choke 212
IF 212
Printed Circuit 212
RF Choke 212
RF Transmitting 212
Solenoid 212
Transducer 212
COLLECTOR RINGS 212
COMMUNICATIONS SYSTEM 213
COMPARATORS 213
COMPASSES 214
Electronic Gyro 214
Gyro 214
Magnetic 214
Radio 214
Remote Indicating 214
COMPUTERS 215
Analog 215
Course Line 215
Digital 215
Navigation 215
Offset Track 215
Storage, Electrostatic 215
Storage, Ferroelectric 215
Storage, Magnetic 215
CONNECTORS 216
Electric Subminiature 216
Miniature 216
Printed Circuit 216
Rack & Panel 216
RF 216
CONNECTORS, PRESSURIZED 217
CONTACTORS 217

. . . cross index

CONTROLS 217
Automatic Approach 217
Capacitance Operated 217
Machine Safety 217
Motors & Generators 217
Push-Pull 217
Radio Remote 217
Register 217
Remote, Antenna 217
Servo 217
Signal 217
Tension 217
Timing 217
Torque, Electronic 217
Voltage Regulator 218
Volume 218
CONVERTERS 220
COOLING SYSTEMS, ELECTRONIC 221
COUPLING & PHASING UNITS 222
CRYSTAL 223
Cartridges 223
Mounts 223
CRYSTALS 223
DAMPERS, CONTROL 224
DELAY LINES 225
Computer 225
Digital 225
Distributed-Constant Fixed .. 225
Distributed-Constant Variable 225
Lumped-Constant Fixed 225
Lumped-Constant Variable .. 225
Printed Circuit 225
DELAY NETWORKS 225
DEMODULATORS, COMPUTER 225
DESTRUCTORS & ASSOCIATED MECHANISMS . 225
DETECTORS 225
Magnetic 225
Scintillation 225
DIAL CRYSTALS 226
DIALS, COMPLETE 226
DIODES 227
DIRECTION FINDERS 227
DYNAMOMETERS 229
ENGINE CONTROL SYSTEMS 231
EXCITERS, FIELD 232
EXTENSIONS, SHAFT 232
FILMS, CAPACITOR 233
FILMS, PLASTIC FOR WOUND INSULATION .. 233
FILTERS 233
Antenna 233
Audio 233
Band Elimination 233
Band Pass 233
Continuously Variable 233
Crystal 233
Electric Wave Section 233
High Pass 233
IF 233
Interference 233
Low Pass 233
Microwave 23
Noise Suppressing 23
Polarizing 23
RF 23
Radio 23
Radio Noise 23
Telemetering 23
UHF & VHF 23
Vacuum System 23
Variable Electronic 23
Vestigial Sideband 23
Wave Trap 23
FLANGES, MICROWAVE ... 23
FLIGHT DIRECTORS 23
FLIGHT TERMINATION DEVICES 23
FREQUENCY METERS 23
GROUND LANDING SYSTEMS 24
GUIDANCE EQUIPMENT, MISSILES 24
GUIDANCE SYSTEMS 24
Inertial 24
Infrared 24
Pilotless Aircraft 24
Radar 24
Radio 24
Stellar 24
GUIDED MISSILE TELEMETERING 24
GYROS 24
Attitude 24
Directional 24
Free 24

R.D. WERNER CO. INC.

ALUMINUM



WRITE OR PHONE FOR FULL DETAILS
DEPT. MR-5 • GREENVILLE, PA. • PHONE: GREENVILLE 1600

CUSTOM EXTRUSIONS
ROLL-FORMED SHAPES
AND SECONDARY OPERATIONS

WERNER Aluminum plays a vital role in the production efficiency and sales success of such industries as: aircraft—appliances—curtain walls—electrical fixtures—furniture—railway coaches—storm doors and windows—sliding door hardware—trailers—trucks—buses—TV antenna tubing and masts.

WERNER extrusion and roll-forming services cover all alloys including the High Duty alloys, RR57, RR58 and RR257.

WERNER equipment includes heat-treating and fabricating facilities as well as other secondary operations such as punching, drilling, riveting, cutting, bending, welding. Every manufacturing phase from coil or billet to finished part can be performed in our own plant.

WERNER quality controls guarantee exact conformance to critical dimension requirements and design specifications.

WERNER experience, skill and versatility assure prompt delivery to meet production schedules.

WERNER *also manufactures a full line of UL approved aluminum stairway, span and bridge scaffolds — stages — launching towers — ladders.*

R.D. WERNER CO. INC. ALUMINUM

Fill in No. 55 on Subscriber Service Card.

Integrating 244
Missiles 244
Rate 244
GYROSCOPES 244
HARNESSES 245
Electric 245
HEADS, COMPUTER 245
HOLDERS, CHASSIS 246
HOLDERS, CRYSTAL 246
HOLDERS, FUSE 246
HORNS, MICROWAVE 246
HORNS, SPEAKER PROJECTOR 246
INCLINOMETERS 248
INDICATORS 248
INDUCTANCES, VARIABLE 249
INDUCTORS 249
INDUCTORS, COILS 250
INFRARED 250
Detection Systems 250
Image Converters 250
Systems, Guidance 250
INSTRUMENTS, ELECTRICAL MEASURING .. 250
Ammeters 250
Audiometers 250
Bridges 250
Calibrators 250
Circuit Linearity 250
Comparators 250
Comparators Voltage 250
Galvanometers 250
Magnetometers 250
Megohmmeters 250
Microammeters 250
Microfaradmeters 250
Micro-Microammeters 250
Milliammeters 250
Millivoltmeters 250
Ohmmeters 250
Ratiometers 250
Recorders 250
Tracers, Signal 250
Voltmeters 250
Volt-Ohm-Milliammeters ... 250
Wattmeters 250
INSTRUMENTS, ELECTRICAL MEASURING METERS . 251
Electronic Capacitance 251
FM Deviation 251
Field Strength 251
Frequency 251
Impedance 251
Modulation 251
Null 251
Output 251
Panel 251
Phase Angle 251
Power Factor 251
Q 251
RF Power 251
Standing Wave Ratio 251
Wave 251
X-Ray Intensity 251
INSTRUMENTS, GRAPHIC RECORDING 252
INSULATORS 253
Antenna Insulators & Spring Assemblies 253
Bead 253
Bearing 253
Can Liner 253
Ceramic 253
Cord 253
Electric 253
Fabricated 253
Feed Through 253
Feeder Spreader 253
Fused Quartz 253
Glass Bonded Mica 253
HV Power Line 253
High Dielectric Paper 253
Laminated 253
Metallized Bushing 253
Mica 253
Molded 253
Plastic 253
Rods 253
Sheets 253
Shock 253
Shock & Vibration 253
Sleeve 253
Standoff 253
Strain 253
Test Clip 253
Thermal 253
Thermocouple 253
Tower 253
Transmitting Antenna 253
INTEGRATORS, ELECTRONIC 253
INVERTERS 254
DC-AC 254
ION TRAPS 254
ISOLATORS, MICROWAVE .. 254
JACK PANEL ASSEMBLIES . 254
JEWELS, GLASS 255
JUNCTION BOXES & PANELS 255
JUNCTIONS, HYBRID, MICROWAVE 255
KEYERS 255
KEYERS & COUPLERS 255
KEYS & CODING EQUIPMENT 255
KILOVOLTMETERS 255
LAMINATIONS, TRANSFORMER 256
LAMPS, INFRA-RED 256
LANDING AIDS, ELECTRONIC 256

MIRAX

31 YEARS

OF ACKNOWLEDGED PERFORMANCE IN DEVELOPMENT AND MANUFACTURE OF HANDLING AND SUPPORT EQUIPMENT FOR ASSURING RELIABLE DELIVERY OF MILITARY PRODUCTS

- Missile Shipping Containers
- Transit Containers
- A N Containers
- Ground Handling Equipment
- Shock and Vibration Controls
- Ground Support Equipment
- Electro-Mechanical Products
- Missile and Rocket Assemblies
- Fuel Tanks
- Polyurethane and Rubberized Hair Cushioning
- Marine Equipment
- Experimental and Testing Facilities

MIRAX CHEMICAL PRODUCTS CORPORATION

• METAL CONTAINER DIVISION
• ELECTRO-MECHANICAL PRODUCTS DIVISION

ST. LOUIS 9, MO.

Fill In No. S6 on Subscriber Service Card.

BLACK LIGHT Inspection for LOX/GOX Cleanliness

Learn details on lamps to use, colors to look for, operating procedures

Meets Government Requirements

SMALLER SOURCE of ULTRA-VIOLET—PEN-RAY

for optical instrumentation, guidance control systems

Long-Lasting INVISIBLE INKS for Coding, Marking

For free information, write Dept. MG59

ULTRA-VIOLET PRODUCTS, INC.

San Gabriel, California

Fill in No. S7 on Subscriber Service Card.

. . . cross index

LENSES 257
LUGS, CABLE-ELECTRIC ... 259
MAGNETS, ELECTRO 261
MAGNETS, FOCUSING 261
MAGNETS, PERMANENT .. 261
MICROWAVE ACCESSORIES 265
MONITORS 267
MOTORS 267
- Electric 267
- Fluid 267
- Fractional Hp 267
- Hydraulic 267
- Hysteresis 267
- Instrument 267
- Miniature 267

MULTIPLIERS 269
- Crystal 269
- Diode 269
- Electronic 269
- Frequency 269
- Magnetic 269
- Meter 269
- Servo 269

NAVIGATION SYSTEMS 269
OMNIRANGE 271
OMNIRANGE RECEIVERS .. 271
OSCILLATORS 272
- Audio 272
- Audio Fork Controlled 272
- Audio Frequency 272
- Cavity 272
- Code 272
- Crystal 272
- Grid Dip 272
- Grip Dip—High Frequency & VHF 272
- Microwave 272
- Oven Crystal Control 272
- Pulse 272
- Pushbutton 272
- RF 272
- Radio Frequency 272
- Sweep 272
- Tuning Fork 272
- Ultra-Low Frequency 272
- Ultrasonic 272
- Video Pattern 272
- Video Range 272

OSCILLOGRAPHS 272
OUTLETS, ANTENNA 272
PAINTS 273
PANEL BOARDS, ELECTRIC 273
PANELS 273
- Fibre 273
- Instrument 273
- Jack 273
- Receiver & Transmitter 273
- Relay Rack 273

PARABOLAS, MICROWAVE . 274
PATCH CORDS, CONNECTORS 274
PATCH CORDS, STUDIO 274
PATCH PANELS 274
PERMEAMETERS, HIGH H .. 275
PERMEATERS, RF 275
PHOTO ETCHED COMPONENTS 275
PILOTS, AUTOMATIC 2
PITOT TUBES 2
PLOTTERS, X-Y 2
PLUG-IN-CIRCUIT UNITS .. 2
PLUGS 2
- Computer Board 2
- Connector 2
- Dehydrator 2
- Expansion 2
- Hardware 2
- Metallic 2
- Non-Metallic 2
- Printed Circuit 2
- Telephone 2
- Terminal 2

PNEUMATIC CONTROLS & SYSTEMS 2
POTENTIOMETER TRIMMERS 2
POTENTIOMETERS 2
- High Resistance 2
- High Voltage 2
- Induction 2
- Linear & Non-Linear Precision Carbon Film 2
- Linear & Non-Linear Precision Wire Wound 2
- Metallic Film 2
- Portable Instrument 2
- Precision 2
- Precision Auto-Transformer . 2
- Precision Carbon Film 2
- Printed Circuit 2
- Rectilinear 2
- Slidewire 2

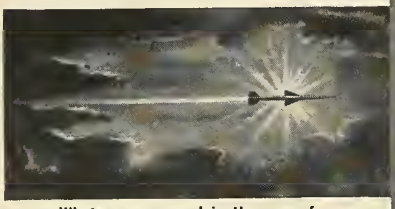
POWER SUPPLIES 2
PRINTED CIRCUITS 2
PROBES 2
- Crystal 2
- High Frequency 2
- High Voltage 2
- Measurement 2
- Microwave 2
- Pitot Static 2

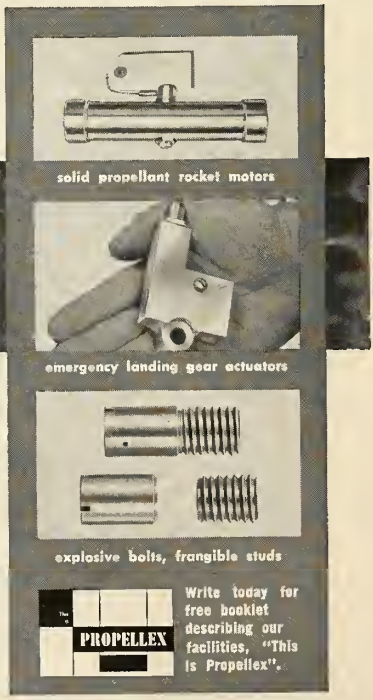
PULSATION CONTROL 2
RADAR, AIRBORNE 2
RADAR, PRECISION APPROACH 2
RADAR, SURVEILLANCE ... 2
RADIO COMPASS INDICATORS 2
RADIO DIRECTION FINDERS 2
RADIOSONDES 2
RADOMES 2
RECEIVERS 2
- AM & FM Communication .. 2
- AM Fixed Frequency 2
- Direction Finding, Navigation 2
- Distance Measuring, Navigation 2
- Diversity 2
- FM 2
- FM Multiplex 2
- Fixed Frequency 2
- Frequency Shift 2
- Infra-Red Navigation 2
- Microwave 2
- Mobile 2
- Portable & Mobile 2
- Radar 2
- Radiation 2

from research, design, development and manufacturing

from *PROPELLEX*

A NEW SOURCE OF FLIGHT TESTED COMPONENTS





Whatever you need in the way of propellants, explosives and cartridge actuated devices, Propellex can deliver in a minimum of time at a minimum of cost.

PROPELLEX

CHEMICAL CORPORATION
P. O. BOX 187 • EDWARDSVILLE, ILLINOIS
PHONE: EDWARDSVILLE 3400

serving as prime contractor to the U. S. Government and to the nation's aircraft and missile manufacturers.

Engineers and scientists with vision and ability are invited to investigate the opportunities at Propellex.

PROPELLEX

Write today for free booklet describing our facilities, "This is Propellex".

Fill In No. 58 on Subscriber Service Card.

Radio Communication 284
Radio, Hand Powered Emergency 284
Radio Navigation 284
Remote Pickup, Fixed 284
Selective Signalling, Navigation 284
Short Wave, Fixed 284
Short Wave, Portable 284
Single Side Band 284
Transistor Operated 284
UHF 284
VHF 284
WWV 284
ECEIVING EQUIPMENT, VHF OMNIRANGE 285
ECORDERS, AIRBORNE FILM 286
ECORDERS, AIRBORNE MAGNETIC 286
ECTIFIERS 286
Copper Oxide 286
Electronic Tube 286
Germanium 286
Mercury Arc 286
Metallic Oxide 286
Metallic, Power Supplies 286
Metallic Stack 286
Selenium 286
Silicon 286
Titanium 286
Tube 286
Tube Rectifying Units 286
EGULATORS 287
Battery Charging 287
Frequency 287
Generator 287
ELAYS 288
Audio Operated 288
Capacitance 288
Coaxial 288
Contact 288
Cross-Bar 288
D Arsonval 288
Differential 288
Electronic, Resistance Activated 288
Frequency Selective 288
High Voltage 288
Impulse 288
Keying & Break-In 288
Latching 288
Mercury 288
Meter 288
Microwave 288
Overfrequency 288
Overload 288
Overvoltage & Undervoltage . 288
Photoelectric 288
Plate Circuit 288
Polarized 288
Power 288
RF 288
Reverse Current 288
Rotary 288
Sensitive 288
Sequence 288
Stepping 288
Subminiature 288
Synchronizing, Transfer 288
Telephone 288
Temperature Compensated ... 288
Thermal 288
Thermostatic Delay 288
Time Delay 288
Timing 288
Under Frequency 288
Vacuum Contact 288
Vibrating Reed Type 288
REMOTE PICKUP, AUDIO .. 289
REPEATERS, MICROWAVE . 289
REPEATERS, PASSIVE, MICROWAVE 289
RESISTANCE THERMOMETER BULBS 289
RESISTORS 289
Boroncarbon 289
Carbon Film 289
Decade 289
Deposited Carbon 289
Encapsulated 289
Film 289
Fixed Wire-Wound 289
Fuse 289
Glass 289
High Frequency 289
High Temperature 289
High Voltage 289
Miniature Variable 289
Photo Sensitive 289
Plug-In-Tube 289
Precision 289
Printed Circuit 289
Rectilinear 289
Silicone 289
Subminiature 289
Tape 289
Temperature Sensitive 289
Variable, Composition 289
Variable, Miniature 289
Wire Wound 289
RESOLVERS 290
RHEOSTATS 290
SERVO MECHANISM CONTROL SYSTEMS 293
SERVOS, MEASUREMENTS . 294
SHEETS, METAL CLAD, PRINTED CIRCUIT 294
SHIELDING 294
Coil 294
Electrostatic 294
Transformer 295
Tube 295
SHUNTS, METER 295
SHUTTERS, MICROWAVE .. 295
SLIDING LOADS, MICROWAVE 296
SOLDER 296
Printed Circuit 296
Rings & Preforms 296
Silver 296
SOLENOIDS 297
SONAR 297
SQUIBS 298
STANDARDS 298
Capacitance 298
Frequency 298
Inductance 298
Laboratory Time 298



4635 WEST LAKE ST., CHICAGO, ILLINOIS

Fill in No. 59 on Subscriber Service Card.

. . . cross index

STANDS, WAVEGUIDE 299
STATIC ELIMINATORS 299
STATORS, MOTOR & GENERATOR 299
STRIPS, MOUNTING 300
SUBMINIATURIZATION SERVICES 300
SUPPRESSORS, NOISE 300
SWITCH, GUARDS 300
SWITCH INERTIA 300
SWITCHES 300
- Acceleration 300
- Alarm 300
- Aneroid 300
- Automatic 300
- Contact 300
- Control 300
- Crossbar 300
- Decade 300
- Duplex 300
- Electronic 300
- Float 300
- Foot 300
- Hermetically Sealed 300
- Hydraulic 300
- Ignition 300
- Impact 300
- Indicating 300
- Jack 300
- Key 300
- Knife 300
- Limit 300
- Liquid Oxygen Control 300
- Mach Limit 300
- Mechanical Control 300
- Mercury 300
- Microphone 300
- Microwave 300
- Miniature 300
- Oil Immersed 300
- Plunger 300
- Pressure 300
- Printed Circuit 300
- Pulse 300
- Pushbutton 300
- Radio 300
- Remote Control 300
- Reset 300
- Rotary 300
- Rotary Chopper 300
- Rotary Sampling 300
- Rotary Selector 300
- Safety 300
- Slide 300
- Snap Action 300
- Specialty 300
- Step Type 300
- Sub-Miniature 300
- Tap 300
- Telemetering 300
- Temperature Control 300
- Thermal 300
- Timing 300
- Toggle 300
- Transformer 300
- Transistor 300
- Vacuum 300
- Wavechange Receiver 300
- Wavechange Transmitter 300
- Waveguide 300
- Waveguide Microwave 300

SWITCHING EQUIPMENT, ANTENNA 301
SYNCHROS 302
TARGET DEVICES 303
TERMINAL BLOCKS 304
TERMINAL BOARDS 304
TERMINAL LUG SWAGGERS 304
TERMINAL STRIPS 304
TERMINALS 304
TRANSFORMERS 310
- Output 310
- Power 310
- Precision Voltage Dividing .. 310
- Pulse 310
- RF & IF 310
- Ultrasonic 310

TRANSISTORS 311
TRANSMITTERS 311
TUBE 311
TUBES 312
- ATR 312
- Backward Wave 312
- Ballast 312
- Battery Charger 312
- Bolometer 312
- Cathode Ray 312
- Ceramic 312
- Computer, Storage 312
- Counter Beam 312
- Electrometer 312
- Electron Multiplier 312
- Gamma Ray, Nuclear 312
- Glow or Discharge 312
- Ignitron 312
- Infra-Red 312
- Ionization 312
- Klystron 312
- Magnetron 312
- Miniature 312
- Noise Source 312
- Phototubes 312
- Phototubes, Multiplier 312
- Pirani 312
- Power Amplifier 312
- Receiving 312
- Rectifying, Gas-Filled Type .. 312
- Rectifying, Transmitting 312
- Rectifying, Vacuum Type ... 312
- Scintillation, Nuclear 312
- Sparkgap 312
- Strobe 312
- Subminiature 312
- Switching 312
- TR 312
- Thyratron 312
- Transducer 312
- Transmitting 312
- Transmitting-Receiving 312
- Traveling Wave 312
- Ultra-Violet 312
- Vacuum 312
- Voltage Reference or Regulating 312
- X-Ray 312

TUBING 312
TUNERS 313
TUNING DEVICES 314
VALVES 315
- Solenoid 315

VIBRATION CONTROLS 317
WINDINGS, TRANSFORMER 319





response:
200 MSEC
TEMPERATURE TRANSDUCERS



The newest line of Arnoux temperature transducers—100-ohm resistance, 200-millisecond response—permits accurate measurement of transient temperatures such as those in missile and aircraft applications. The output signal is 0-5 vdc for as small a span as 180 F, when Arnoux transistorized TME-1 or TME-2 systems or similar equipment is used.

The fluid-immersion transducer (4101L-11), for static or moving fluid, is LOX compatible and available in two calibration ranges: —302 F to —285 F, —320 F to + 500 F.

The air transducer (4101H-10) is for static to high-velocity gases.

The surface transducer (2101H-15) is for materials of limited area and thickness, and has great mounting versatility.

Both air and surface types are available in two calibration ranges: —100 F to +500 F, —100 F to +1200 F.

Other Specifications:

Calibration accuracy: 0.1-1.0%, depending on temperature range

Repeatability and hysteresis: within calibration accuracy

Resistance at 32 F: 100 ±5 ohms

Nominal temperature-resistance coefficient: 0.0018/°C

Output: 0-5 vdc, when Arnoux 100-ohm TME is used.

ARNOUX

ARNOUX CORPORATION

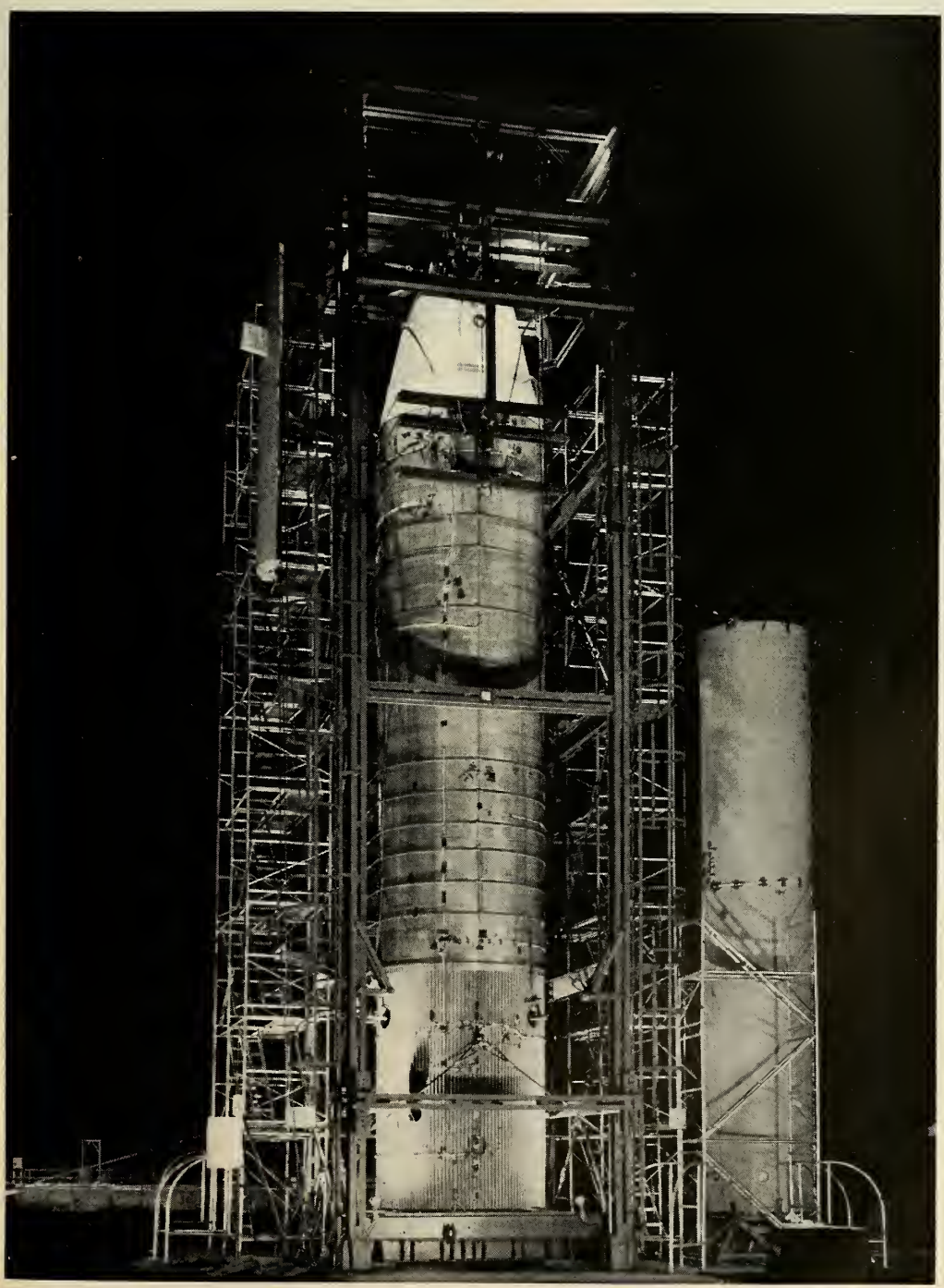
11924 WEST WASHINGTON BLVD., LOS ANGELES 66, CALIF.

Sales Offices: Beverly Hills, Calif. • Dallas • Great Neck, N.Y. • Seattle • Bryn Mawr, Pa.

Fill in No. 60 on Subscriber Service Card.

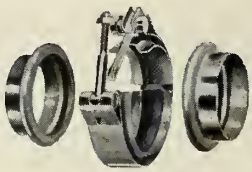
TEST EQUIPMENT

This includes everything in missile testing, ranging from checkout equipment through static test stands, launching pads and flight simulators.



proved | reliable

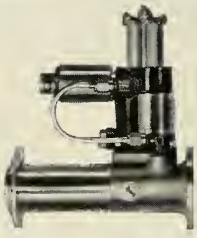




duct couplings / duct supports

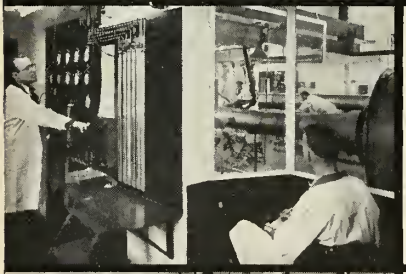
Couplings provide metal-to-metal seal, fast disconnects, for high pressure, high temperature air ducts. Standard diameters 1″ to 7″, specials to 36″. Separate or integral duct supports. Many materials.





pneumatic controls

Multi-function weight-saving air valves and regulators manufactured to missile tolerances. Adequate staff for fast design and production changes.



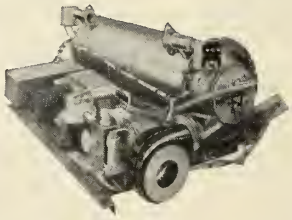


Platular heat exchangers*

Combine efficiency of plates with strength of tubes into new economical modular design. Can fit into cramped, odd-shaped spaces in missiles and high performance aircraft for great variety of applications.

**Trademark of Surface Combustion Corporation.*





ground support liquid heaters

Standard units for vehicle, space, and fuel transfer applications. Available in capacities from 90,000 to 1,000,000 Btu/hour and can be combined easily for greater output. Now in service in a wide range of ground support equipment.

Janitrol development and test facilities provide proof in advance of reliable performance in service.

Contact your Janitrol representatives when you need components or systems for heat transfer or air control. Janitrol Aircraft Division, Surface Combustion Corporation, Columbus 4, Ohio.

JANITROL®

pneumatic controls • duct couplings & supports • heat exchangers

Fill in No. 36 on Subscriber Service Card.

New Products

• *test equipment*

IGH VOLTAGE TEST SETS BECOME AVAILABLE

Testing of high voltage electronic tes, cables and bushings, as well as t dielectric strength of all insulating nterials to ASTM standards is per- f med with the new super-duty line of HYPOT® high voltage test sets, an- nunced by Associated Research, Inc.

The new Series 5700 DC HYPOT® nodels provide facilities for non-de- structive proof testing of high voltage ectronic equipment during production a well as at final inspection. They also net the needs of preventive mainte- nance inspection of high voltage elec- tronic gear, since they are readily port- a e.

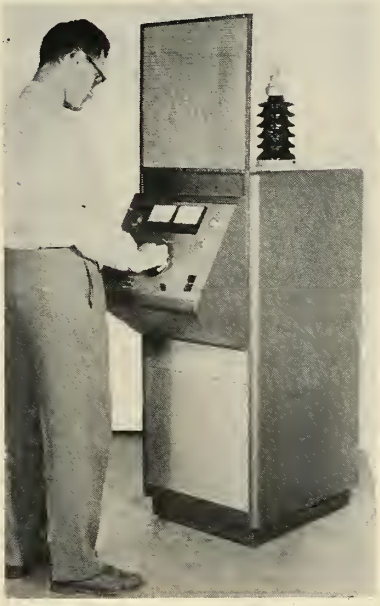
The new super-duty models are hused in a single caster-mounted floor cbinet which affords more convenient oeration and greater safety than do tv-unit high voltage test sets.

All controls are located on the wist high panel which is sloped for ey reading. Two 4½" meters on the pael indicate output voltage and leak- a current.

Many important safety features are irorporated, including the zero-reset h h voltage interlock, quick acting o rload breaker, and a safety screen b ween the operator and the high volt- a output bushing.

A new "Amplivolt" power supply is irorporated in these models, having th selenium rectifiers, capacitors, and k voltmeter multipliers sealed in an o filled tank.

The output test potential is continu- ously variable from zero to maximum an indicated by metering directly in th final output.



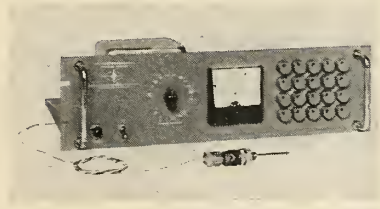
Effects of corona, surface and phase leakage are eliminated by an advanced by-pass return (guard) metering circuit, allowing accurate reading of small leakage currents.

A bulletin describing these new super-duty models, as well as the complete line of AC and DC HYPOT® High Voltage Test Sets is available by request.

Fill in No. 138 on Subscriber Service Card.

Uni-Temp Has Greater Range and Accuracy

Increased operating ranges and greater accuracy are specified for resistance temperature measurement systems and components released by the Cardinal Instrumentation Corp. Marked under the trade name of "UNI-TEMP," the new lines are designed on a "building block" principle which makes it possible to purchase either individual components or completely packaged systems.



UNI-TEMP systems cover the entire range of –320°F to +2000°F utilizing resistance temperature transducers. Maximum sensitivity is achieved through the material property of Balco and Platinum resistance wires which display high temperature coefficients and excellent linearity characteristics. Resistance variations as a function of temperature, are changed into voltage variations by UNI-TEMP bridges and power supplies. This provides a full 5 volt output for direct reading on the UNI-TEMP readout module or as input to any standard recording, telemetering or readout device.

The new Cardinal systems require no amplifiers, reference junctions or special shielding—they eliminate the grounding problems inherent in thermoelectric assemblies. System accuracies are available up to ±0.1°F with LOX compatible platinum transducers and up to ±3/4°F with Balco transducers including high pressure applications.

Fill in No. 139 on Subscriber Service Card.

New Dynamometer Model Checks Gyro Motors

The Eder Engineering Co.'s Model 3366 Gyro Wheel Motor Dynamometer for checking the parameters of gyro wheel motors, is used for determining the characteristics for development purposes, and for production testing stators and/or hysteresis rings. The dynamometer measures stall torques and synchronous pullout torques.

For the synchronous pullout test (torque), the hysteresis ring is rotated at 100 RPM less than sync speed of the rotating electrical field of the stator.

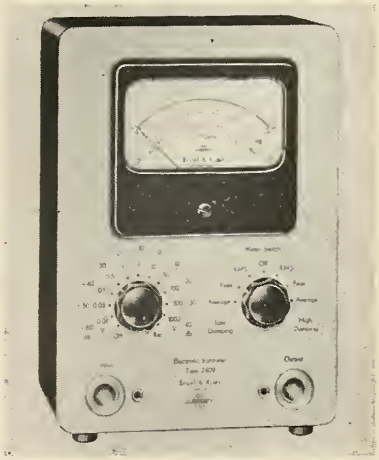
Model 3366 Dynamometer comes in several torque ranges from 0-10,000 to 0-100,000 dyne cm ±2%. Other torque ranges are available.

The drive motor for the rotor or hysteresis ring can be obtained with almost any desired RPM. Model 3366 has the following RPM: 1200 ±12, 7800 ±50, 11,900 ±50, 15,900 ±50.

Fill in No. 140 on Subscriber Service Card.

Electronic Voltmeter Reads True RMS

The Bruel & Kjaer Model 2409 Electronic Voltmeter measures either the True RMS, peak or average values of voltages over the frequency range from 2 to 200,000 c/s. An accuracy of 0.5 db is obtained for RMS indication of signals with crest factors up to 5.



According to B & K Instruments, Inc., the Model 2409 may serve as a VTVM with full scale sensitivities of 10 MV to 1,000 V or as a calibrated decade amplifier with 60 db gain.

Fill in No. 141 on Subscriber Service Card.

Cross Index

• test equipment

ACTUATORS 188
Electric 188
Hydraulic 188
ADAPTERS 188
Crystal 188
Foreign 188
Lamp Socket 188
Line & Dot Sequential 188
Phase 188
Plug 188
Test 188
Tube 188
Tube Socket 188
ALARM SYSTEMS 189
ALARMS, AUTO 190
ALNICO 190
ALTERNATORS 190
ALTIMETERS, BAROMETRIC PRESSURE 190
AMMETERS 190
AMPLIFIERS 190
Audio Subminiatures 190
Cathode Followers 190
Computer 190
DC 190
Decade, Audio 190
Development 190
Differential 190
Direct Current 190
Distribution, Audio 190
Distribution, RF & IF 190
Encapsulated 190
Instrumentation 190
Intermediate Frequency 190
Isolation 190
Limiting 190
Line 190
Logarithmic 190
Microwave 190
Mixing Audio 190
Mixing, RF 190
Monitoring Audio 190
Monitoring, RF 190
Operational 190
Oscilloscope 190
Peak Limiting 190
Plug-In 190
Power 190
Stabilizing 190
Strain Gage 190
Ultrasonic 190
Wideband, Audio 190
Wideband, RF 190
ANALYSIS EQUIPMENT, ELECTRO-CHEMICAL .. 192
ANALYZERS 192
Antenna Pattern 192
Audio Amplifier 192
Cable 192
Capacitor 192
Circuit 192
Coincidence 192
Crystal 192
Differential Computer 192
Digital 192
Dimensional 192
Distortion 192
Electro-Chemical 192
Engine 192
Frequency 192
Ignition 192
Infrared 192
Intermodulation 192
Magnetic 192
Microwave 192
Neutron Absorption 192
Noise 192
Phase 192
Spectrum 192
Transducer 192
Transistor 192
Ultrasonic 192
Vibration 192
Wave 192
Waveform 192
ANEMOMETERS 193
ANNUNCIATORS 193
ANTI-VIBRATION EQUIPMENT 195
ARSENIC 195
BALANCING EQUIPMENT .. 196
BAROGRAPHS 197
BAROMETERS 197
BATTERIES 197
Dry Cell 197
Lead-Acid 197
BELTS, DIAL DRIVE 198
BEZELS 198
BIMETAL, THERMOSTATIC . 198
BINDING POSTS 198
BOARDS, PLUG 199
BREADBOARD KITS, ELECTRONIC 201
BREAKERS, CIRCUIT 202
BRIDGES 202
BRUSHES, SOUND REPRODUCTION EQUIPMENT . 202
CABINETS 203
Plastic 203
Temperature Test 203
CABLE 203
CALIBRATORS 205
CAMERA AUXILIARY EQUIPMENT 205
CAMERA MOUNTS 205
CAMERAS 205
Data Recording 205
High Speed 205
Oscilloscope 205
Recording, Radar & Oscilloscope 205
Sequence, Pulse 205
X-Ray 205
CELLS, PHOTOELECTRIC .. 207
CELLS, STANDARD 207
CHAMBERS 20
Acoustic 20
Alpha, Nuclear 20
Environmental 20
Ionization 20
CHASSIS, CABINET 20
CHECKERS, CATHODE RAY TUBE 20
CHECKERS, CRYSTAL RECTIFIER 20
CIRCUITS 21
Plated 21
CLAMPS 21
Harness 21
CLIPS 21
COIL ASSEMBLIES 21
COILS, HIGH TEMPERATURE 21
COLLIMATORS 21
COLORIMETERS 21
COLORIMETERS, PHOTOELECTRIC 21
COLORIMETERS, SPECIAL PURPOSE 21
COMPARATORS 21
CONNECTORS 21
Rack & Panel 21
CONTROLS 21
Conductivity 21
Density 21
Dimension 21
Film Thickness 21
Heat Treating 21
Humidity 21
Inspection 21
Materials Thickness 21
CORD SETS 22
COUNTERS 22
Computer 22
Electro-Magnetic 22
Electronic 22
Footage 22
Frequency 22
Impulse 22
Mechanical 22
Preset 22
Proportional 22
Radiation 22
Revolution 22
Scintillation 22
CRYSTAL 22
Crystal Analysis Equipment .. 22
DAMPERS, VIBRATION & SHIMMY 22
DELAY LINES 22
DENSITOMETERS, ELECTRONIC 22
DETECTION SYSTEMS 22
DETECTORS 22
Crack 22
Crystal 22
Detonation 22
Explosive Gas 22
Flaw & Defect, Electronic .. 22
Impedance 22
Leak 22
Magnetic 22
Metal, Electronic 22
Monoxide 22
Radiation 22
Resistance 22

Standing Wave 225
Vibration 225
Voltage 225
Water Leak 225
IALS 226
IODES 227
Crystal 227
Germanium 227
Microwave Mixer 227
Silicon 227
Silicon Power 227
ISCRIMINATORS 227
IDSIMETERS 228
IRIVERS, RECORDING 228
IRIVES 228
Small Electric Drive Mechanisms 228
Tachometer 228
NAMEL, INSULATION 230
FLOWMETERS, DIFFERENTIAL PRESSURE 236
FLOWMETERS, VOLUMETRIC 236
FLUOROMETERS 236
FORCE MEASURING CELLS 237
FREQUENCY CALIBRATION SERVICES 237
GALVANOMETERS 238
GAS ANALYZERS 238
GAUGES 239
Air Pressure 239
Compression 239
Differential Pressure 239
Fuel Pressure 239
Fuel Quantity 239
Hydraulic Pressure 239
Liquid Level 239
Manifold Pressure 239
Oil Level 239
Oil Pressure 239
Outside Air Temperature 239
Pressure 239
Quantity 239
Strain 239
Suction 239
Torque Pressure 239
GAUSSMETERS 239
GENERATORS 240
Timing Marker 240
GEOPHYSICAL APPARATUS 241
GRILLS, SPEAKER 241
HARNESSES 245
Electric 245
HEADS, COMPUTER 245
INDICATORS 248
Arc Back 248
Arc-Over 248
Capacitor Leakage 248
Detonation Indicators & Meters 248
Deviation 248
Dew Point 248
Dielectric Constant 248
Dive Angle 248
Drift 248
Electric Synchronizer 248
Fluid Conductivity 248
Fluid Flow, Electronic 248
Frequency 248
Fuel Flow Rate 248
Fuel Mixture 248
Ground Position 248
Gyro 248
Humidity 248
Illumination 248
Industrial 248
Magnetic Field 248
Materials Thickness 248
Moisture, Electronic 248
Moving Target 248
Null 248
Null-Balance 248
Oxygen 248
PH 248
Photographic Exposure 248
Plan Position 248
Pressure 248
Proximity 248
Pulse Time Riser 248
Radiation 248
Radiation, Nuclear 248
Rate-of-Climb 248
Recording Engine 248
Remote 248
Servo 248
Smoke & Combustion, Electronic 248
Sound Level 248
Specific Gravity 248
Strain 248
Temperature 248
Thrust 248
Timing 248
Torque 248
True Air Speed 248
Vacuum 248
Volume 248
Vibration 248
INDUCTANCE SPECIALTIES, MEASUREMENT 249
INDUCTANCES, VARIABLE . 249
INDUCTORS 249
INDUCTORS, COILS 250
INFRARED 250
Detection Systems 250
Image Converters 250
Systems, Guidance 250
INSTRUMENTS, ELECTRICAL MEASURING 250
Ammeters 250
Audiometers 250
Bridges 250
Calibrators 250
Comparators 250
Galvanometers 250
Magnetometers 250
Megohmmeters 250
Microammeters 250
Microfaradmeters 250
Milliammeters 250
Millivoltmeters 250
Ohmmeters 250
Panel 250
Ratiometers 250
Recorders 250
Standards 250
Tracers, Signal 250
Ultrasonic 250
Voltmeters 250
Volt-Ohm-Milliammeters 250
Wattmeters 250
INSTRUMENTS, GRAPHIC RECORDING 252
INSULATING COMPOUNDS . 252
LENSES, PRISMS, MIRRORS . 258
LIGHTS 258
LINES, SLOTTED 259
LOCATORS 259
Cable & Line Fault 259
Metal Flaw 259
Non-Metal Flaw 259
Open-Short 259
LUGS 259
MACH LIMIT SWITCHES ... 260
MACHINES 260
Vibration Fatigue Testing ... 260
Weighing 260
MACHMETERS 260
MAGNETIC ANALYSIS EQUIPMENT 260
MAGNETOMETERS 260
MANOMETERS 261
MEGOHMMETERS, VACUUM TUBE 262
METEOROLOGICAL EQUIPMENT, ELECTRONIC .. 263
METEOROLOGICAL INSTRUMENTS 263
METERS 263
Acceleration 263
Ammeter 263
Ammeter RF 263
Attenuation 263
Audio 263
Cable Testing 263
Capacitance 263
Conductance 263
Counting Rate, Nuclear 263
D Arsonval 263
Decibel 263
Deflection 263
Deviation 263
Distortion & Noise 263
Dosimeter 263
Dosimeter, Nuclear 263
Elapsed Time 263
Electrometer 263
Electronic Micrometer 263
Events-Per-Unit-Time 263
Exposure for Film 263
Field Strength 263
Flow 263
Flutter 263
Flux 263
FM Deviation 263
Frequency 263
Galvanometer 263
Goniometer 263
Grid Dip 263
Impedance 263
Infrared 263
Intermodulation 263
Kilovolt 263
Kilowatt 263
Light 263
Megohm 263
Microfarad 263
Microvolt 263
Microwave 263
Milliampere 263
Millivolt 263
Modulation 263
Moisture, Electronic 263

Multimeter 263
Multiplier 263
Ohm 263
Output, RF 263
Panel 263
Ph Meters, Recorders & Comparators 263
Phase 263
Photoelectric Reflection 263
Power Output 263
Pressure 263
Pyrometer 263
Q 263
Radiation, Nuclear 263
Rate 263
Ratio 263
Recording 263
RF Power 263
Snap Around 263
Sound Level 263
Spectral 263
Standing Wave Radio 263
Tachometer 263
Tension 263
Thermocouple 263
Thermometer 263
Thrust 263
Time 263
Torque 263
Ultra-Violet 263
Vacuum Tube Volt 263
Vibrating Reed 263
Vibration 263
Viscosity, Electronic 263
Volt-Ohm, Electronic 263
Watt 263
Watt-Hour 263
Wave 263
Wow & Flutter 263
X-Ray Intensity 263
MICA PLATE & SHEET 264
MICROMETERS, ELECTRONIC 264
MICROMANOMETERS 264
MICRO-OHMMETERS 264
MICROSCOPES, ELECTRON . 265
MICROSCOPES, OPTICAL ... 265
MICROWAVE ACCESSORIES 265
MIDFRAME SECTIONS, AXIAL FLOW 265
MILLIOHMMETERS 265
MOTORS 267
Servo 267
Timing-Regulated, Constant Speed 267
NUCLEAR PRODUCTS 271
OSCILLOGRAPHS 272
Multi-Channel 272
Multi-Element 272
Portable 272
Projection 272
Radar 272
Recording 272
Transient Study 272
OSCILLOMETERS 272
OSCILLOSCOPES 272
PANELS 273
Jack 273
PHASEMETERS 275
PHOTOMETERS 275
PICKUPS 275
Pressure 275
Temperature 275
Vibration 275
PILOT LIGHT ASSEMBLIES . 275
POTENTIOMETER TRIMMERS 278
POTENTIOMETERS 278
Absolute Pressure 278
Differential Pressure 278
High Resistance 278
High Voltage 278
Induction 278
Metallic Film 278
Portable Instrument 278
Precision 278
Printed Circuit 278
Rectilinear 278
Slidewire 278
POWER ABSORBERS 278
PRECIPITATORS, ELECTROSTATIC 280
PRESSURE INSTRUMENTS .. 280
PROBES 280
Pressure 280
Temperature 280
PSYCHOGALVANOMETERS . 281
PSYCHROMETERS 281
PYROMETERS, OPTICAL ... 282
PYROMETERS, RADIATION 282
PYROMETERS, RESISTANCE 282
RADAR TEST SETS 283
RADIATION DETECTORS .. 283
RADIATION EQUIPMENT, NUCLEAR 283
RADIOACTIVITY EQUIPMENT 284
RECORDERS 285
Depth 285
Film Thickness 285
Fluid Conductivity, Electronic 285
Frequency 285
Frequency Response 285
Liquid Level, Electronic 285
Magnetic, Mobile Comm. 285
Materials Thickness, Electronic 285
Mechanical 285
Potentiometers 285
Power Level 285
Pressure, Electronic 285
Sound Level 285
Specific Gravity, Electronic .. 285
Strain 285
Tape & Wire 285
Temperature, Electronic 285
Timing 285
Torque, Electronic 285
Transient 285
Vacuum 285
Vibration 285
Weight, Electronic 285
XY 285
REVERBERATION UNITS .. 290
SALT BATHS 291
SHOCK TUBES 295
SHOCK TUNNELS 295
SIMULATORS, FLIGHT 296
SLIDING LOADS, MICROWAVE 29
SPECTROMETERS 29
SPECTROPHOTOMETERS ... 29
SPECTROSCOPIC EQUIPMENT 29
SPRINGS 29
Instrument Hairsprings 29
Knob 29
STANDARDS 29
STANDS, MICROPHONE 29
STANDS, TEST 29
STANDS, WAVEGUIDE 29
STATIC ELIMINATORS 29
STATORS, MOTOR & GENERATOR 29
STRAIN RELIEFS 29
STROBOSCOPE, SYNCHRONIZER 30
STROBOSCOPES 30
SWITCHES 30
SWITCHING EQUIPMENT, CAMERA 30
SYNCHROS 30
SYNCHROSCOPES 30
SYSTEMS, REMOTE CONTROL 30
TABS 30
TABS, DIAL ACCESS 30
TACHOMETERS 30
TACHOMETERS, ELECTRONIC 30
TAPES 30
Test 30
TEMPERATURE MEASURING EQUIPMENT 30
TEMPERATURE RESISTANCE BULBS 30
TEST CHAMBERS, ENVIRONMENTAL 30
TEST CHAMBERS, FLIGHT SIMULATION 30
TEST EQUIPMENT 30
TEST LEADS 30
TEST STANDS, STATIC 30
TEST UNITS, ACCELERATION MILITARY 30
TESTERS 30
THERMOMETERS, RESISTANCE 30
THERMOPILES 30
THERMOSTATS 30
THICKNESS EQUIPMENT .. 30
THRUST MEASURING INSTRUMENTS 30
TOOLS, ALIGNMENT 30
TOOLS, HAND OR MECHANICAL 30
TRANSCEIVERS, PORTABLE 30
TRANSCEIVERS, UHF 30
TRANSCEIVERS, VHF 30
TRANSDUCERS 30
TRANSFORMER WINDINGS 31
TRANSFORMERS 31
TRANSISTORS 31
TUBE 31
TUBE PARTS 31
TUBES 31
TUNERS 31
ULTRASONIC EQUIPMENT.. 31
WIND TUNNELS 31

TRACKING AND TELEMETERING EQUIPMENT

These devices (optical, electronic, or both) follow a missile in flight and report on how it is actually functioning internally. This equipment includes telemetry, radio, radar and optical devices.





The catalog sheets shown here are descriptive of HOBART power supplies available to aviation and avionics industries!

Only at HOBART... can you get such a wide range of units to meet any type of ground power requirement.

Hobart machines are available to match the new requirements of today's aircraft, whether 400 cycle a.c., 28 or 112 volt d.c. In addition to the airlines and corporate users, airframe, powerplant, component part, helicopter and guided-missile manufacturers look to Hobart to meet their power supply needs.

It will pay to look into this! You can get your operations under way sooner and keep costs down when you use Hobart power supplies. 50 to 1500 amperes are available with wide continuously adjustable 26 to 31 volt range for either reciprocating or jet engine starting and testing. For the new jet aircraft and missile check-out and launching there are in the Hobart line, 400 cycle generators in capacities ranging from 3.75 to 125 KVA. This equipment is available in electric motor or engine driven designs and in the type of mounting you need. In other words, no matter what kind of equipment you're looking for, you can get it at one source—Hobart!

The company planning ahead in the fast-moving aviation field will do well to check into Hobart Power Supplies. Your inquiry will promptly bring complete literature and information on the equipment of interest to you. WRITE, PHONE, or WIRE today!

MOTOR GENERATOR CORPORATION

Hobart Brothers Affiliate

Box MI-59, Troy, Ohio

Fill in No. 37 on Subscriber Service Card.

New Products

• *tracking and telemetering equipment*

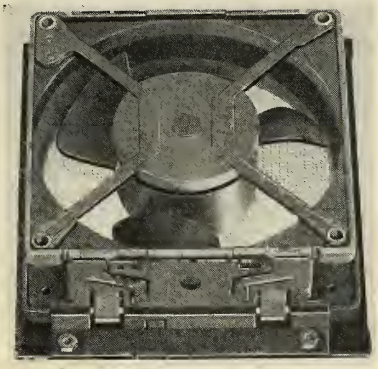
MUFFIN FAN COOLS ELECTRONIC EQUIPMENT

Rotron Mfg. Co. Inc.'s Muffin is logical choice for a wide cross section of cooling projects. Typical applications would include: electronic Black boxes"—transmitters, receivers, adar, etc.; microwave-link equipment; ower supplies—rectifiers, converters, attery chargers, etc.; machine tools—lectronic control enclosures, speed hangers, clutches; light projectors—ide and filmstrip, contour projection; st equipment, instruments; industrial aintenance equipment.

Muffin Fan provides efficient forced ir cooling for projects where cooling as hitherto prohibitive. It is an riginal aerodynamic design with a igh air performance of 100 CFM hile developing sufficient pressure for peration through a dust filter and ghtly packed electronic equipment. uffin Fan is available in three versons: Skeleton Fan; A whirling proeller with 4 mounting arms is what sults from using the "guts" only of e Muffin Fan. It can be mounted s an air-stirring device among hot mponents or can be mounted in the uipment enclosure; Venturi Fan, and rilled Fan.

The Muffin Fan features an inside-ut motor with cantilevered bearings nd with the air impeller integral with e rotor. This shaded-pole motor aws only 13 watts. No capacitor is quired nor are there any commutors, slip rings or brushes which uld shorten life or threaten reliility. No oiling or maintenance of y kind is necessary throughout the e of the fan. Due to the inside-out, ntilevered design the grease does not emically deteriorate nor is there a ed for a large grease reservoir.

A permanent, solid electrical conction is made to two solder terminals quiring just a few seconds time. The



solder terminals eliminate the possibility of lead wires being damaged in shipment, in handling or at the time of final installation—a common source of trouble in the case of conventional motors.

The Muffin Fan is designed for continuous duty operation with a life expectancy of 3 to 5 years when operated within the ambient temperature limits of 40°F to 110°F and within the nameplate electrical rating of 105 to 120 volt AC, 60 cycles. It requires no maintenance and is lubricated for the entire life of the fan.

Since the stator and all electrical parts, including the two input terminal lugs are molded into a watertight shell, the fan is not subject to humidity damage and is, in fact, submergence proof.

When installed in a cabinet with the grille assembly in place and measured in accordance with NAFM code, the noise level is only 42 db on the A scale or about 10 db lower than the average present day room air conditioner.

Fill in No. 142 on Subscriber Service Card.

---

laytector--
lonitors Radar

Miller Associates' Raytector monirs any radar system. It notifies inuntly—by audible or visual means or th—of the entrance of an object into search zone selected by the radar opator and it maintains a constant check the conditions of operation of the dar system and on its own operation. relieves the radar operator and ennces the dependability of search operations. Features—high sensitivity is achieved by a new means of greatly enhancing signal-to-noise ratio; zone of search is adjustable from 2 to 30 miles out with an adjustable width of 2 to 30 miles for a maximum zone operation reach of 60 miles; on early warning it will operate out to radar's full reach; produces its own range rings for easy selection of search zone; notifies operator of radar failure; notifies operator of Raytector failure; gives constant "magic eye" indication of top echo-to-noise efficiency adjustment. Dimensions: 1. 15½", h. 10½", d. 9-1/8"; weight: 30 lbs.; power: 115 volts, 60 cycles, 100 Va. Raytector produces a steady or repeated alarm signal; is easy to install, simple to operate and will not interfere with normal radar operation.

Fill in No. 143 on Subscriber Service Card.

New Duplexer Has High Reject Attenuation

D. S. Kennedy & Co. has introduced a duplexer having a reject attenuation greater than 100 db and designed for operation in the 755 to 985 mc band. It is especially suited to tropospheric scatter applications. The duplexer enables the same antenna to be used simultaneously for both transmitting and receiving. It is made of high strength aluminum alloy. The transmitter and receiver ports are equipped with transitions which are fitted with coaxial inputs.

Fill in No. 144 on Subscriber Service Card.

4-5 Digital Ohmmeters Give High Accuracy

Production of four and five-digit Digital Ohmmeters has been announced by Cubic Corp., San Diego electronics firm.

The new Ohmmeter, powered by Cubic Control Unit Model C-2, provides high accuracy on all ranges, Cubic says, plus or minus .01% and one digit for typical resistance measurements with the four-digit instrument for example.

Features include the incorporation of four input leads to avoid the effects of lead or contact resistance; an AC rejection filter which prevents induced



hum pickup; an open circuit test voltage of 10 volts maximum, which eliminates shock hazards and reduces resistor dissipation. Another feature, the addition of a resistor in the digital bridge, provides the instrument with the capability of calibration against standards up to 10% over full scale.

The firm says that only a small magnitude of current is drawn through the unknown resistance, because of unique bridge design and the incorporation of a highly sensitive null detector.

The Ohmmeter features Cubic's "controlled drive" stepping switches, with the switch turning off the drive circuit part way through the switch cycle, thus reducing the mechanical impact to a minimum and preventing the switches from being overdriven.

Fill in No. 145 on Subscriber Service Card.

New Multifarious Core Storage Unit Is Versatile

A series of revolutionary random access data storage units is now available from Telemeter Magnetics, Inc., manufacturer of data equipment. These memory-buffer units offer addressable random access, sequential access, or a combination of both as desired.

Designated SERIES RB random access buffer units, they feature:

Variable input output—Will accept pulses or levels of either polarity and input may be changed during operation. Output is equally versatile. Accepts and emits single-ended or double-ended information. Environment—Reliable operation between 0° and 55°C, unaffected by humidity. High speed—200 kc operating rate. Long term reliability—Solid state active elements conservative derating of components advanced design and manufacturing techniques. Wide range of capacities—from 256 to 1024 words of from 4 to 20 bits per word. Random or sequential access—Addressable storage registers for regenerative read/write or buffer operation in a sequential nonregenerative mode. Binary or decimal—Either binary or binary coded decimal addressing.

Fill in No. 146 on Subscriber Service Card.

Cathode Ray Tubes Have Ultra-High Resolution

The CBS-Hytron cathode ray tubes, primarily ultra-high resolution read out tubes or monitors, are designed for high precision display and photographic use. They are capable of resolving 2000 lines per inch. For a line scan of 4.5 inches in a 5 inch diameter tube, a total of 8000 lines can be achieved.

By the immersion electron optical design, the beam is controlled over its entire post-acceleration path. The half-deflection angle of 9.5° insures accurate deflection linearity with suitable yokes. Defocusing at the edge of the usable screen is less than 2.5%, but may be corrected to near zero by simple dynamic focusing. Some loss of resolution will occur at the extremes of deflection.

Tubes are available with P5 or P11 phosphore. These CR tubes are particularly suitable for photographic recording since the peak wavelengths of the phosphor fall within the blue region of the spectrum (4300A° and 4600A° respectively).

Tubes are also available in P16 phosphore. P16 has a shorter persistence of 1γs permitting use of these tubes in flying spot scanner work.

Fill in No. 147 on Subscriber Service Card.

Transmitter Is Designed for Space Satellites

An all-transistor 20 megacycle telemetering transmitter, designed for possible use in space satellites, and built by Philco Corp. for the U.S. Army is the first U.S. satellite transmitter to operate in the 20 mc band and it has the same type of modulation used by standard radio stations and amateur radio operators. It also has more power output and is more efficient than the transistorized transmitters used in present U.S. satellites.



Developed by Philco's Research division for the Army Ordnance Missile Command, the satellite transmitter weighs less than 10 ounces, is five inches in diameter and one inch high.

New Philco high frequency power transistors made it possible to build this telemetering transmitter which provides up to one watt of output power. This is in contrast to one-to-two hundredths of a watt of output from transistorized transmitters in present U.S. satellites.

These power transistors, developed especially for the 20 mc transmitter by Philco's Lansdale Tube division, are used instead of bulky vacuum tubes which require large batteries of short life span.

Another transistor advantage is that nearly one half of the power taken from a satellite's batteries, which operate the transmitter, is radiated as radio frequency energy. This is important since electrical power is limited and precious in an orbiting space satellite.

The Philco satellite transmitter is capable of operating at high efficiency in outer space within a temperature range of 5 to 187 degrees Fahrenheit. —It consists of three sections:

Oscillator—Uses one Philco high frequency power transistor in crystal controlled oscillator circuit.

Power Amplifier—Uses four Philco high frequency power transistors in parallel. Power gain of amplifier is 8 to 10 db.

Modulator—Uses one Philco transistor as audio amplifier-driver and two transistors in Class B push-pull. Power gain of the modulator is in excess of 50 db. Modulation is applied to the collector of the RF amplifier.

Performance—Power output is about 600 milliwatts unmodulated carrier; 830 milliwatts with full modulation (nominal operating conditions).

Fill in No. 148 on Subscriber Service Card.

Oscillators for Missile Systems Are Pretuned

M F Electronics Co.'s series 101 and 102 fixed frequency RC pretuned sine wave oscillators are available in standard telemetering and decimal frequencies as stock items.

Oscillators are delivered from the factory set for the desired frequency; no external adjustments are required, thus reducing possibilities for misadjustment in final equipment. They become operative upon application of only one DC voltage (12 volts or 28 volts).

Resistance to mechanical shock and humidity is achieved by epoxy resin filling and the complete unit is hermetically sealed; oscillators may be operated under water. They are built in drawn metal cans of approximately 1½ cubic inches and may be conveniently mounted with two side flanges.

The 101 is distinguished from the 102 Series by difference in the frequency tolerance. The 101 has a total accuracy of ±5%, while the 102 has a total accuracy of ±2%. All oscillators are characterized by low distortion. Stability and functionality have been the two key factors in their development. Mechanical description: case-drawn steel, hot tin dipped; terminals-hermetic seal solder pin or hermetic noval connector; potting-epoxy resin; weight-35 grams nominal; storage temperature-minus 40 to plus 75°C.; operating temperature-minus 29 to plus 60°C.



The purpose of the packaged oscillator is to provide a reliable and stable frequency source, thereby allowing the systems designer to work with a black box with known performance.

Although rated for either 12 or 28 VDC, the 101 and 102 Series are operable with the wide range of supply voltages which might be expected during a typical battery life. With a nominal 12 volt source, the 101 or 102 should be chosen, while the 101A and 102A are intended for use with aircraft battery voltages of from 24 to 32 volts.

Oscillators will find their greatest use in aircraft, space vehicle and portable ground equipment. Typical applications include: telemetry, balloons, water vessels, missiles, guidance systems, timing circuits, bridge circuits, and test equipment.

Fill in No. 149 on Subscriber Service Card.

Cross Index

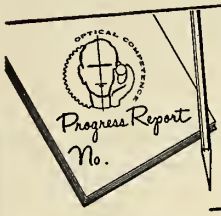
• tracking and telemetering equipment

BSORBERS 187
CCUMULATORS 187
CTUATORS 188
Electric 188
DAPTERS 188
Battery 188
Crystal 188
Field Sequential 188
Foreign 188
Line & Dot Sequential 188
Phase 188
Plug 188
Tube 188
Tube Socket 188
LARM SYSTEMS 189
LTERNATORS 190
LTIMETERS, BAROMETRIC PRESSURE 190
LTIMETERS, RADIO & RADAR 190
MMETERS 190
MPLIFIERS 190
NALYZERS 192
Capacitor 192
Circuit 192
Differential 192
Differential Computer 192
Digital 192
Flight 192
Infrared 192
Microwave 192
Radar 192
Transistor 192
Ultrasonic 192
Wave 192
Waveform 192
NNUNCIATORS 193
NODES, METAL 193
NTENNA FEED SYSTEMS . 193
NTENNA FITTINGS & ACCESSORIES 194
NTENNA TOWER LIGHTING 194
NTENNA TUNING UNITS . 194
ENNAS 194
Direction Finding 194
Fixed Station 194
High Frequency 194
Loop-Direction Finder 194
Low Frequency 194
Microwave-Radar 194
Radar 194
Rotary Beam 194
Slotted Line 194
Ultra High Frequency 194
Very High Frequency 194
SSEMBLERS, FEEDERS 195
SSEMBLIES, MICROWAVE ..195
TTENUATORS 195
Audio 195
Logarithmic 195
Microwave 195
Precision 195
RF & IF 195
BALLISTOCARDIOGRAPHS . 197
BASES 197
Antenna 197
Diode 197
Relay 197
Transistor 197
BELLS & BUZZERS 198
BINDING POSTS 198
BLOWERS, TRANSMITTER .. 199
BOARDS, CAPACITOR OR RESISTOR 199
BOARDS, PLOTTING 199
BOBBINS, COIL WINDING .. 199
BOBBINS, TRANSFORMER WINDING 200
BOXES, JUNCTION 200
BRIDGES 202
Capacitance 202
Cathode Interface Impedance 202
Electrical 202
Impedance 202
Inductance 202
Megohm 202
Resistance 202
RF 202
Self Balancing 202
Standing Wave 202
Synchro 202
VHF 202
Wheatstone 202
CAMERA AUXILIARY EQUIPMENT 205
CAMERA MOUNTS 205
CAMERAS 205
Data Recording 205
High Speed 205
Motion Picture 205
Oscilloscope 205
Recording, Radar & Oscilloscope 205
Television 205
CAPACITOR SPECIALTIES MEASUREMENT 206
CAPACITORS 206
Ceramic 206
Ceramic Trimmer 206
Composition 206
Decade 206
Electrolytic 206
Feed-Through 206
Fixed 206
Gas-Filled 206
Glass 206
Glass Trimmer 206
Hermetically Sealed 206
High Temperature 206
High Voltage 206
Industrial 206
Metallized Paper 206
Mica 206
Mica Trimmer 206
Miniature 206
Mylar Dielectric 206
Neutralizing 206
Oil 206
Oil Filled 206
Piston 206
Plastic 206
Plug-In 206
Polystyrene Insulated 206
Porcelain 206
Precision 206
Pressure Types 206
Printed Circuit 206
Receiver Tuning 206
Silicone-Filled 206
Silvered Mica 206
Standard 206
Tantalum 206
Teflon 206
Temperature Compensated ... 206
Transmitter Tuning 206
Transmitting 206
Vacuum Types 206
Variable 206
CASES 206
Diode & Transistor 206
Transformer 206
CATHODES 207
CELLS, PHOTOELECTRIC ... 207
CHECKERS, CATHODE RAY TUBE 209
CHECKERS, CRYSTAL RECTIFIER 209
CHECKERS, KYLSTRON TUBE 209
CHOKES 209
CHROMATOGRAPHS, VAPOR PHASE 209
CHRONOGRAPHS 209
CHRONOMETERS 209
CIRCUITS 210
Computer, Logic 210
Computer, Packaged 210
Plated 210
Plug-In 210
CLAMPS 210
Harness 210
CLIPS 211
Alligator 211
Crystal Diode 211
CLOCKS, TIME 211
COIL ASSEMBLIES 211
COILS 212
COLLECTOR RINGS 212
COMMUNICATIONS SYSTEMS 213
COMMUTATORS, SWITCHING 213
COMPARATORS 213
Capacitance 214
Circuit Linearity 214
Dielectric 214
Iron Core 214
Q. 214
Voltage 214
COMPASSES 214
COMPUTER INPUT EQUIPMENT 215
COMPUTER OUTPUT EQUIPMENT 215

COMPUTERS 215
Analog 215
Course Line 215
Data Processing 215
Digital 215
Navigation 215
CONES, SPEAKER 216
CONNECTORS 216
CONTROLS 217
Audio Recording 217
Automatic Approach 217
Broadcast Input 217
Camera 217
Camera, Remote 217
Capacitance Operated 217
Computer 217
Counting & Sorting 217
Electronic AC Motor Speed . 217
Loop Regulation 217
Master 217
PH 217
Photographic Exposure 217
Photoelectric 217
Voltage Regulator 218
Volume 218
CONVERTERS 220
Analog Digital 220
Electric 220
Field Sequential 220
Microwave 220
RF 220
Rotary 220
Voltage 220
Waveform 220
COOLING SYSTEMS, ELECTRONIC 221
COPPER LAMINATES, PRINTED CIRCUIT 221
CORES 221
C Type 221
Ceramic 221
Cut 221
E Type 221
Ferrite 221
High Permeability Magnetic . 221
Iron 221
Laminated 221
Powdered 221
Slug Tuning Units 221
Tape Wound 221
COUNTING DEVICES 222
COUPLERS, DIRECTIONAL, MICROWAVE 222
COUPLERS, TRANSMITTER . 222
COUPLING & PHASING UNITS 222
COUPLINGS 222
Microwave 222
CRYSTAL 223
CRYSTALS 223
CUTOUTS 223
DATA 224
Recorders, Analog 224
Recorders, Digital 224
Recording Equipment 224
DECADE BOXES 224
DECODERS 224
DELAY LINES 225
DELAY NETWORKS 225
DEMODULATORS, COMPUTER 225
DETECTORS 225
Magnetic 225
Null 225
Scintillation 225
Standing Wave 225
Voltage 225
DIAL CRYSTALS 226
DIALS, COMPLETE 226
DIODES 227
Crystal 227
Germanium 227
Microwave Mixer 227
Silicon 227
Silicon Power 227
DISCRIMINATORS 227
DISCS, COMPUTER 227
DISTANCE MEASURING EQUIPMENT 228
DRIFTMETERS 228
DRIVERS, RECORDING 228
DUPLEXERS 229
DUPLICATORS, MAGNETIC TAPE 229
DYNAMOMETERS 229
ELECTROCARDIOGRAPHS .. 230
FILMS, CAPACITOR 233
FILMS, PLASTIC FOR WOUND INSULATION . 233
FILTERS 233
Antenna 233
Audio 233
Band Elimination 233
Band Pass 233
Continuously Variable 233
Crystal 233
Electric 233
Electric Wave Section 233
High Pass 233
IF 233
Interference 233
Low Pass 233
Microwave 233
Needle Scratch 233
Noise Suppressing 233
Optical 233
Polarizing 233
Radio 233
Radio Noise 233
RF 233
Telemetering 233
UHF & VHF 233
Vacuum System 233
Variable Electronic 233
Vestigial Sideband 233
Wave Trap 233
FLANGES, MICROWAVE ... 235
FORMS, ANTENNA 237
FREQUENCY METERS 237
GRID FRAMES 241
GRIDS 241
GRILLS, SPEAKER 241
HARDWARE 244
HEADPHONES & HEADSETS 245
INDICATORS 248
Air Position 248
Airspeed 248
Angle-of-Yaw 248
Antenna Position 248
Bank & Turn 248
Drift 248
Ground Position 248
Gyro 248
Modulation 248
Moving Target 248
Null 248
Null-Balance 248
Plan Position 248
Speed 248
Telemetering 248
True Air Speed 248
Variable 248
INDUCTORS 249
INFRARED 250
Detection Systems 250
Image Converters 250
Systems 250
INSTRUMENTS, ELECTRICAL MEASURING 250
Ammeters 250
Audiometers 250
Bridges 250
Calibrators 250
Comparators 250
Galvanometers 250
Magnetometers 250
Megohmmeters 250
Microammeters 250
Microfaradmeters 250
Micro-Microammeters 250
Milliammeters 250
Millivoltmeters 250
Ohmmeters 250
Ratiometers 250
Recorders 250
Tracers, Signal 250
Voltmeters 250
Volt-Ohm-Milliammeters 250
Wattmeters 250
INSTRUMENTS, GRAPHIC RECORDING 252
INSULATING COMPOUNDS . 252
INSULATION PARTS 252
Bead 252
Rods 252
INSULATORS 253
INVERTERS 254
ION TRAPS 254
ISOLATORS, MICROWAVE .. 254
JACK PANEL ASSEMBLIES . 254
JEWELS 255
JUNCTION BOXES & PANELS 255
KEYERS 255
KILOVOLTMETERS 255
LAMINATIONS, TRANSFORMER 256
LENSES 257
Zoom 257
LIGHTS 258
Black 258
Dial, Panel & Pilot 258
Jewel Pilot 258
Miniature 258
Neon Test 258
Photoelectric Source 258
Signal 258
LINKS, ANTENNA 259
LUGS 259
MACH LIMIT SWITCHES ... 260
MAGNETS 261

MATRIXES COMPUTER 261
MEMORY 262
Crystal 262
Drums 262
Multi-Core Magnetics 262
Systems 262
Tape Loop 262
Tubes 262
MICA PLATE & SHEET 264
MICROWAVE ABSORBERS . 265
MICROWAVE ACCESSORIES 265
MODULATORS, MAGNETIC . 266
MODULATORS, PHASE 266
MODULATORS, PULSE 266
MONITORING EQUIPMENT, TRANSMISSION 267
MONITORS 267
AM & FM Transmitter 267
Antenna Phase 267
Audio 267
Frequency 267
Line & Program 267
Modulation 267
Phase 267
RF Power 267
Service 267
Shift 267
Waveform 267
MOTORS 267
Turntable 267
MOUNTS 268
MULTIPLEX SYSTEMS 268
MULTIPLIERS 269
NETWORKS 269
Crossover 269
Directional Antenna Phasing . 269
Matching 269
Potted 269
Pulse Forming 269
OPTICAL EQUIPMENT & SPECIALTIES 271
OSCILLATORS 272
Audio 272
Audio Fork Controlled 272
Audio Frequency 272
Cavity 272
Code 272
Crystal 272
Grid Dip-High Frequency & VHF 272
Microwave 272
Oven Crystal Control 272
Pulse 272
Pushbutton 272
Radio Frequency 272
RF 272
Strain-gage FM, Voltage-Controlled 272
Sweep 272
Tuning Fork 272
Ultra-Low Frequency 272
Ultrasonic 272
Video Pattern 272
Video Range 272
OSCILLOGRAPHS 272
OSCILLOMETERS 272
OSCILLOSCOPES 272
OUTLETS, ANTENNA 272
PAINTS 273
PANEL BOARDS, ELECTRIC 273
PANELS 273

INFRA·RED
INFRA·RED
INFRA·RED
INFRA·RED



INFRA·RED

BAUSCH & LOMB OPTICAL COMPANY · ROCHESTER 2, NEW YORK

Would you like to be kept informed on progress in infra-red as it occurs at engineering levels? This could be mighty useful in helping you evaluate developments that might well affect your own associated projects. That's the reason for progress reports we're sending out. Why not let us send them to you, also?

The reports will cover information on infra-red items that we feel can prove of value to you - how new calcium aluminate glass simplifies design of transmittance systems; how unique films set new standards of sensitivity in analytical discrimination - and much, much more.

And these aren't just laboratory samples we're going to be talking about. Our infra-red components have been proved in current operational missiles and are being supplied in production volume.

We're doing a lot of interesting work with infra-red materials---from research to performance-tested hardware. Why not fill out the coupon? We're pretty sure we can tell you something that's worth knowing.

BAUSCH & LOMB
SINCE 1853

BAUSCH & LOMB OPTICAL CO.
88441 St. Paul Street, Rochester 2, N.Y.

Please add my name to your distribution list of B&L Infra-Red Progress Reports.

NAME .....
TITLE .....
COMPANY .....
ADDRESS .....
CITY ..... ZONE ..... STATE .....

Fill in No. 62 on Subscriber Service Card.

PAPER, INSULATION 274
PAPER, RECORDING 274
PAPERS, FACSIMILE RECORDING 274
PATCH CORDS 274
PATCH PANELS 274
PERMEATERS, RF 275
PHOTO ETCHED COMPONENTS 275
PHOTOCELLS & PHOTOTUBES 275
PHOTOELECTRIC CELLS ... 275
PHOTOFLASH EQUIPMENT, ELECTRONIC 275
PHOTOMETERS 275
PICKUP ARMS 275
PICKUPS 275
PLASTIC, ELECTRICALLY CONDUCTIVE 275
PLUG-IN-CIRCUIT UNITS .. 277
PLUGS 277
POINTERS, DIAL 277
POSITION INDICATORS 277
POTENTIOMETER TRIMMERS 278
POTENTIOMETERS 278
POWER SUPPLIES 278
PRE-SELECTORS 280
PRINTED CIRCUITS 280
PROBES 280
RADAR BEACONS 283
RADIATORS 283
READOUT DEVICES, COMPUTER 284
RECEIVERS 284
- AM & FM Communication .. 284
- AM Fixed Frequency 284
- Communication 284
- Direction Finding, Navigation 284
- Diversity 284
- Diversity Reception 284
- Fixed Frequency 284
- FM 284
- Frequency Shift 284
- Infrared, Navigation 284
- Microwave 284
- Portable & Mobile 284
- Radar 284
- Radiation 284
- Radio Communication 284
- Radio Navigation 284
- Remote Pickup, Fixed 284
- Selective Signalling, Navigation 284
- Short Wave, Fixed 284
- Short Wave, Portable 284
- Single Side Band 284
- Transistor Operated 284
- UHF 284
- VHF 284
- WWV 284

RECEIVING EQUIPMENT, VHF OMNIRANGE 285
RECORDERS 285
RECTIFIERS 286
REFLECTORS, RADAR 286
REGULATORS 287
RELAYS 288
- Capacitance 288
- Coaxial 288
- Contact 288
- Cross Bar 288
- D Arsonval 288
- Differential 288
- Frequency Selective 288
- High Voltage 288
- Impulse 288
- Keying & Break-In 288
- Latching 288
- Mercury 288
- Meter 288
- Microwave 288
- Overfrequency 288
- Photoelectric 288
- Plate Circuit 288
- Polarized 288
- Power 288
- Reverse Current 288
- RF 288
- Rotary 288
- Sensitive 288
- Stepping 288
- Subminiature 288
- Temperature Compensated .. 288
- Thermal 288
- Thermostatic Delay 288
- Time Delay 288
- Timing 288
- Under Frequency 288
- Vacuum Contact 288
- Vibrating Reed Type 288

REMOTE PICK-UP, AUDIO . 289
REPEATERS, MICROWAVE . 289
REPEATERS, PASSIVE, MICROWAVE 289
RESISTANCE THERMOMETER BULBS 289
RESISTORS 289
- Boroncarbon 289
- Composition, Variable 289
- Decade 289
- Deposited Carbon 289
- Encapsulated 289
- Film 289
- Fixed Composition 289
- Fixed Wire-Wound 289
- Fuse 289
- Glass 289
- High Frequency 289
- High Temperature 289
- High Voltage 289
- Industrial, Fixed 289
- Miniature Variable 289
- Photo Sensitive 289
- Plug-In-Tube 289
- Precision 289
- Printed Circuit 289
- Printed Strip 289
- Silicone 289
- Subminiature 289
- Tape 289
- Temperature Sensitive 289
- Variable, Miniature 289
- Variable Wire Wound 289

RESOLVERS 290
RHEOSTATS 290
SCANNERS, REFLECTED & TRANSMITTED LIGHT . 291
SELECTIVE CALLING APPARATUS 293
SENSING DEVICES 293
SEXTANTS, PERISCOPE TYPE 294
SHEETS, METAL CLAD, PRINTED CIRCUIT 294
SHIELDING 294
- Cathode Ray Tube 294
- Coil 294
- Electrostatic 294
- Transformer 295
- Tube 295

SHIMS, LAMINATED 295
SHUNTS, METER 295
SHUTTERS, MICROWAVE .. 295
SLIDES 296
SOLDER 296
SPRINGS 298
STANDARDS 298
STANDS, WAVEGUIDE 299
STATIC ELIMINATORS 299
STATORS, MOTOR & GENERATOR 299
STRIPS, MOUNTING 300
SUBMINIATURIZATION SERVICE 300
SUPPRESSORS, NOISE 300
SWITCH GUARDS 300
SWITCH, INERTIA 300
SWITCHES 300
SWITCHING EQUIPMENT, ANTENNA 301
SYNCHROS 302
TAPES 303
- Recording 303

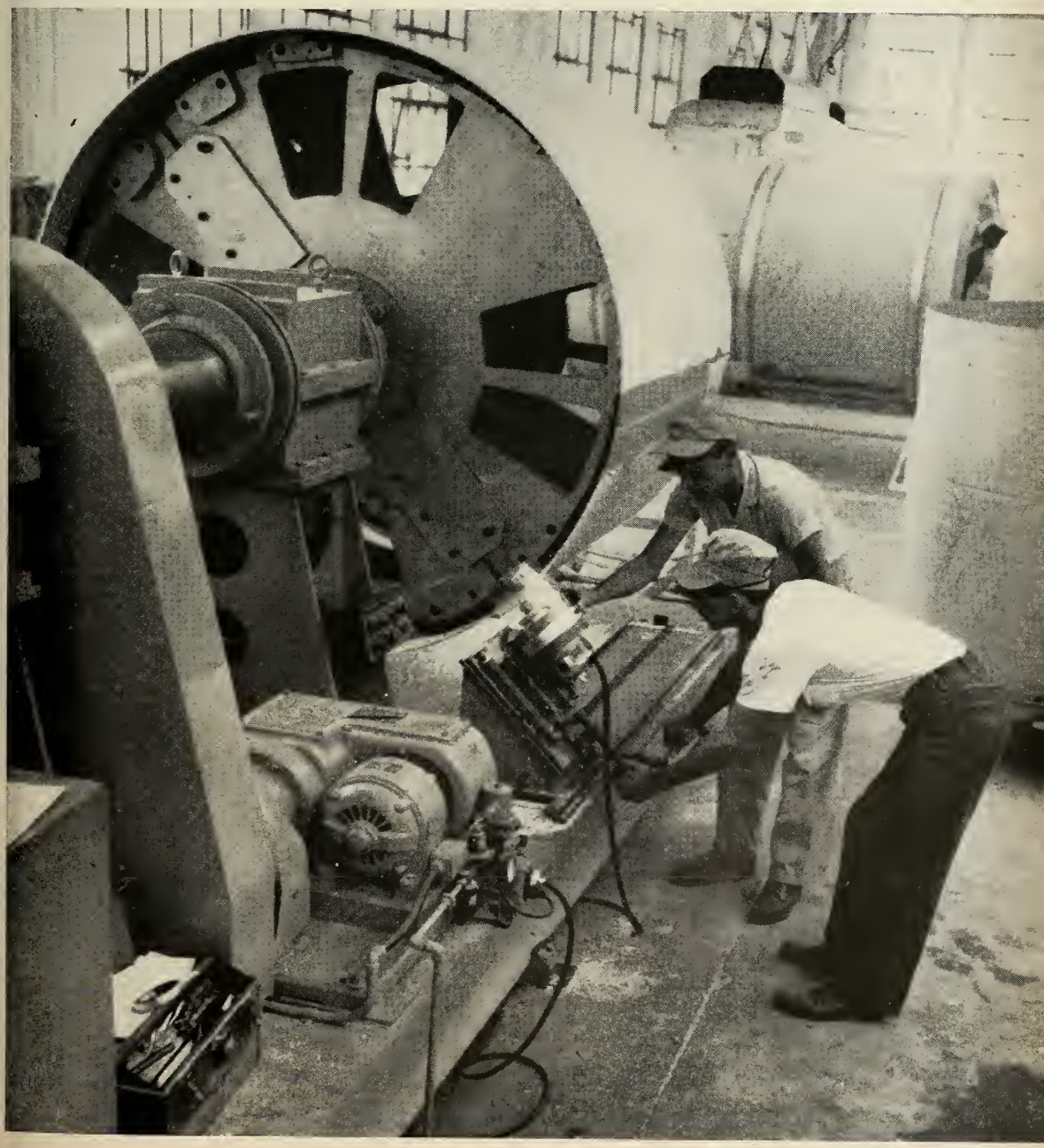
TARGET DEVICES 303
TERMINAL BLOCKS 304
TERMINAL BOARDS 304
TERMINAL LUG SWAGGERS 304
TERMINAL STRIPS 304
TERMINALS 304
TERMINATIONS 305
TRANSDUCERS 309
TRANSFORMERS 310
TRANSISTORS 311
TRANSMITTERS 311
TRANSPONDERS 311
TUBE 311
- Cooling Units 311

TUBE PARTS 312
TUBES 312
TUBING 312
- Waveguide 312

TUNERS 313
TUNING DEVICES, RECEIVER MECHANICAL . 314
TUNING DEVICES, TRANSMITTER MECHANICAL . 314
VIBRATORS, INSTRUMENT PANEL 317
VIBRATORS, MULTI-VIBRATORS 317
VIBRATORS, ULTRASONIC . 317
VOLTAGE SUPPLIES, DECADE 317
VOLTMETERS 317
WAVE TRAPS 318
WAVEGUIDES 318
WINDINGS, TRANSFORMER 319
WINDOWS, WAVEGUIDE ... 319
WIRE 319

MATERIALS AND METALS

The chemicals, metals, and other materials from which missiles are made. This includes the processes which form these materials into the various parts of the missile.



LAVELLE

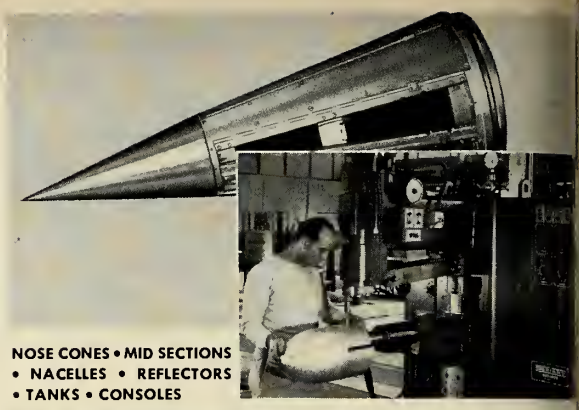
SPECIALISTS IN ROCKET, MISSILE, JET ENGINE, AIRFRAME AND ELECTRONIC COMPONENT FABRICATION

Sheet metal parts and assemblies precision welded, machined, and processed to your specifications by certified men, methods and machines . . . of stainless steel, titanium, aluminum, and heat resistant, high strength nickel alloys.

Weldments fabricated by resistance, inert gas shielded arc, metallic arc and oxyacetylene welding. X-ray, Zyglo and Magnaflux methods of non-destructive inspection are used to establish and control weld quality.

Services include engineering, production planning, tool making, sheet metal fabricating facilities, machine shop, anodizing, painting and quality control.

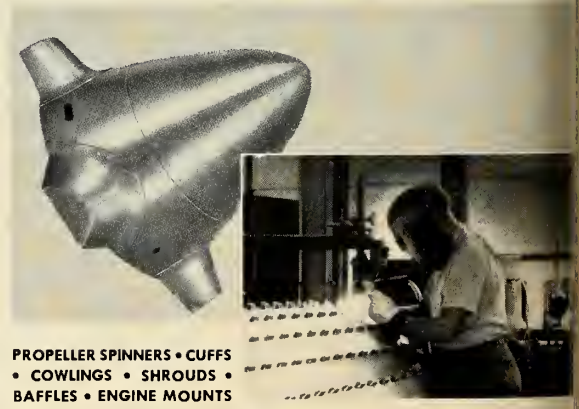
For components requiring precision fabrication, quality workmanship, dependable delivery . . . at reasonable cost . . . contact Lavelle.



NOSE CONES • MID SECTIONS • NACELLES • REFLECTORS • TANKS • CONSOLES



COMBUSTION CHAMBERS • ENGINE CASINGS • DUCTS • SHIELDS • LINERS



PROPELLER SPINNERS • CUFFS • COWLINGS • SHROUDS • BAFFLES • ENGINE MOUNTS



FLAME HOLDERS • EXHAUST NOZZLES • TAIL PIPES • FUEL MANIFOLDS



Write for illustrated brochure describing Lavelle's services in detail.

Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.
Between Philadelphia, Pa., and Trenton, N.J.

Fill in No. 38 on Subscriber Service Card.

New Products

• *materials and metals*

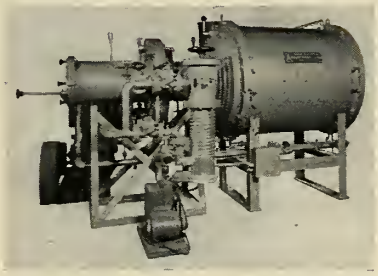
RODUCTION FURNACE IS INTERNALLY HEATED

High Vacuum Equipment Corp. 3000 Series furnaces are internally ated vacuum or controlled atmos- ere furnaces capable of continuous eration at 3000F at a vacuum of 10^{-5}mm Hg or less, or for operation h an inert gas at 2500F. Four (4) dels are available with any one of following three (3) uniform hot nes: 4x8, 6x12, or 6x24 inches, de- ting diameter and length. respec- ely.

The basic unit (Model 1) com- ses a standard 660 or 1800 cfm ckaged pumping system, with the d wall vacuum furnace installed on . Furnace is water jacketed and con- s of a stainless steel inner shell and outer stainless steel water jacket. e furnace elements are made of vy molybdenum rod; the furnace t shields are made of molybdenum l stainless steel. Automatic tempera- e control is achieved by means of a urable core reactor, available with er an indicating or recording con- ller. A hearth is provided for sup- ting the work load. A door with or sight port is provided at one end f access to the working zone.

Necessary ports and fittings are in- ded in the basic unit so that it can converted in the future to any of other three models.

Model 2 is identical to the basic t with the addition of an externally unted, water-cooled heat exchanger l blower to provide extremely fast ling rates using inert atmosphere. s arrangement has the advantages of wing the work load to remain sta- ary and permit fastening thermo- ples directly to the work.



Model 3 is identical to the basic unit with the addition of a cooling zone and a water-cooled gate valve between furnace and cooling zone. Separate cooling zone permits vacuum and temperature to be maintained continually within the furnace since work may be loaded or unloaded using the cold zone as a 'vacuum lock' without breaking the furnace to atmosphere. This type system provides the fastest heating rates.

Model 4 is also identical to the basic unit except for the addition of a high vacuum gate valve and cooling zone with integral quench chamber. A variety of quench oils may be utilized to achieve desired heat treatment properties.

Models 3 and 4 are equipped with separate vacuum manifold and valve for independent evacuation of the chamber—thus, equalizing the vacuum between furnace and cold zone for semi-continuous operation. Both models contain a sliding seal in cooling chamber door to allow manipulation of a charging mechanism.

Fill in No. 150 on Subscriber Service Card.

w Power Rollers ature Magnetic Brake

A new series of six power-operated rers with cam actuated idler roll and gnetic brake to prevent overcoasting ha been introduced by O'Neil-Irwin g. Co., makers of Di-Acro Precision alworking Machines.

Called Di-Acro Power Roller, each del features a magnetic brake which vides a positive stop enabling the rator to work to a scribed or hair lir without having to try and com- sate for the rolls coasting. Accord- in to the company, direction of the ro can be switched backward, for- wa or stopped at anytime by tripping a ot control.

Perfect circles of any diameter larger than two inches can be formed in sheet material in just two passes through the rolls due to the cam actuated idler roll. Bends can be located at any point in sheet material with straight sections on one or both sides. This also enables quantities of parts to be accurately duplicated as the idler roll is always returned by the lower cam to its preset position.

Di-Acro Power Rollers are available in models with 12", 18", 30", 36" and 42" forming widths. Each model has a power unit with enclosed housing mounted to the side frame of the machine and connected directly to the upper and lower rollers through a series of machine cut gears.

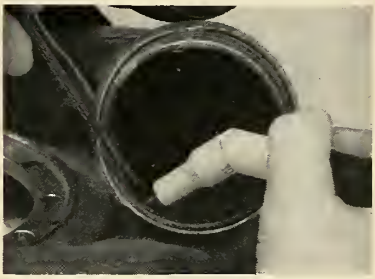
All forming rolls are ground and polished, the company said. Welded steel base extends the full length of the machine for permanent alignment of housing, bearings and rolls.

Standard equipment includes: calibrated rear roll indicators that enable the operator to adjust quickly the idler roll to a previous setting saving the time of rechecking the material for spring back; movable foot control, motor and all electrical equipment.

Fill in No. 151 on Subscriber Service Card.

Arc Welding Torch Is Compact, Lightweight

The Wilson Equipment Corp., of Paterson, N.J., has developed an inert gas shielded arc welding torch that is extremely compact and lightweight. This torch is aircooled, weighs 2¾ ozs. and handles currents from 5 to 150 amps. The overall head length of the angle torch (also available in straight model) is 1¾" with gas cup installed.



Durability is achieved by the use of laminated glass cloth and silicone resin to insulate the head. This material will neither char nor soften.

The lightweight cable remains flexible in all working temperatures, considerably reducing operator fatigue.

Fill in No. 152 on Subscriber Service Card.

Swayne, Robinson & Co. Improves Casting

Swayne, Robinson & Co. announces the development of a process for producing molds for castings by the new CO_2 molding method. This new method is particularly suited for castings designed for ultimate cost reduction through the elimination of machining.

Key to success in the process, according to the company, is proper sand mix. Considerable tests were made to determine proper balance of sand, binder and release agent to produce castings with exceptional fidelity of detail.

Gassing of the mold, the firm stated, is generally more efficient and economical than the shell method of baking since molds are cured in a cold state. Also, there is less chance of dimensional change due to uneven cool in sections of varying thickness as in shell mold baking.

Fill in No. 153 on Subscriber Service Card.

Subminiature Tool Makes Wire Wrapping Easy

The difficult problem of connecting wires to subminiature tube sockets and transistor sockets can be made easy with the subminiature wire wrapping tool manufactured by Winkler Laboratories. The tool makes secure electrical and mechanical connections.

The operation is extremely fast, very simple, and almost obvious. It takes three simple steps.

1. The end of the wire to be wrapped is inserted in the off-center hole of the tool.

2. The center hole of the tool is placed over the socket terminal to provide mechanical alignment.

3. The tool is spun with the fingers, wrapping the wire around the terminal.

During the wrapping, the wire is drawn out of the off-center hold. The rib on the end of the tool wraps the end of the wire neatly against the terminal; it is shaped to prevent snagging at the start of the wrapping operation. As the wrapping progresses, the tool is allowed to push itself away from the terminal. After wrapping, the connections may be soldered easily.

The difficulty of connecting wires to subminiature sockets has undoubtedly influenced other alternatives such as using printed circuit techniques and wiring tubes and transistors directly into the circuit. There is neither strength nor room to wrap size 22 awg (0.025 in. diameter) wire around terminals which are approximately 0.017 in. thick by 0.035 in. wide and spaced 0.096 in. center to center. It might be better to wrap the terminal around the wire. The practice of mounting components directly to subminiature socket terminals is similarly impractical; half watt resistors have size 20 (0.032 in. diameter) leads. For good joints, here are the important considerations.

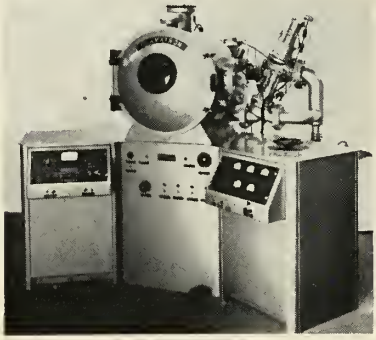
The conductor must be consistent in size with the terminal and its spacing. This can be accomplished if 28 awg wire is used. Under no circumstances should wire larger than size 26 be used.

Some acceptable means must be available to secure mechanically the wire to the terminal.

Fill in No. 154 on Subscriber Service Card.

Production Welder Uses High Velocity Electrons

High Vacuum Equipment Corp., manufacturer of vacuum processing equipment, has introduced a production welder utilizing the concentrated energy of a focused beam of high velocity electrons to weld metals.



These new welders, termed BEAMATRON will be used to weld those high temperature reactive metals and super-alloys important in today's nuclear, electronic and missile hardware. They are capable of welding metals ranging from aluminum to zirconium. By this process, it is possible to weld tungsten, tantalum or molybdenum to each other or to other metals, with results unobtainable by previously known methods.

The use of electrons in welding is possible only in a high vacuum, hence the union of electronic and vacuum techniques to produce a new welding process.

BEAMATRON equipment is effective in applications involving metals which react unfavorably with minute amounts of oxygen, nitrogen or hydrogen. It is a notable improvement over other welding processes such as the dry-box or shielded arc. Operation in high vacuum provides the most inert atmosphere—an atmosphere many times more pure than the best commercially available inert gases. Because most impurities trapped in metal become volatile in the high operating vacuum of the BEAMATRON, the entire weld zone, not just the surface is purified. The net result is a weld joint with physical properties and life expectancies which cannot be obtained by other means. At the same time the unit cost of such items as nuclear fuel jackets and electronic parts is reduced by the elimination of costly shielding atmospheres and the reduction of rejects.

Fill in No. 155 on Subscriber Service Card.

Uniweld Process Offered for Space Vehicles

Menasco Manfacturing Co. has successfully applied its Uniweld process to extremely light weight spherical and cylindrical pressure vessels for space age vehicles.

Qualification testing to rigid customer specifications have been completed on several sizes of vessels constructed of both titanium alloy and high heat treat steels. Among the most unique of these is a cylindrical tank believed to be the largest yet made in titanium alloy. Approximately 9 inches in length and 14 inches in diameter, it contains liquid helium at 3,900 pounds per square inch pressure and yet weighs only 275 pounds.

While Menasco has produced over 6,000 missile pressure vessels, these new vessels represent the first application of Uniweld to tanks utilizing the latest in high strength, low weight materials. The consistent high strength of the Uniwelds, made under completely automatic machine control, also allows the company to offer a vessel with the maximum in reliability factor which is so extremely important in the space travel industry.

Fill in No. 156 on Subscriber Service Card.

TUBULAR ENGINE and FRAME COMPONENTS for
AIRCRAFT, MISSILES and INDUSTRIAL use

- in Rigid, Convoluted, Flexible Forms.
- from ALL Metal Materials.
- including processes of Swaging, Floring, Beading, Piercing, Brazing, Welding, Bending, Vapor Blasting, Anodizing, Silver and Nickel Plating.
- with Hydrostatic, Radiographic, Temperature, Instrument, Flow, Hypotentiometer and Resistance Qualifying Tests — with U.S.A. and C.A.A. surveillance.



ENGINEERING REPRESENTATION AT MOST SIGNIFICANT CENTERS

THE BEATON & CORBIN MFG. CO.

328 North Main St. • Southington, Conn., U.S.A. | Telephone: MArket 8-4747

Fill in No. 6 on Subscriber Service Card.

MATERIALS AND METALS

Product Directory

Since Materials and Metals is a new category with this edition, a complete listing of products and manufacturers is listed within this section rather than in the MISSILE PRODUCT DIRECTORY, which appears in the last part of this book. As with the regular Product Directory, company names and addresses can be found in the MISSILE PURCHASING DIRECTORY which begins on page 111.

LOYS, HIGH PERMEABILITY

Accurate Specialties Co. Inc.
Alad Aluminum Ladder Corp.
All Baro Metal Products Co., Inc.
Allegheny Ludlum Steel Corp.
Alloys Unlimited Inc.
Aluminum Co. of America
American Hinge Corp.
American Silver Co.
Arnold Engrg. Co., The
AVCO MFG. CORP., NASHVILLE DIV.
Belmont Smelting & Refining Works, Inc.
Benson Mfg. Co., The
Bishop & Co., Platinum Works
Bond Metal Surplus Co.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Byrne Doors Inc.
Carpenter Steel Co., The
Consolidated Wire & Associated Companies
Continental Metals, Inc.
Crucible Steel Co. of America
Delta Chemical Works, Inc.
Electric Steel Foundry Co.
Electronic Parts Mfg. Co., Inc.
Hamilton Watch Co.
Hamilton Watch Co.—Industrial Div.
Handy & Harman
International Nickel Co., The
Karle M. Jorgensen Co.
Kelsey-Hayes Co.
Kelcast Industries—Div. Thompson Ramo Wooldridge Inc.
Lucas Aircraft Supply Co.
Magnetic Shield Div. Perfection Mica Co.
Mercast Mfg. Corp.
Nesor Alloy Products Co.
Nereg Mfg. Inc.
Ow. Renneburg & Sons Co.
Joseph T. Ryerson & Son, Inc.
Timken Roller Bearing Co., The
U. S. Steel Supply Div., United States Steel Corp.
Universal-Cyclops Steel Corp.
Wascolay-Ramet Corp.
Vaimet Alloys Co., Div. Consolidated Foundries & Mfg. Corp.
Waukesha Foundry Co.
Western Gold & Platinum Co.
Westinghouse Electric Corp.
Westinghouse Electric Corp., Metals Plant

ALUMINUM

Accurate Specialties Co. Inc.
Adam Metal Supply Inc.
Advance Carbon & Electric Mfg. Co.
Alloys Unlimited Inc.
American Brazing Alloys Co.
American Nickel Alloy Mfg. Corp.
American Silver Co.
American Smelting & Refining Co.
Anchor Metal Co. Inc.
AVCO MFG. CORP., NASHVILLE DIV.
Avion Foundry Corp.
Baker Steel & Tube Co.
Belmont Smelting & Refining Works, Inc.
Bridgeport Brass Co.
Chase Brass & Copper Co., Inc.
Continental Metals, Inc.
Copperweld Steel Co., Wire & Cable Div.
Dalweld Co. Inc.
Delta Chemical Works, Inc.
Devcon Corp.
Doehler-Jarvis Div., National Lead Co.
Empire State Aluminum Corp.
Fomson Orban Co., Inc.
Hamilton Watch Co.-Industrial Div.
Harvey Aluminum
Kaiser Aluminum & Chemical Sales, Inc.
Kelcast Industries—Div.— Thompson Ramo Wooldridge Inc.
Light Metals, Inc.
Lucas Aircraft Supply Co.
LYCOMING DIV., AVCO MFG. CORP.
Matheson Co., Inc., The
Mueller Brass Co.
National Metallurgical Corp.
Nesor Alloy Products Co.
Ohio Precision Castings, Inc.
Perfect Paul & Stein Brothers, Inc.
Peerless Machine Co.
Precision Castings, Inc.
Precision Shapes, Inc.
Precision Tube Co., Inc.
Reynolds Metals Co.
Sidney Metals Inc.
Scovill Mfg. Co.
Wayne, Robinson & Co.
Wed Mineral & Chemicol Corp.
Vanadium Corp. of America
Wellman Bronze & Aluminum Co.
Wisconsin Aluminum Foundry Co., Inc.

ANTIMONY

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
American Smelting & Refining Co.
Barium & Chemicals, Inc.
Bow Solder Products Co., Inc.
Bram Metallurgical & Chemical Co.
Division Lead Co.
Lamtex Industries, Inc.
Matheson Co., Inc., The
National Lead Co.
Nesar Alloy Products Co.
Ohio Semiconductors, Inc.
Raybestos-Manhattan, Inc.
United Mineral & Chemical Corp.

ASBESTOS

Abesto Corp.
Allied Plastics Supply Corp.
American Smelting & Refining Co.
Armstrong Cork Co.
Auburn Mfg. Co., The
Eagle-Picher Co., The
Electrical Insulation Co., Inc.
Gatke Corp.
General Gasket Inc.
Johns-Manville
Johns-Manville Sales Corp.
Matheson Co., Inc., The
Raybestos-Manhattan, Inc., Pa.
Union Asbestos & Rubber Co.
United States Rubber Co.
Zippertubing Co., The

ASPHALT

Ashland Oil & Refining Co.
Belmont Smelting & Refining Works, Inc.
Delta Chemical Works, Inc.
Esso Standard Oil Co.
Matheson Co., Inc., The
Zophar Mills Inc.

BARIUM

Alloys Unlimited Inc.
Barium & Chemicals, Inc.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical & Chemical Co.
Consolidated Wire & Associated Companies
Delta Chemical Works, Inc.
Matheson Co., Inc., The
Mercast Mfg. Corp.
United Mineral & Chemical Corp.

BERYLLIUM

Accurate Specialties Co. Inc.
American Beryllium Co.
Belmont Smelting & Refining Works, Inc.
Beryllium Corp., The
Bios Labs., Inc.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Brush Beryllium Co., The
Damascus Tube Co.
***LYCOMING DIV., AVCO MFG. CORP**
P. R. Mallory & Co. Inc.
Metals & Controls Corp., General Plate Div.
Miniature Precision Bearings, Inc.
Nesor Alloy Products Co.
Ohio Precision Castings, Inc.

BORON

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
***AMERICAN POTASH & CHEMICAL CORP.**
Belmont Smelting & Refining Works, Inc.
Bond Metal Surplus Co.
Bram Metallurgical & Chemical Co.
Callery Chemical Co.
Dalweld Co. Inc.
George K. Garrett Co., Inc.
Lucas Aircraft Supply Co.
Matheson Co., Inc., The
Norton Co., New Products Dept.
Shenango Furnace Co., The, Centrifugally Cast Products Div.
Waukesha Foundry Co.

BRASS

Advance Carbon & Electric Mfg. Co.
American Brake Shoe Co.
American Brass Co., The
American Hinge Corp
American Silver Co.
American Smelting & Refining Co.
Bearium Metals Corp.
Belmont Smelting & Refining Works, Inc.
Bond Metal Surplus Co.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Bristol Brass Corp., The
Chase Brass & Copper Co., Inc.
Dalweld Co. Inc.
Damascus Tube Co.
Doehler-Jarvis Div., National Lead Co.
Fromson Orban Co., Inc.
George K. Garrett Co., Inc.
Hamilton Watch Co.—Industrial Div.
Harvey Aluminum
Mercast Mfg. Corp.
Mueller Brass Co.
Nesor Alloy Products Co.
Ohio Precision Castings, Inc.
Peerless Machine Co.
Phelps Dodge Copper Products Corp.
Precision Shapes, Inc.
Scovill Mfg. Co.
Shenango Furnace Co., The, Centrifugally Cast Products Div
Somers Brass Co. Inc.
Titan Metal Mfg. Co.
Waukesha Foundry Co.
Wisconsin Aluminum Foundry Co., Inc.

BRONZE

American Brake Shoe Co.
American Brass Co., The
American Hinge Corp.
American Silver Co.
American Smelting & Refining Co.
Ampco Metal, Inc.
Bearium Metals Corp.
Belmont Smelting & Refining Works, Inc.
Bond Metal Surplus Co.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Bristol Brass Corp., The
Chase Brass & Copper Co., Inc.
Consolidated Wire & Associated Companies
C. Lee Cook Co., Airtomic Products Div.
Dalweld Co. Inc.
Damascus Tube Co.
George K. Garrett Co., Inc.
Hamilton Watch Co.—Industrial Div.
Lucas Aircraft Supply Co.
Mercast Mfg. Corp.
Mueller Brass Co.
Nesor Alloy Products Co.
Ohio Precision Castings, Inc.
Peerless Machine Co.
Phelps Dodge Copper Products Corp.
Precision Shapes, Inc.
Randall Graphite Bearings, Inc.
Saginaw Bearing Co.
Scovill Mfg. Co.
Somers Brass Co. Inc.
Titan Metal Mfg. Co.
Wisconsin Aluminum Foundry Co., Inc.

BRONZE, PHOSPHOR

American Brass Co., The
American Brazing Alloys Co.
American Silver Co.
Ampco Metal, Inc.
Belmont Smelting & Refining Works, Inc.
Bios Labs., Inc.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Chase Brass & Copper Co., Inc.
Damascus Tube Co.
George K. Garrett Co., Inc.
Hamilton Watch Co.
Hamilton Watch Co.—Industrial Div.
Lucas Aircraft Supply Co.
Mueller Brass Co.
Nesor Alloy Products Co.
Precision Shapes, Inc.
Randall Graphite Bearings, Inc.
Saginaw Bearing Co.
Scovill Mfg. Co.
Somers Brass Co. Inc.
Wisconsin Aluminum Foundry Co., Inc.

CADMIUM

Accurate Specialties Co. Inc.
Allied Research Products, Inc.
Alloys Unlimited Inc.
American Silver Co.
American Smelting & Refining Co.
Anchor Metal Co. Inc.
Belmont Smelting & Refining Works, Inc.
Bios Labs., Inc.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Division Lead Co.

Eagle-Picher Co., The
Hamilton Watch Co —Industrial Div.
Lucas Aircraft Supply Co
P R Mallory & Co. Inc
Matheson Co , Inc. The
Nesor Alloy Products Co
United Mineral & Chemical Corp.

CALCIUM

Alloys Unlimited Inc
Beryllium Corp , The
Bios Labs , Inc
Brom Metallurgical & Chemical Co.
Matheson Co., Inc., The
Metal Hydrides Inc.
Republic Lens Co Inc.
Union Carbide Metals Co., Div —Union Carbide Corp.

CARBIDES

Allegheny Ludlum Steel Corp.
Brom Metallurgical & Chemical Co.
Carbone Corp., The
Carborundum Co., Refractories Div.
Firth Sterling Inc.
General Electric Co , Metallurgical Products Dept.
Kennametal Inc
Linde Co., Div —Union Carbide
Lucas Aircraft Supply Co.
National Lead Co
Norton Co.
Norton Co., New Products Dept
Union Carbide Metals Co., Div —Union Carbide Corp.
United Mineral & Chemical Corp.
Vascolay-Ramet Corp.
Wayne Pump Co., The, Div.—Symington Wayne Corp.

CARBON

American Nickel Alloy Mfg. Corp
Barnebey-Cheney Co.
Carbone Corp., The
Delta Chemical Works, Inc.
Great Lakes Carbon Corp.—Electrode Div
Helwig Carbon Products, Inc.
Kolcast Industries—Div., Thompson Ramo Wooldridge Inc.
Louthan Mfg Co., The, Div.—Ferro Corp.
Morganite, Inc.
Ohio Carbon Co., The
Peerless Machine Co.
Joseph T. Ryerson & Son, Inc.
St. Marys Carbon Co.
Stackpole Carbon Co.
Superior Carbon Products, Inc.
United Carbon Products Co.

CERAMICS

Aerojet-General Corp.
American Lava Corp.
American Refractories & Crucible Corp
Auburn Spark Plug Co., Inc
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Beryllium Corp., The
Bios Labs., Inc.
Carbone Corp., The
Carborundum Co., Latrobe Plant, Refractories Div
Carborundum Co., Refractories Div
Centralab, Div —Globe-Union
Cooper Development Corp., Sub.—Marquardt Aircraft Co.
Corning Glass Works
Curtiss-Wright Corp., Research Div
Curtiss-Wright Corp., Santa Barbara Div
Diamonite Products Mfg Co.
Duramic Products Inc
Dyna-Therm Chemical Corp.
Electric Auto-Lite Co., The
Electrical Refractories Co., The
Emerson & Cuming, Inc
General Electric Co., Insulator Dept
General Electric Co , Metallurgical Products Dept.
Gladding, McBean & Co.
Haveg Industries, Inc.
Haynes Stellite Co., Div —Union Carbide Corp.
International Resistance Co.
Isolantite Mfg. Corp
Linde Co., Div —Union Carbide
Maryland Lava Co.
Metallizing Co. of Los Angeles Inc.
Minneapolis-Honeywell Regulator Co., Ordnance Div
Minnesota Mining & Mfg. Co.
Mitronics Inc
Motorola Inc , Military Electronics Div
National Beryllia Corp.
National Lead Co.
Norton Co.
Norton Co., New Products Dept
Pittsburgh Corning Corp
Radar Design Corp.
Rogers Corp.
Thermal Refractories Corp.
Topper Mfg Co., Inc
Trionics Corp.
United Mineral & Chemical Corp
Vascolay-Ramet Corp.
Western Gold & Platinum Co.
Zirconium Corp of America

CESIUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc
***AMERICAN POTASH & CHEMICAL CORP.**
Belmont Smelting & Refining Works, Inc.
Bios Labs., Inc
Brom Metallurgical & Chemical Co
Matheson Co., Inc., The
United Mineral & Chemical Corp

CHEMICALS, DEHUMIDIFYING

Aluminum Co. of America
Barium & Chemicals, Inc.
Belmont Smelting & Refining Works, Inc.
Bios Labs., Inc.
Borden Chemical Co.
Dow Chemical Co., The
Drierite, Inc.
Fisher Scientific Co.
Foote Mineral Co.
Matheson Co., Inc., The
Merix Chemical Co.
Metal Hydrides Inc.
United Mineral & Chemical Corp.

CHEMICALS, ELECTROPLATING

***ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.**
Allied Research Products, Inc
American Smelting & Refining Co.
J. T Baker Chemical Co.
Barium & Chemicals, Inc.
Belmont Smelting & Refining Works, Inc.
J. Bishop & Co., Platinum Works
Delta Chemical Works, Inc.
E I. Du Pont de Nemours & Co. Inc.
Engelhard Industries, Inc.
Penetone Co., The
Sel-Rex Corp.
Shell Chemical Corp., Industrial Chemicals Div
Wildberg Bros. Smelting & Refining Co.
Wyandotte Chemicals Corp.

CHROMIUM

Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
Brom Metallurgical & Chemical Co.
Hoskins Mfg. Co.
Kolcast Industries—Div. Thompson Ramo Wooldridge Inc.
Matheson Co., Inc., The
Joseph T. Ryerson & Son, Inc.
Union Carbide Metals Co., Div —Union Carbide Corp.
United Mineral & Chemical Corp.
Vanadium Corp. of America

CLOTH, GLASS

Aerojet-General Corp.
Allied Plastics Supply Corp.
American Machine & Foundry Co., Government Products Group
Auburn Mfg. Co., The
Aviation Textile Associates
Bellofram Corp.
Birma Mfg. Co. Inc.
Coast Mfg. & Supply Co.
Continental Can Co., Inc
C R Daniels, Inc.
Duracote Corp.
Eagle-Picher Co., The
Electro Technical Products Div. Sun Chemical Corp.
Emmco Plastic Fabricators—Div.—E M. McCarthy Machine Co
Haveg Industries, Inc.
Johns-Manville
Minnesota Mining & Mfg. Co.
Reinhold Engrg. & Plastics Co.
St. Regis Paper Co., Panelyte Div.

CLOTH, PLASTIC

Aerojet-General Corp.
Allied Plastics Supply Corp.
Auburn Mfg Co., The
Aviation Textile Associates
Blossom Mfg. Co. Inc.
Cordo Chemical Corp.
C. R Daniels, Inc.
Duracote Corp.
Electrical Insulation Co., Inc.
Emmco Plastic Fabricators—Div.—E. M. McCarthy Machine Co.
General Plastics Corp. of New Jersey
Johns-Manville
Kressilk Products, Inc.
Minnesota Mining & Mfg. Co.
New York Rubber Corp.
Plastic Film Co., Inc
St Regis Paper Co., Panelyte Div.
Schlegel Mfg. Co.
United States Rubber Co.
Zippertubing Co., The

CLOTH, RUBBERIZED

Asbesto Corp
Auburn Mfg Co., The
Aviation Textile Associates
J. Bishop & Co., Platinum Works
Cordo Chemical Corp.
C R Daniels, Inc
E. I. Du Pont de Nemours & Co. Inc.
Duracote Corp
Emmco Plastic Fabricators—Div.—E. M McCarthy Machine Co.
Gatke Corp.
Goodyear Tire & Rubber Co., The, Aviation Products Div
Hewitt-Robbins, Inc.
Johns-Manville
Minnesota Mining & Mfg. Co.
Permacel
Raybestos-Manhattan, Inc. Pa
Rez-Coat of California
Schlegel Mfg. Co.
United States Rubber Co.

CLOTHS, WOVEN WIRE

Aviation Textile Associates
Birma Mfg Co. Inc.
Buffalo Wire Works Co., Inc.
Chase Brass & Copper Co., Inc
Flock Process Co., Inc.
Goodyear Tire & Rubber Co , The, Aviation Products Div
Hewitt-Robins, Inc.
International Nickel Co., The
Kressilk Products, Inc.
Lofstrand Co., The
National-Standard Co.
Republic Steel Corp.
Schlegel Mfg. Co.

COATINGS

a. Conductive-tube interior
b. Finishing
c. High temperature
d. Printed circuit
e. Protective
f. Salt spray resistance
g. Special purpose

Acheson Colloids Co., Div.—Acheson Industries, Inc., **a, c, d.**
Aerojet-General Corp., **c, g.**
Allied Research Products, Inc., **b, e, f.**
American Latex Products Corp., **c, e, f, g.**
American Optical Co., Instrument Div., **g.**
American Rocket Co., **b, e, g.**
American Solder & Flux Co., **e, f.**
Arco Co., The, **b, e.**
Aries Laboratories, Inc., **c thru g.**
Ashland Oil & Refining Co., **e, f, g.**
Atlas Precision Products, Co., **b, e.**
Bart Mfg. Corp., **e, f, g.**
George Basch Co., The, **e, g.**
Belmont Smelting & Refining Works, Inc., **g.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., c, e, f, g.**
Carl H. Biggs Co., **b thru g.**
J. Bishop & Co., Platinum Works, **h.**
Borden Chemical Co., **a, b, c, e, f, g.**
Boston Insulated Wire & Cable Co., **c, e.**
Carboline Co., **e, f, g.**
Carbone Corp., The, **c.**
Carborundum Co., Refractories Div., **c, g.**
Chemplast, Inc., **c, g.**
Columbia Technical Corp., **b thru g.**
Consolidated Electrodynamics Corp., **c.**
Cordo Chemical Corp., **e, f, g.**
Curtiss-Wright Corp., Research Div., **c.**
Curtiss-Wright Corp., Santa Barbara Div., **c, g.**
Delta Chemical Works, Inc., **a thru g.**
Devcon Corp., **e, f, g.**
Division Lead Co., **d.**
***DOW CORNING CORP., c, e, g.**
E. I. Du Pont de Nemours & Co. Inc., **a thru g.**
Duracote Corp., **c, e, g.**
Duralith Corp., **e, f, g.**
Dyno-Therm Chemical Corp., **c, f, g.**
Eagle-Picher Co., The, **b, c, e.**
Eastman Kodak Co., **d.**
Eaton Electronics Corp., **d.**
Ed-Berl Products, Inc., **c, e, f.**
Electro Technical Products Div. Sun Chemical Corp., **c.**
Emerson & Cuming, Inc., **a thru g.**
Emmco Plastic Fabricators—Div.—E M. McCarthy Machine Co., **b, e, g.**
Engelhard Industries, Inc., **d, e.**
Esso Standard Oil Co., **e, f, g.**
Fidelity Chemical Products Corp., **d, f, g.**
Fluorocarbon Co., The, **g.**
Fluorulon Labs., Inc., **f, g.**
Furane Plastics, Inc. **c thru f.**
General Plastics Corp. of New Jersey, **c, g.**
B. F. Goodrich Industrial Products Co., **d.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **e, f.**
Grant Chemical Co., Inc., **c, e, f, g.**
Green Rectifier Co., **g.**
Gulton Industries, Inc., **c, e.**
Haveg Industries, Inc., **c.**
R M. Hollingshead Corp., **e.**
E F. Houghton & Co., **e, f.**
Houghton Laboratories, Inc., **d, e, g.**
Huntington Rubber Mills, **e.**
Industrial Metal Protectives, Inc., **e.**
Integrated Mica Corp., **c.**
International Nickel Co., The, **f, g.**
Johns-Manville, **c, e, g.**
Kano Labs, **b, e.**
Kinney Mfg. Div., The New York Air Brake Co., **c, g.**
Kressilk Products, Inc., **d.**
Krylon, Inc. **a, b, d, e, f.**
Lebec Chemical Corp., **c, e, f, g.**
Liberty Mirror Div., Libbey-Owens-Ford Glass Co., **g.**
Linde Co., Div.—Union Carbide, **b, c, e, g.**
London Chemical Co., Inc., **c thru g.**
Maas & Waldstein Co , **a, b, d thru g.**
Marblette Corp., The, **d, e.**
Marquardt Aircraft Co , **c.**
Merix Chemical Co , **a, b, e, g.**
Metalectro Lab., **a, b, c, e, f, g.**
Metallizing Co. of Los Angeles Inc., **c thru g.**
Metaplast Co. Inc.
Micro-Circuits Co., **a, e, f, g.**
Midland Industrial Finishes Co., **a thru f.**
Minnesota Mining & Mfg. Co., **d, e, g.**
Minnesota Mining & Mfg. Co.—Adhesives, Coating & Sealers Div., **e, f, g.**
Minnesota Rubber Co., **e.**
Mitronics Inc., **a, c.**
Narmco Resins & Coatings Co., **c, e.**
National Beryllia Corp., **c.**
National Research Corp., **c, f.**
Nesor Alloy Products Co., **g.**
New England Tape Co., Div.-United-Carr Fastener Corp., **a, e, g.**
Norton Co., **c, e, g.**
Norton Co., New Products Dept , **c, e, g.**
Optical Coating Lab., Inc., **g.**
Penetone Co., The, **g.**
Pennsalt Chemicals Corp., **e, f.**
Permacel, **c thru f.**
Joseph E. Podgor Co., Inc., **a, d.**
Polymer Corp., The, **b, e, f, g.**
Products Research Co., **c thru g.**
Protex-A-Cote, Inc., **b, c, e, f, g.**

Raybestos-Manhattan, Inc., **e.**
Raybestos-Manhattan, Inc., Pa., **e.**
Reinhold Engrg. & Plastics Co., **c, e, g.**
Republic Lens Co. Inc., **e, g.**
Saureisen Cements Co., **c, e.**
Sel-Rex Corp., **d, g.**
Servwell Products Co., **g.**
W. S. Shamban & Co., **d.**
Sierracin Carp., The, **g.**
Silicones Div.-Union Carbide Carp., **c, e, f.**
Skycraft Tool Engrg. Co., **f.**
Thiokol Chemical Corp., **e.**
Thomas Electronics, Inc., **a, b.**
Arthur Tickle Engrg. Works, Inc., **c, e, g.**
Topper Mfg. Co., Inc., **a, c thru g.**
Trionics Corp., **c thru g.**
Turco Products, Inc., **e, f, g.**
United States Chemical Milling Corp., **d.**
Vitro Labs., **a, b, c, e, g.**
Vorac Co., The, **b, c, e, f, g.**
Western Coating Co., **e, g.**
Westline Products Div.—Western Lithograph Co., **f.**
X-Pando Corp., **e, f, g.**
Zenith Optical Laboratory, **g.**
Zippertubing Co., The, **a, c, e, f, g.**
Zirconium Corp. of America, **c.**
Zophar Mills Inc., **d thru g.**

BALT

Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical & Chemical Co.
Delta Chemical Works, Inc.
Foote Mineral Co.
Haynes Stellite Co., Div.—Unian Carbide Corp.
International Nickel Co., The
Kolcast Industries—Div. Thompson Rama Wooldridge Inc.
Matheson Co., Inc., The
Mercast Mfg. Carp.
National Lead Co.
Waimet Alloys Co., Div. Consolidated Foundries & Mfg. Corp.

LUMBIUM METALS

American Silver Co.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Damascus Tube Co.
Delta Chemical Works, Inc.
Hamilton Watch Co.
Hamilton Watch Co.—Industrial Div.
Kennametal Inc.
Kolcast Industries—Div.—Thompson Rama Wooldridge Inc.
***MALLORY-SHARON METALS CORP.**
Metals & Controls Corp., General Plate Div.
National Research Corp.
Somers Brass Co. Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Union Carbide Metals Co., Div.—Union Carbide Corp.
Universal-Cyclops Steel Corp.
Vanadium Corp. of America
Waimet Alloys Co., Div. Consolidated Foundries & Mfg. Corp.
Westinghouse Electric Corp., Metals Plant

MPOUNDS

a. Calking & sealing
b. Electrical insulating & sealing
c. Encapsulating
d. Impregnating
e. Mica
f. Phenolic molding
g. Potting
h. Waterproofing

Acheson Colloids Co., Div.—Acheson Industries, Inc.
Adhesive Engrg., Div.—Hiller Aircraft Corp. **b, c, g.**
Alloys Unlimited Inc.
American Latex Products Corp., **a, c, d, g, h.**
Anchor Metal Co. Inc., **a.**
Arco Co., The, **a, h.**
Aries Laboratories, Inc., **b, c, d, f.**
Armstrong Cork Co., **a, b, g, h.**
Bacon Industries, Inc., **c, d, g.**
George Basch Co., The, **d.**
Belmont Smelting & Refining Works, Inc., **g.**
Carl H. Biggs Co., **a thru e, g, h.**
Borden Chemical Co., **a thru d, f, g, h.**
Carboline Co., **a, h.**
Carborundum Co., Refractaries Div., **a, b, c, g.**
Chicago-Allis Mfg. Corp., **d.**
Ciba Products Corp., **c, g.**
Coast Mfg. & Supply Co., **f.**
Cooper Industries, Inc., **a.**
Curtiss-Wright Corp., Research Div., **c.**
Dayton Rubber Co., The, **a, b, c, g, h.**
Delta Chemical Works, Inc., **a thru g.**
Devcon Carp., **a, b, c, g, h.**
***DOW CORNING CORP., a thru d, g, h.**
E. I. Du Pont de Nemours & Co. Inc., **a, b, c, g, h.**
Duracote Carp., **d, h.**
Durez Plastics Div.—Hooker Chemical Corp., **f.**
Dyna-Therm Chemical Corp., **c, d.**
Eagle-Picher Co., The, **h.**
Eco Engrg. Co., **a.**
Ed-Berl Products, Inc., **h.**
Emerson & Cuming, Inc., **a thru d, f, g.**
Fluorocarbon Co., The, **b.**
Foote Mineral Co., **c, e, g.**
Form-It Products, Inc., **f, h.**
Furane Plastics, Inc., **a thru d, f, g, h.**
Grant Chemical Co., Inc., **a thru d, f, g.**
Haveg Industries, Inc., **b thru h.**
Houghton Laboratories, Inc., **b, c, d, g.**
Johns-Manville, **a, b, d, h.**
Lamtex Industries, Inc., **a, b, c, g, h.**
Lebec Chemical Corp., **d, f, g, h.**
Leffingwell Chemical Co., **g, h.**
Magnetic Shield Div. Perfection Mica Co., **e.**
Marblette Corp., The, **a, b, c, d, g.**
Micacraft Products Inc., **e.**
Midland Industrial Finishes Co., **g.**
Minnesota Mining & Mfg. Co., **a thru h.**
Minnesota Mining & Mfg. Co.—Adhesives, Coating & Sealers Div., **a, b, g, h.**
Narmco Resins & Coatings Co.
National Engrg. Products, Inc., **a, b, c, g.**
New England Tape Co., Div.—United-Carr Fastener Corp., **b, d, g, h.**
Nopco Chemical Co., **c, g.**
Pennsalt Chemicals Corp., **g.**
Permacel, **a thru d, g, h.**
Permatex Co., Inc., **a.**
Products Research Co., **a, b, c, g, h.**
Protex-A-Cote, Inc., **a thru d, g, h.**
Raybestos-Manhattan, Inc., Pa., **a, f, g, h.**
***REDEL INC., a.**
Reichhold Chemicals, Inc., **f.**
Reinhold Engrg. & Plastics Co., **a, c, d, f, g.**
Rez-Coat of California, **f.**
Saureisen Cements Co., **a, b, c, f.**
Seal-Peel, Inc., **a, g, h.**
Servwell Products Co., **d.**
Shell Chemical Corp., Industrial Chemicals Div., **c, d, g.**
Silicones Div.—Union Carbide Corp., **a thru h.**
Smooth-On Mfg. Co., **a, b, c, g, h.**
Special Projects Lab., Food Machinery & Chemical Corp., **g.**
Thiokol Chemical Corp., **a, b, h.**
Topper Mfg. Co., Inc., **a thru d, g, h.**
Trio Chemical Works, Inc., **h.**
Trionics Corp., **g, h.**
United States Rubber Co., **c, d.**
Westinghouse Electric Corp., **b.**
X-Pando Corp., **a, c, h.**
Zophar Mills Inc., **a thru d, g, h.**

CONES, METAL

American Brake Shoe Co.
Belmont Smelting & Refining Works, Inc.
Brooks & Perkins, Inc.
Consolidated Wire & Associated Companies
Delta Chemical Works, Inc.
Diversey Engrg. Co.
Dresser Industries, Inc.
Farwell Metal Fabricating
General Communication Co.
General Electric Co., Missile & Space Vehicle Dept.
Kaiser Aircraft & Electronics, Div.—Kaiser Industries Corp.
Kaiser Metal Products, Inc.—Fleetwings Div.
C. B. Kaupp & Sons, Inc.
Kelsey-Hayes Co.
Kling Metal Spinning & Stamping Co.
Lukens Steel Co.
***LYCOMING DIV., AVCO MFG. CORP.**
Metal Textile Corp., Electronics Div.
Nippert Electric Products Co., The
Peerless Machine Co.
Superior Spinning & Stamping Co.
United States Chemical Milling Corp.

COPPER

Acme Mfg. & Gasket Co.
Allied Research Products, Inc.
American Brass Co., The
American Brazing Alloys Co.
American Hinge Corp.
American Nickel Allay Mfg. Corp.
American Silver Co.
Anchor Metal Co. Inc.
J. T. Baker Chemical Co.
Belmont Smelting & Refining Works, Inc.
Bond Metal Surplus Co.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Chase Brass & Copper Co., Inc.
Copperweld Steel Co., Wire & Cable Div.
Deringer Metallurgical Corp.
Fromson Orban Co., Inc.
George K. Garrett Co., Inc.
Hamilton Watch Co.—Industrial Div.
Kensico Tube Co. Inc.
Matheson Co., Inc., The
Mueller Brass Co.
Phelps Dodge Copper Products Corp.
Precision Tube Co., Inc.
Sel-Rex Corp.
Standard Metals Corp.
Superior Carbon Products, Inc.

CORK

Acme Mfg. & Gasket Co.
Armstrong Cork Co.
Auburn Mfg. Co., The
General Gasket Inc.

FABRIC

Aero Leather Products Co.
Bemis Brothers Bag Co.
Coast Mfg. & Supply Co.
Cooper Industries, Inc.
C. R. Daniels, Inc.
Duracote Corp.
Johns-Manville
Schlegel Mfg. Co.
W. S. Shamban & Co.
United States Rubber Co.

FELT & FELT PARTS

Acme Mfg. & Gasket Co.
Aero Leather Products Co.
American Felt Co.
Armstrong Cork Co.
Auburn Mfg. Co., The
Aviation Textile Associates
Booth Felt Co. Inc.
Boston Felt Co.
Commonwealth Felt Co.
Delta Chemical Works, Inc.
E. I. Du Pont de Nemours & Co. Inc.
Felters Co., The
General Gasket Inc.
National Felt Co.
W. S. Shamban & Co.
Western Felt Works & Acadia Synthetic Products Div.

FERRIC OXIDES

Columbian Carbon Co., Mapica Iron Oxides Unit
Delta Chemical Works, Inc.
***KEARFOTT CO., INC.**
Matheson Co., Inc., The
Minnesota Mining & Mfg. Co.
United Mineral & Chemical Carp.
Vitro Labs.

FERRITES

Crucible Steel Co. of America
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Santa Barbara Div.
DBM Research Corp.
Ferroxcube Corp. of America
***KEARFOTT CO., INC.**
Matheson Co., Inc., The
Motorola Inc., Military Electronics Div.
National Moldite Co.
Stackpole Carbon Co.
Trionics Corp.
United Mineral & Chemical Corp.
Vitro Labs.

FIBER GLASS

Aerojet-General Corp.
Air Logistics Corp.
Aircraft Porous Media, Inc.
Allied Plastics Supply Corp.
Almac Plastics Inc.
American Rocket Co.
Apex Reinforced Plastics, Div.—White Sewing Machine Corp.
Auburn Mfg. Co., The
Aviation Textile Associates
Coast Mfg. & Supply Co.
DBM Research Corp.
Duracote Corp.
Eagle-Picher Co., The
Electrical Insulation Co., Inc.
Emmco Plastic Fabricators—Div.—E. M. McCarthy Machine Co.
Gustin-Bacon Mfg. Co.
Hardman Tool & Engrg., Co.
Haveg Industries, Inc.
Johns-Manville
Johns-Manville Sales Carp.
Narmco Mfg. Co.
Reinhold Engrg. & Plastics Co.
W. S. Shamban & Co.
Skydyne, Inc.
Swedlow Inc.
H. I. Thompson Fiber Glass Co.
United States Chemical Milling Carp.
Universal Moulded Products Corp.
Wenzlau Engrg. Co.
Westinghouse Electric Corp.

FIBER GLASS REINFORCED PLASTICS

Aero Gasket Corp.
Aerojet-General Corp.
Air Logistics Corp.
Allied Plastics Supply Carp.
Almac Plastics Inc.
American Aerophysics Corp.
American Printed Circuits Co., Inc.
American Rocket Co.
Apex Reinforced Plastics, Div.—White Sewing Machine Corp.
Aristocrat Plastics, Inc.
Astrodyne, Inc.
Atkins & Merrill, Inc.
Carl H. Biggs Co.
Bonny Mfg. Carp.
Boston Insulated Wire & Cable Co.
Bow Solder Products Co., Inc.
Calfibe Co., Inc.
Chemplast, Inc.
Coast Mfg. & Supply Co.
Colonial Aircraft Corp.
Columbia Products Co.
Continental Can Co., Inc.
Continental Diamond Fibre Corp.
Cordo Chemical Corp.
Crystal-X Carp.
Curtiss-Wright Corp., Santa Barbara Div.
DBM Research Corp.
Delta Products Div.—Air Accessaries, Inc.
E. I. Du Pont de Nemours & Co. Inc.
Duracote Carp.
Durez Plastics Div.—Hooker Chemical Corp.
Electrical Insulatian Co., Inc.
Electro Technical Products Div. Sun Chemical Corp.
Eljay Corp.
Emerson & Cuming, Inc.
Emerson Plastics Corp.
Emmco Plastic Fabricatars—Div.—E. M. McCarthy Machine Co.
Engineered Plastics, Inc.
Form-It Products, Inc.
Franklin Fibre-Lamitex Corp.
General Plastics Corp. of New Jersey
Gering Products, Inc.
B. F. Goodrich Aviation Products
Goodyear Aircraft Corp.
Grant Chemical Co., Inc.
Hardman Tool & Engrg., Co.
Haveg Industries, Inc.
Hays Mfg. Co.
Honeycomb Co. af America, Inc.
Jarvis Corp.

Joclin Mfg. Co.
Johns-Manville
Johns-Manville Sales
H. Koch & Sons
Lamtex Industries, In
Liss Products, Inc
Lone Star Plastics Co
Thomas J. Long, Inc
Lunn Laminates, Inc
Mansfield Fabricators Inc.
Marblette Corp., The
McMillan Industrial Corp.
Mica Insulator Div.—Minnesota Mining & Mfg., Co.
Milam Electric Mfg. Co.
Minnesota Mining & Mfg. Co.
Narmco Mfg. Co.
Narmco Resins & Coatings Co.
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
Northern Plastics Corp
Penn Fibre & Specialty Co., Inc.
Perry Plastics, Inc.
Plastic Age Sales, Inc.
Printronics Corp.
Raybestos-Manhattan, Inc., Pa.
Reinhold Engrg. & Plastics Co.
Republic Aviation Corp
Rogers Corp.
Russell Reinforced Plastics Corp.
Ryan Aeronautical Co.
Scaife Co.—Div.—Wilson Bros.
W. S. Shamban & Co.
Skydyne, Inc.
Spaulding Fibre Co., Inc.
Specialty Engrg. & Electronics Co.
Stevens Products, Inc.
Swedlow Inc.
H. I. Thompson Fiber Glass Co.
Topper Mfg. Co., Inc.
U. S. Fiber & Plastics Corp.
United States Chemical Milling Corp.
United States Plywood Corp.
United States Rubber Co.
Universal Moulded Products Corp.
Wenzlau Engrg. Co.
Young Development Div., Hercules Powder Co.

FIBER, VULCANIZED

Acme Mfg. & Gasket Co.
Allied Plastics Supply Corp.
American Aerophysics Corp
Auburn Mfg. Co., The
Boston Insulated Wire & Cable Co.
Comco Plastics Inc.
Continental Diamond Fibre Corp.
Electrical Insulation Co., Inc.
Engineered Plastics, Inc.
Form-It Products, Inc.
Franklin Fibre-Lamitex Corp.
General Gasket Inc.
Haveg Industries, Inc.
Thomas J. Long, Inc.
Mansfield Fabricators Inc.
Milam Electric Mfg. Co.
National Vulcanized Fibre Co.
Penn Fibre & Specialty Co., Inc.
Rogers Corp.
Spaulding Fibre Co., Inc.
Taylor Fibre Co.
Wilmington Fibre Specialty Co.

GERMANIUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical & Chemical Co.
Delta Chemical Works, Inc.
Eagle-Picher Co., The
Knapic Electro-Physics
Metals & Controls Corp., General Plate Div.
Motorola Inc., Military Electronics Div.
Sylvania Electric Products Inc., Chemical & Metallurgical Div.
United Mineral & Chemical Corp.

GLASS INSULATION

Acme Wire Co.
Allied Plastics Supply Corp
American Machine & Foundry Co., Government Products Group
Auburn Mfg. Co., The
Boston Insulated Wire & Cable Co.
Corning Glass Works
Eagle-Picher Co., The
Electrical Insulation Co., Inc.
Gustin-Bacon Mfg. Co.
Johns-Manville Sales Corp
Lamtex Industries, Inc.
Mica Fabricating Co.
Pittsburgh Corning Corp.
Union Asbestos & Rubber Co.
Universal Moulded Products Corp
Wenzlau Engrg. Co.
Westinghouse Electric Corp.

GLASS, MICA-WOVEN OR LAMINATED

Allied Plastics Supply Corp.
American Machine & Foundry Co., Government Products Group
American Printed Circuits Co., Inc.
Boston Insulated Wire & Cable Co.
Continental Diamond Fibre Corp.
Deringer-Metallurgical Corp.
Duracote Corp
Electrical Insulation Co., Inc.
Haveg Industries, Inc.
Integrated Mica Corp.
Thomas J. Long, Inc.
Mica Fabricating Co.
Mica Insulator Div.—Minnesota Mining & Mfg., Co.
New England Laminates Co., Inc.
St. Regis Paper Co., Panelyte Div.
Sierracin Corp., The
Sterling Glass Corp
United Mineral & Chemical Corp.
Westinghouse Electric Corp.

GOLD

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Printed Circuits Co., Inc.
American Silver Co.
Attleboro Refining Co., Inc.
J. Bishop & Co., Platinum Works
Bram Metallurgical & Chemical Co.
Eastern Smelting & Refining Corp.
Engelhard Industries, Inc.
Engelhard Industries, Inc., D. E. Makepeace Div
Handy & Harman
M-W Labs., Inc.
Matheson Co., Inc., The
Metals & Controls Corp., General Plate Div.
Nesor Alloy Products Co.
J. M. Ney Co., The
Pacific Scientific Co.
Precision Electroplating Co.
Sel-Rex Corp.
Spectronic Plating Co., Inc., Div.—Spectranome Plating Co., Inc.
Standard Metals Corp.
United Mineral & Chemical Corp.
Western Gold & Platinum Co.
Wildberg Bros. Smelting & Refining Co.

GRAIN, ALUNDUM

Del's Tumbling Service
Thermal Refractories Corp.

GRAPHITE, COLLOIDAL

Acheson Colloids Co., Div.—Acheson Industries, Inc.
Delta Chemical Works, Inc.
Grafo Colloids Corp.

GRAPHITE, LUBRICATING

Acheson Colloids Co., Div.—Acheson Industries, Inc.
Carbone Corp., The
Dyna-Therm Chemical Corp.
Grafo Colloids Corp.
Helwig Carbon Products, Inc.
Permatex Co., Inc.
Randall Graphite Bearings, Inc.
Servwell Products Co.
Superior Carbon Products, Inc.
Topper Mfg. Co., Inc.

GREASES, VACUUM

***DOW CORNING CORP.**
Kinney Mfg. Div., The New York Air Brake Co.
Minnesota Mining & Mfg. Co.

INSULATION MATERIALS

a. Aluminum oxide
b. Asbestos
c. Ceramic
d. Fabric
e. Fibre
f. Glass
g. Glass Fibre
h. Nylon
i. Paper
j. Silicone compounds

Acme Wire Co., **h. i.**
Aero Gasket Corp., **b, g, h. j.**
Aero Leather Products Co., **f.**
Allied International Co.
Allied Plastics Supply Corp., **b, d thru i.**
Aluminum Co. of America, **a.**
American Latex Products Corp., **j.**
American Lava Corp., **a, c.**
American Refractories & Crucible Corp., **a, c.**
Auburn Mfg. Co., The, **b, d, e, g thru j.**
Auburn Spark Plug Co., Inc., **a, c.**
Aviation Textile Associates, **d, e, g, h.**
Bacon Industries, Inc., **j.**
J. T. Baker Chemical Co., **a.**
Bemis Brothers Bag Co., **d, i.**
Bendix Filter Div., Bendix Aviation Corp., **g.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., c.**
Bio-Rad Labs., **a.**
Birma Mfg. Co. Inc., **c, e, g.**
Calfibe Co., Inc., **g.**
Campco, Div.—Chicago Molded Products Corp., **h.**
Carborundum Co., Latrobe Plant, Refractories Div., **c, f.**
Carborundum Co., Refractories Div., **c, e.**
Centralab, Div.—Globe—Union, **c.**
Chemplast, Inc., **h.**
Coast Mfg. & Supply Co., **d.**
Colonial Rubber Co., **j.**
Comco Plastics Inc., **e, h, i.**
Connecticut Hard Rubber Co., The, **j.**
Continental Diamond Fibre Corp., **e.**
Corning Glass Works, **a, c, f.**
Crucible Steel Co. of America, **j.**
Crystal-X Corp., **h.**
Curtiss-Wright Corp., Santa Barbara Div., **a, c.**
DBM Research Corp., **c.**
Delta Chemical Works, Inc., **i.**
Diamonite Products Mfg. Co., **c.**
***DOW CORNING CORP., j.**
E. I. Du Pont de Nemours & Co. Inc., **e, h.**
Duracote Corp., **d, g, h.**
Duramic Products Inc., **a, c.**
Dyna-Therm Chemical Corp., **b, c, j.**
Eagle-Picher Co., The, **b, e, g.**
Ed-Berl Products, Inc., **j.**
Electrical Insulation Co., Inc., **b, d thru h, j.**
Electrical Refractories Co., The, **c.**
Electronic Mechanics, Inc., **a, c.**
Emerson & Cuming, Inc., **c.**
Emerson Plastics Corp., **e, h.**
Emmco Plastic Fabricators—Div.—E. M. McCarthy Machine Co., **f thru i.**
Enfab Inc., **g.**
Fluorulon Labs., Inc., **h.**
Form-It Products, Inc., **e, g, h.**
Franklin Fibre-Lamitex Corp., **e, g, h, j.**
Frenchtown Porcelain Co., **c.**
Furane Plastics, Inc., **f.**
George K. Garrett Co., Inc., **j.**
Gatke Corp., **b.**
General Electric Co., Insulator Dept., **c, j.**
General Gasket Inc., **b, e, g thru j.**
Gladding, McBean & Co., **a, c.**
Gulton Industries, Inc., **c.**
Gustin-Bacon Mfg. Co., **e, g.**
Haveg Industries, Inc., **b thru g, j.**
Hewitt-Robins, Inc., **i.**
Integrated Mica Corp., **i.**
Isolantite Mfg. Corp., **c.**
Johns-Manville, **b thru e, g, i, j.**
Johns-Manville Sales Corp., **b thru g, i.**
Jonesville Paper Tube Corp., **i.**
***KEARFOTT CO., INC., a.**
Kip Electronics Corp., **c.**
Lamtex Industries, Inc., **g.**
Thomas J. Long, Inc., **d thru j.**
Magnetic Shield Div. Perfection Mica Co., **d, f.**
Maryland Lava Co., **b, h.**
Metallizing Co. of Los Angeles Inc., **a, c, j.**
Mica Fabricating Co., **c, e.**
Milam Electric Mfg. Co., **b, d, e, i.**
Minnesota Mining & Mfg. Co., **a, c, d.**
Mitronics Inc., **a, c.**
Motorola Inc., Military Electronics Div., **c.**
National Beryllia Corp., **a, b, c.**
National Vulcanized Fibre Co., **e, h.**
New England Tape Co., Div.—United-Carr Fastener Corp., **h.**
Northern Plastics Corp., **b, d, g, h, i.**
Norton Co., **a, c.**
Norton Co., New Products Dept., **a, c.**
Penn Fibre & Specialty Co., Inc., **e, i.**
Permacel, **d, g, i, j.**
Perry Plastics, Inc., **h.**
Pilgrim Products Inc., **d thru i.**
Pittsburgh Corning Corp., **c, f.**
Plastic Age Sales, Inc., **b, c, g, j.**
Polymer Corp., The, **h.**
Products Research Co., **j.**
Raybestos-Manhattan, Inc., **b, j.**
Raybestos-Manhattan, Inc., Pa., **b, j.**
Reinhold Engrg. & Plastics Co., **b, f.**
Rogers Corp., **b, c, e, i.**
Sanford Plastics Corp., **h.**
Schlegel Mfg. Co., **d, h.**
W. S. Shamban & Co., **i.**
Silicones Div.—Union Carbide Corp., **j.**
Spaulding Fibre Co., Inc., **e, h. i.**
Sterling Glass Corp., **f.**
Stone City Products Co., **i.**
Superior Steatite & Ceramic Corp., **c.**
Swedlow Inc., **g, h.**
Thermal Refractories Corp., **a, c.**
H. I. Thompson Fiber Glass Co., **g.**
Topper Mfg. Co., Inc., **a, c.**
Union Asbestos & Rubber Co., **b, d, e, f.**
United Mineral & Chemical Corp., **a, c.**
United States Plywood Corp., **b.**
United States Rubber Co., **b.**
Universal Moulded Products Corp., **a thru j.**
Wenzlau Engrg. Co., **b, f.**
Western Gold & Platinum Co., **c.**
Westinghouse Electric Corp., **d.**
Westinghouse Electric Corp., Lamp Div., **f.**
Wilmington Fibre Specialty Co., **e.**
Zippertubing Co., The, **b.**
Zirconium Corp. of America, **c.**

IRON

American Brake Shoe Co.
American Silver Co.
Armco Steel Corp.
C. Lee Cook Co., Airtomic Products Div.
Farrel Birmingham Co. Inc.
Hamilton Watch Co.—Industrial Div
Lapham Hickey Steel Corp.
Lindgren Foundry Co.
Matheson Co., Inc., The
Nesor Alloy Products Co.
Nordberg Mfg. Co.
Peerless Machine Co.
Precision Shapes, Inc.
Republic Steel Corp.
Joseph T. Ryerson & Son, Inc.
Swayne, Robinson & Co.

LEAD & ALLOYS

Accurate Specialties Co. Inc.
Allied Research Products, Inc.
Alloys Unlimited Inc.
Alpha Metals, Inc.
American Brake Shoe Co.
American Smelting & Refining Co
Anchor Metal Co. Inc.
J. T. Baker Chemical Co.
Belmont Smelting & Refining Works, Inc.
Bow Solder Products Co., Inc.
Delta Chemical Works, Inc.
Devcon Corp.
Division Lead Co.
Eagle-Picher Co., The
Farrel Birmingham Co. Inc.
Liss Products, Inc.
National Lead Co.
Nesor Alloy Products Co.
United Mineral & Chemical Corp.

LITHIUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
AMERICAN POTASH & CHEMICAL CORP.
Clarium & Chemicals, Inc.
Belmont Smelting & Refining Works, Inc.
Brom Metallurgical & Chemical Co.
Continental Metals, Inc.
Delta Chemical Works, Inc.
Foote Mineral Co.
Lithium Corp. of America, Inc.
Matheson Co., Inc., The
Republic Lens Co. Inc.
United Mineral & Chemical Corp.

MAGNESIUM & ALLOYS

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Brake Shoe Co.
American Brazing Alloys Co.
American Silver Co.
American Smelting & Refining Co.
Avian Foundry Corp.
Belmont Smelting & Refining Works, Inc.
Hansa Mfg., Co., The
Bond Metal Surplus Co.
Brom Metallurgical & Chemical Co.
Bridgeport Brass Co.
Brooks & Perkins, Inc.
Crucible Steel Co. of America
Delweld Co. Inc.
Davison Chemical Co.
Delta Chemical Works, Inc.
Doehler-Jarvis Div., National Lead Co.
Dow Chemical Co., The
Eight Metals, Inc.
Ercast Mfg. Corp.
Metals & Controls Corp., General Plate Div.
Precision Shapes, Inc.
Joseph T. Ryerson & Son, Inc.
Kellman Bronze & Aluminum Co.

MANGANESE

Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
Belmont Smelting & Refining Works, Inc.
Brom Metallurgical & Chemical Co.
Delta Chemical Works, Inc.
Electric Steel Foundry Co.
Foote Mineral Co.
Matheson Co., Inc., The
Union Carbide Metals Co., Div.—Union Carbide Corp.
Woimet Alloys Co., Div.—Consolidated Foundries & Mfg. Corp.

MERCURY

Alloys Unlimited Inc.
Bichor Metal Co. Inc.
Belmont Smelting & Refining Works, Inc.
Brom Metallurgical & Chemical Co.
Eastern Smelting & Refining Corp.
Fisher Scientific Co.
General Electric Co., Lamp Metals & Components Dept.
Matheson Co., Inc., The
Hildberg Bros. Smelting & Refining Co.

METAL PARTS

a. Bushings
b. Lead
c. Powdered
e. Screw machine
e. Small metal stampings
f. Spinnings
g. Trimmings

ACF Industries Inc., **d, e.**
Accurate Specialties Co. Inc., **b, c, e.**
Acme Mfg. & Gasket Co., **b, e.**
Adra Gasket Corp., **e.**
Airrodex, Inc., **e.**
Allen Tool Corp.
Alloys Unlimited Inc., **b, e.**
Alpha Metals, Inc., **b, e.**
Aluminum Co. of America, **c, d, e.**
Amatom Electronic Hardware Co. Inc., **d, e.**
American Aluminum Co., **e, f.**
American Brake Shoe Co., **a.**
American Brass Co., The, **e.**
American Hinge Corp., **a, d.**
American Non Gran Bronze Co., **a, d.**
American Silver Co., **e.**
American Standard Products, Inc., **a, d, e.**
Ampco Metal, Inc., **a.**
Anchor Metal Co. Inc., **b.**
Anchor Metal Spinning Co., The, **e, f.**
Associated Engrg. & Mfg. Corp., **c, e, f.**
Aeronautics Engrg. Co., **d, e.**
Auburn Mfg. Co., The, **e.**
Bagot Brothers, Inc., **e.**
Bamer Engrg. Co., **a, c.**
Belmont Smelting & Refining Works, Inc., **b, c.**
BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., c.
Benson Mfg. Co., The, **d, e, f.**
Best Aircraft Corp., **a, d.**
Brighton Corp., **e, f.**
Brooks & Perkins, Inc., **e, f.**
Capital City Mfg. Co., **a thru d.**
Carmac Aviation, **a, d, e, f.**
Century Fasteners Corp., **a, d, e.**
Chicago Screw Co., The, Div.—Standord Screw Co., **c.**
Cleveland Graphite Bronze, Div.—Clevite Corp., **a.**
Corbin Products Div., **a, d.**
Cronome Inc., **e.**
Curtiss-Wright Corp.—Wright Aeronautical Div., **d, e, f.**
Danbury Centerless Grinding Co., **d.**
Dersey Engrg. Co., **f**
Division Lead Co., **b.**
Eckendorfl & Co., Inc., **d, e.**
Elsser Industries, Inc., **a, d, e, f.**
Era Soecialty Co., Inc., **d, e.**
Eastern Specialty Co., The, **d, e.**
Electric Steel Foundry Co., **a.**
Electronic Parts Mfg. Co., Inc., **d, e.**
Elzee Metal Products Co., Inc., **d, e, f.**
Emmco Plastic Fabricators—Div.—E. M. McCarthy Machine Co., **d, e, f.**
Engelhard Industries, Inc., **c.**
Etched Products Corp., **e, g.**
Farwell Metal Fabricating, **e.**
George K. Garrett Co., Inc., **e.**
Gibson Electric Co., **c.**
Globe Industries, Inc., Supermet Div., **c.**
Gordon Enterprises, **d, e, f.**
Great Eastern Metal Products Co., **e.**
Green Rectifier Co., **e.**
HPL Mfg. Co., **e.**
Harvey Aluminum, **d.**
Hobson Brothers, Inc., **e,**
Interlake Stamping Corp., **e.**
Jan Hardware Mfg. Co., Inc., **a, d, e.**
Joma Inc., **e.**
Kaiser Aircraft & Electronics, Div.—Kaiser Industries Corp., **e, f, g.**
Kaiser Metal Products, Inc.—Fleetwings Div., **e, f.**
C. B. Kaupp & Sons, Inc., **e, f.**
Kelsey-Hayes Co., **e.**
Keystone Electronics Corp., **a, d, e.**
Kickhaefer Mfg. Co., **e.**
Kling Metal Spinning & Stamping Co., **e, f, g.**
Lamson & Sessions Co., The, **d.**
***LAVEZZI MACHINE WORKS, a, d, e.**
Lucas Aircraft Supply Co., **c, d.**
Lux Clock Mfg. Co., Inc., **c, d, e.**
***LYCOMING DIV., AVCO MFG. CORP., f.**
Malco Mfg. Co., **e.**
Metals & Controls Corp., General Plate Div.
Maody Machine Products Co., Inc., **d.**
Moran Co., **d.**
Mueller Brass Co., **c, d.**
National Moldite Co., **c.**
J. M. Ney Co., The, **c, d.**
Pacific Cut Washer Co., **e.**
Peerless Machine Co., **d, e.**
H. K. Porter Co., Inc., **d.**
Precision Shapes, Inc.
Prereg Mfg. Inc., **e.**
R & R Engrg. Co.
Randall Graphite Bearings, Inc., **a.**
Raybestos-Manhattan, Inc., Pa., **c.**
Red Devil Mfg. Co., **d.**
Research Development Mfg. Inc., **d.**
Roll Formed Products Co., **g.**
Joseph T. Ryerson & Son, Inc., **e.**
St. Marys Corban Co., **a, c, e.**
Roy A. Schorer & Co., **a, d, e.**
Shenanga Furnace Co., The, Centrifugally Cast Products Div
Sphinx-American Co., **d.**
Spincroft, Inc., **e, f.**
Standard Lacknut & Lockwasher Inc., **d, e.**
Stanley-Judd Div.—The Stanley Works, **d thru g.**
Stover Co., Inc., The, **a, d.**
Edwin B. Stimpson Co., Inc., **e.**
Stone City Products Co., **e.**
Superior Carbon Products, Inc., **a, c.**
Superior Spinning & Stamping Co., **e, f.**
Swiss Jewel Co., **d.**
Sylvonia Electric Products Inc., Parts Div., **e.**
Roland Teiner Co., Inc., **e, f.**
Torrington Co., The
True Alloys Inc., **a.**
United Mineral & Chemical Corp., **c, e.**
United States Chemical Milling Corp., **e, f.**
Waltham Screw Co., **d.**
***WEATHERHEAD CO., THE, d.**
Westinghouse Electric Corp., Metals Plant, **c.**
Wilks Precision Instrument Co., Inc., **a, d, e, f.**
Woadworth Specialties Corp., **d.**
Worcester Pressed Steel Co., **e.**
Wrought Washer Mfg. Co., **a, e.**
Zierick Mfg. Corp., **e.**

METAL STOCK, POROUS BEARING

Beemer Engrg. Co.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Keystone Carbon Co.
St. Marys Carbon Co.

METAL STOCK, THERMOSTATIC

American Silver Co.
Engelhard Industries, Inc.

MICA, GLASS BONDED

Allied Plastics Supply Corp.
Camca Plastics Inc.
Haveg Industries, Inc.
Integrated Mica Corp.
Magnetic Shield Div. Perfection Mica Co.
Mica Fabricating Co.
Minnesota Mining & Mfg. Co.
United Mineral & Chemical Corp.
Westinghouse Electric Corp.

MOLYBDENUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
American Silver Co.
Associated Engrg. & Mfg. Corp.
J. T. Baker Chemical Co.
Belmont Smelting & Refining Works, Inc.
Brom Metallurgical & Chemical Co.
Bridgeport Brass Co.
Continental Metals, Inc.
Crucible Steel Co. of America
Damascus Tube Co.
Delta Chemical Works, Inc.
Eisler Engrg. Co., Inc.
Electronic Parts Mfg. Co., Inc.
Elmet Div.—North American Philips Co., Inc.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
General Electric Co., Lamp Metals & Components Dept.
Hamilton Watch Co.
Hamilton Watch Co.—Industrial Div.
Johnston & Funk Titanium Corp.
P. R. Mallory & Co. Inc.
***MALLORY-SHARON METALS CORP.**
Matheson Co., Inc., The
Mercast Mfg. Corp.
Metals & Contrals Corp., General Plate Div.
Nesor Alloy Products Co.
Precision Shapes, Inc.
Sylvania Electric Products Inc., Chemical & Metallurgical Div.
Universal-Cyclops Steel Corp.
Waimet Allays Co., Div. Consolidated Foundries & Mfg Corp.
Waukesha Foundry Co.
Westinghouse Electric Corp., Lamp Div.
Westinghouse Electric Corp., Metals Plant

MONEL

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Hinge Corp.
American Nickel Alloy Mfg. Corp.
American Silver Co.
J. T. Baker Chemical Co.
Belmont Smelting & Refining Works, Inc.
Benson Mfg., Co., The
Bond Metal Surplus Co.
Brom Metallurgical & Chemical Co.
Bridgeport Brass Co.
Continental Metals, Inc.
Crucible Steel Co. of America
Damascus Tube Co.
Delta Chemical Works, Inc.
Wilbur B. Driver Co.
Electric Steel Foundry Co.
Electronic Parts Mfg. Co., Inc.
Hamilton Watch Co.
Hamilton Watch Co.—Industrial Div.
Haynes Stellite Co., Div.—Union Carbide Corp.
International Nickel Co., The
Kalcast Industries—Div. Thompson Ramo Wooldridge Inc.
Charles E. Larson & Sons, Inc.
Lebanon Steel Foundry
M-W Labs., Inc.
Nesar Alloy Products Co.
Precision Shapes, Inc.
Precision Tube Co., Inc.
Shenango Furnace Co., The, Centrifugally Cast Products Div.
Somers Brass Co. Inc.
Waimet Alloys Co., Div Consolidated Foundries & Mfg Corp.
Waukesha Foundry Co.

NICKEL

Accurate Specialties Co. Inc.
Allied Research Products, Inc.
Alloys Unlimited Inc.
American Brazing Alloys Co.
American Hinge Corp.
American Nickel Alloy Mfg. Corp.
American Silver Co.
Belmont Smelting & Refining Works, Inc.
Brom Metallurgical & Chemical Co.
Bridgeport Brass Co.
Delweld Co. Inc.
Damascus Tube Co.
Wilbur B. Driver Co.
Electric Steel Foundry Co.
Foote Mineral Co.
Hamilton Watch Co.
Hamilton Watch Co.—Industrial Div.
Haskins Mfg. Co.
International Nickel Co., The
Kalcast Industries—Div. Thompson Ramo Wooldridge Inc.
Lebanon Steel Foundry
Lucas Aircraft Supply Co.
Matheson Co., Inc., The
Mercast Mfg. Corp.
National Lead Co.
Nesar Alloy Products Co.
Precision Shapes, Inc.
Precision Tube Co., Inc.
Shenango Furnace Co., The, Centrifugally Cast Products Div
Somers Brass Co. Inc.
Waimet Alloys Co., Div. Consolidated Foundries & Mfg. Corp.

NUCLEAR SHIELDING, LEAD

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Smelting & Refining Co.
Belmont Smelting & Refining Works, Inc.
Division Lead Co.
Farrel Birmingham Co. Inc.
Stover Co., Inc., The

OXIDE, ALUMINUM

Accurate Specialties Co. Inc.
Aluminum Co. of America
American Lava Corp.
J. T. Baker Chemical Co.
Bio-Rad Labs.
Corning Glass Works
Curtiss-Wright Corp., Research Div
Curtiss-Wright Corp., Santa Barbara Div.
Del's Tumbling Service
Delta Chemical Works, Inc.
Diamanite Products Mfg. Co.
Engelhard Industries Inc., D. E. Makepeace Div.
Glodding, McBean & Co.
Matheson Co., Inc., The
Metallizing Co. of Los Angeles Inc.
Norton Co.
Norton Co., New Products Dept.
Thermal Refractaries Corp.
United Mineral & Chemical Corp.
Vascalay-Ramet Corp.

PALLADIUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
Almac Plastics Inc.
American Silver Co.
Bram Metallurgical & Chemical Co.
Delta Chemical Works, Inc.
Deringer Metallurgical Corp.
Eastern Smelting & Refining Corp.
Engelhard Industries, Inc.
Hamilton Watch Co.—Industrial Div.
Handy & Harman
M-W Labs., Inc.
Matheson Co., Inc., The
Metals & Controls Corp., General Plate Div.
J. M. Ney Co., The
Sel-Rex Corp.
Spectronic Plating Co., Inc., Div.—Spectranome Plating Co., Inc.
United Mineral & Chemical Corp.
Wildberg Bros. Smelting & Refining Co.

PHENOLICS

Abesto Corp.
Air Logistics Corp.
Allied Plastics Supply Corp.
Auburn Mfg. Co., The
Bios Labs., Inc.
Borden Chemical Co.
Comco Plastics Inc.
Continental Diamond Fibre Corp.
Crystal-X Corp.
Duralith Corp.
Electrical Insulation Co., Inc.
Electro Technical Products Div. Sun Chemical Corp.
Engineered Plastics, Inc.
Fisher & Crome
Franklin Fibre-Lamitex Corp.
Haveg Industries, Inc.
Joclin Mfg. Co.
Thomas J. Long, Inc.
Mansfield Fabricators Inc.
Marblette Corp., The
Mica Fabricating Co.
Minnesota Mining & Mfg. Co.
National Moldite Co.
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
Reichhold Chemicals, Inc.
Reinhold Engrg. & Plastics Co.
Rogers Corp.
Spaulding Fibre Co., Inc.
Wilmington Fibre Specialty Co.

PLASTIC

a. Acrylic
b. Allyls
c. Cellulose acetate
d. Cellulose acetate butyrate
e. Cellulose nitrate
f. Ceramic-plastic combinatians
g. Epoxy resins
h. Ethyl cellulose
i. Fiber glass
j. Fluorocarbons
k. Melamine formaldehyde
l. Mica-plastic combinatian
m. Phenolics
n. Polyester
o. Polyethylene
p. Polystyrene
q. Polytrifluorochlarethylene
r. Reinforced
s. Silicones
t. Styrene
u. Tetrafluoroethylene resin
v. Urea formaldehyde
w. Vinyl

Abesto Corp., **a, c, d, e, g thru k, m thru w.**
Acheson Colloids Co., Div.—Acheson Industries, Inc.
Acme Mfg. & Gasket Co., **c, s, w.**
Adhesive Engrg., Div.—Hiller Aircraft Carp., **g, i, m, r.**
Aero Gasket Corp., **j, q, r, s, u.**
Air Logistics Corp.
***ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV., j, q, u.**
Allied Plastics Supply Carp., **a, c, d, e, g thru u, w.**
Almac Plastics Inc., **a, c, d, i, l., n, a, v, w.**
American Agile Carp., **o, u.**
American Latex Products Corp., **f, g, n, q, t.**
American Rocket Co., **g, m, n, r, w.**
Anchar Plastics Co., Inc., **a, c, d, h, o, p, t.**
Apex Reinforced Plastics, Div.—White Sewing Machine Corp., **r.**
Aries Labaratories, Inc., **g.**
Aristocrat Plastics, Inc., **a, c, d, h, j, a, p, q, t, w.**
Astrodyne, Inc., **r.**
Auburn Mfg. Co., The, **a, c, e, i, j, m, a, p, q, w.**
J. T. Baker Chemical Co., **a.**
Balco Research Labs., Inc., Capacitor Div., **g, n, p, q.**
Bemis Brothers Bag Co., **o.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., f.**
Carl H. Biggs Co., **g.**
Bios Labs., Inc., **a thru k, m thru q, s thru w.**
Blossam Mfg. Co. Inc., **m, n, o, w.**
Bonny Mfg. Corp., **j, u.**
Borden Chemical Co., **f, g, k, m, p, v, w.**
Borden Chemical Co., The, Div.—The Borden Co., Resinite Dept., **w.**
Brilhart Plastics Corp., **g, j.**
Butler Mfg. Co.
Calfibe Co., Inc., **r.**
Campco, Div.—Chicago Molded Products Corp., **c, d, h, o, p, t.**
Carboline Co., **g, m, w.**
Carbone Carp., The, **r.**
Catalin Corp. af America, **o, p, t.**
Chemical Products Corp., **w.**
Chemold Co., **n, r, s.**
Chicago Gasket Co., **u.**
Chicaga Rawhide Mfg. Co., **j, q, r, s.**
Ciba Products Corp., **g.**
Cimastra Div., The Cincinnati Milling Machine Co., **r.**
Coast Mfg. & Supply Co., **f, g, i, m, n, r, s.**
Colonial Rubber Co., **s.**
Comco Plastics Inc., **a, c, d, g, j, k, m, a, p, s, t, w.**
Continental Can Co., Inc., **i, r.**
Continental Diamond Fibre Carp., **g, i, j, l, m, n, r, s, u.**
Cooper Industries, Inc., **d, e.**
Cordo Chemical Carp., **g, m, w.**
Crystal-X Carp., **a, c, d, e, h thru r, t, w.**
DBM Research Corp., **f, g, i, m, p, w.**
De Bell & Richardson Inc.
Delta Products Div.—Air Accessories, Inc., **a, c, d, e, o, p, q.**
Devcan Carp., **a, c, d, e, g, p, s, t.**
Daw Chemical Co., The, **g, h, o, p, t, w.**
***DOW CORNING CORP., s.**
E. I. Du Pant de Nemours & Co. Inc., **a, c, e, i, j, n, o, r, u, w.**
Duracote Corp., **i, w.**
Duralith Carp., **k, m, n, r, w.**
Durez Plastics Div.—Hooker Chemical Corp., **m, n, r.**
Eagle-Picher Co., The, **i.**
Eastman Kodak Co., **c, d.**
Electrical Insulation Co., Inc., **a, i, k, m thru q, s, u, w.**
Electro Technical Products Div. Sun Chemical Corp., **g, i, m, n, r, s.**
Eljay Corp., **a.**
Emerson & Cuming, Inc., **f, g, n thru t.**
Emersan Plastics Corp., **a thru d, g thru k, m thru u, w.**
Emmca Plastic Fabricators—Div.—E. M. McCarthy Machine Co., **g, l, w.**
Engineered Plastics, Inc., **a, c, j, k, m, a, p.**
Fabri-Farm Co., The, **a, c, d, m, o, p, t, w.**
Fidelity Chemical Products Carp., **d, h.**
Flexrock Co., **j.**
Fluorocarbon Co., The, **q, t.**
Fluorulan Labs., Inc., **j, q, u.**
Food Machinery & Chemical Corp., **b.**
Franklin Fibre-Lamitex Corp., **a, c, g, m thru p, w.**
Furane Plastics, Inc., **f, g, r, u.**
General Gasket Inc., **c, d, j, o, s, u, w.**
General Plastics Corp. of New Jersey, **i, j, q, u.**
Gering Products, Inc., **a, c, d, h, i, o, p, t, w.**
Gladding, McBean & Co., **f.**
B. F. Goodrich Industrial Products Co., **w.**
Grant Chemical Co., Inc., **g, i, l, n, r.**
Halogen Insulator & Seal Corp., **i, t.**
Hardman Toal & Engrg., Co., **g, i, r.**
Haveg Industries, Inc., **f, g, j thru n, q, r, s, u, v, w.**
Hewitt-Rabins, Inc., **r.**
Homalite Corp., The, **b, g, i, n.**
Houghton Laborataries, Inc., **g.**
Huntington Rubber Mills, **s.**
Illumitranic Engrg. Co., **a, m, o, p, t.**
International Resistance Co., **m.**
Joclin Mfg. Co., **i, j, k, m, q, r, u.**
Jodee Plastics Co., **a, c, d, e, h, j, m, o, p, q, t, u, w.**
Johns-Manville, **i.**
Johns-Manville Sales Corp., **f, i, r.**
Koppers Co., Inc., **n, o, t.**
Lamtex Industries, Inc., **g, i, r.**
Lebec Chemical Corp., **d, g, h, m.**
Liss Products, Inc., **a, r.**
Thomas J. Long, Inc., **a, c, m thru t, w.**
Luminous Resins Inc., **a, a, p.**
Magnetic Shield Div. Perfection Mica Co., **k.**
Mansfield Fabricators Inc., **m, n.**
Marblette Corp., The, **a, g, m.**
Maryland Lava Co., **g, p.**
Matheson Co., Inc., The, **c, j.**
Metallizing Co. of Los Angeles Inc., **f.**
Mica Fabricating Co., **l.**
Mica Insulator Div.—Minnesota Mining & Mfg., Co., **l.**
Milam Electric Mfg. Co., **r.**
Minnesota Mining & Mfg. Co., **g, i, j, l, m, q, r, w.**
Morningstar-Paisley, Inc., **w.**
Mueller Brass Co., **o, t, w.**
Narmco Mfg. Co., **g, i, m, n, o, r.**
Narmco Resins & Coatings Co., **g, q.**
National Tube Div.—United States Steel Corp., **o, w.**
National Vulcanized Fibre Co., **g, j, k, m, n, r, s, u.**
Natvar Corp., **o, p, w.**
New England Laminates Co., Inc., **m, r.**
New England Tape Co., Div.—United-Carr Fastener Corp., **c, d, o, p, t, w.**
Narton Co., **f.**
Orchard Industries, Inc., Actianflex Div., **g, n, s.**
Penn Fibre & Specialty Co., Inc., **m.**
Permacel, **g, j, s, u.**
Pilgrim Products Inc., **a.**
Plasteck, Inc., **a.**
Plastic Age Sales, Inc., **a, c, d, f, g, i, m, n, r, s.**
Polyken Sales Div., The Kendall Co., **a.**
Polymer Corp., The, **g, j, o, p.**
Printronics Corp., **m.**
Pry Welding & Mfg., Inc., **p.**
Raybestos-Manhattan, Inc., Pa., **g, j, m, r, s, u.**
Reichhold Chemicals, Inc., **a, g, k, m, n, r, v.**
Reinhold Engrg. & Plastics Co., **b, g, i, l, m, n, r.**
Republic Aviatian Corp., **g.**
Rex Corp., The, Sub.—American Enka, **q.**
Rez-Coat of California, **i, m, n, r.**
Rogers Corp., **f, j, m, r.**
Milton Ross Metals Co., The, **a, c, d, e, g, h, j thru q, s thru w.**
Russell Reinforced Plastics Corp., **r.**
Joseph T. Ryerson & Son, Inc., **o, p, t.**
St. Regis Paper Co., Panelyte Div., **k, m, a, r, s.**
Sanford Plastics Corp., **j, q.**
Ray A. Scharer & Co., **a, c, d, e, k, m thru w.**
Schlegel Mfg. Co., **n, o.**
Seal-Peel, Inc., **d, h.**
W. S. Shamban & Co., **j, q, u.**
Shell Chemical Corp., Industrial Chemicals Div., **g.**
Sierracin Corp., The, **a, n.**
Silicane Insulation, Inc., **g, m, n, r, s.**
Silicanes Div.—Union Carbide Corp., **s.**
Smooth-On Mfg. Co., **g.**
Special Projects Lab., Food Machinery Chemical Corp., **g.**
Superior Carbon Products, Inc., **g, m.**
Swedlow Inc., **a.**
Thermech Engrg. Corp., **j.**
H. I. Thompson Fiber Glass Co., **i, r.**
Tapper Mfg. Co., Inc., **f, g, j, p.**
Trionics Corp., **a, f, g, m, n, a.**
Tri-Point Plastics Inc., **j.**
Turbo Products, Inc., **j.**
United Mineral & Chemical Carp., **l.**
U. S. Fiber & Plastics Corp., **w.**
United States Rubber Co., **g, n, w.**
United Supply Co., **a, b.**
Universal Unlimited, Inc., **a, c, d, n, a, s, v.**
Virginia Plak Co., **a, w.**
Western Coating Co., **d, h.**
Western Felt Works & Acadia Synthetic Products Div., **a, c, d, h, m, n, o, s.**
Westinghouse Electric Carp., **k, m, n, r, s.**
Westlake Plastics Co., **a, c, d, g, h, i, n, o, p, s, t, w.**
Winzen Research Inc., **n.**
X-Pando Corp., **g.**
Zippertubing Co., The, **i, j, o, w.**

PLASTICS, LAMINATED

Abesto Corp.
Adept Industries Inc.
Aerojet-General Corp.
Air Logistics Corp.
Allied Plastics Supply Corp.
American Aerophysics Carp.
American Printed Circuits Co., Inc.
American Rocket Co.
Atkins & Merrill, Inc.
Auburn Mfg. Co., The
Carl H. Biggs Co.
Calfibe Co., Inc.
Chemold Co.
Coast Mfg. & Supply Co.
Colonial Aircraft Corp.
Columbia Products Co.
Comco Plastics Inc.
Continental Diamond Fibre Carp.
C. Lee Cook Co., Airtomic Products Div.
Crystal-X Corp.
Curtiss-Wright Corp., Santa Barbara Div.
E. I. Du Pont de Nemours & Co. Inc.
Duralith Corp.
Eagle-Picher Co., The
Electrical Insulation Co., Inc.
Emerson Plastics Carp.
Emmco Plastic Fabricatars—Div.—E. M. McCarthy Machine Co.
Engineered Plastics, Inc.
Farley & Loetscher Mfg. Co., Plastics Div.
Fluorulon Labs., Inc.
Franklin Fibre-Lamitex Corp.
Furane Plastics, Inc.
Gatke Corp.
General Gasket Inc.
General Plastics Corp. of New Jersey
B. F. Goodrich Aviation Products
Goodyear Aircraft Corp.
Grant Chemical Co., Inc.
Hardman Tool & Engrg., Co.
Haskelite Mfg. Corp.
Haveg Industries, Inc.
Honeycomb Co. of America, Inc.
International Resistance Co.
Joclin Mfg. Co.
Jodee Plastics Co.
Lamtex Industries, Inc.
Liss Products, Inc.
Thomas J. Long, Inc.
Luminous Resins Inc.
Mica Insulator Div.—Minnesota Mining & Mfg., Co.
Mico Instrument Co.
Milam Electric Mfg. Co.
Minnesota Mining & Mfg. Co.
Narmco Mfg. Co.
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
Northern Plastics Corp.
Panel Engrg. Corp.
Penn Fibre & Specialty Co., Inc.
Perry Plastics, Inc.
Pilgrim Products Inc.
Plasteck, Inc.
Plastic Age Sales, Inc.
Pracess & Instruments
Raybestos-Manhattan, Inc.
Raybestos-Manhattan, Inc., Pa.
Reinhold Engrg. & Plastics Co.
Roberts Industries Inc.
Rogers Corp.
Milton Ross Metals Co., The
Russell Reinforced Plastics Corp.
Joseph T. Ryerson & San, Inc.
St. Regis Paper Co., Panelyte Div.
W. S. Shamban & Co.
Sierracin Corp., The
Silicone Insulation, Inc.
Spaulding Fibre Co., Inc.
Specialty Engrg. & Electranics Co.
Superior Carbon Products, Inc.
Swedlaw Inc.
Taylar Fibre Co.
H. I. Thompson Fiber Glass Co.
U. S. Relay Co.
United States Chemical Milling Corp.
Universal Moulded Products Carp.
Virginia Plak Co.
Wenzlau Engrg. Co.
Westinghouse Electric Corp.
Winzen Research Inc.
Zippertubing Co., The

PLYWOOD & METAL, BONDED

American Rocket Co.
Carl H. Biggs Co.
Furane Plastics, Inc.
Haskelite Mfg. Corp.

Liss Products, Inc.
Met-L-Wood Corp.
Skydyne, Inc.
United States Plywood Corp.

OLONIUM

Bios Labs., Inc.
United States Radium Corp.

ORCELAIN

Emerson & Cuming, Inc.
General Electric Co., Insulator Dept.
Gladding, McBean & Co.

UARTZ, FUSED

Associated Engrg. & Mfg. Corp.
Bram Metallurgical & Chemical Co.
Corning Glass Works
Dell Optics Co., Ltd.
Emerson & Cuming, Inc.
Engelhard Industries, Inc.
General Electric Co., Lamp Glass Dept.
Haveg Industries, Inc.
Honeycomb Co. of America, Inc.
Mica Fabricating Co.
Narmco Resins & Coatings Co.
Republic Lens Co. Inc.
***ULTRA-VIOLET PRODUCTS, INC.**

SINS, BONDING

Acheson Colloids Co., Div.—Acheson Industries, Inc.
Adhesive Engrg., Div.—Hiller Aircraft Corp.
American Rocket Co.
Aries Laboratories, Inc.
Armstrong Products Co.
Carl H. Biggs Co.
Borden Chemical Co.
Catalin Corp. of America
Cordo Chemical Corp.
DBM Research Corp.
Dayton Rubber Co., The
Dennis Chemical Co.
***DOW CORNING CORP.**
Emerson & Cuming, Inc.
Furane Plastics, Inc.
Grant Chemical Co., Inc.
Haveg Industries, Inc.
Honeycomb Co. of America, Inc.
Houghton Laboratories, Inc.
Lamtex Industries, Inc.
Lebec Chemical Corp.
Liss Products, Inc.
Minnesota Mining & Mfg. Co.
Permacel
Permatex Co., Inc.
Products Research Co.
Reichhold Chemicals, Inc.
Reinhold Engrg. & Plastics Co.
Shell Chemical Corp., Industrial Chemicals Div.
Silicones Div.—Union Carbide Corp.
Smooth-On Mfg. Co.
Topper Mfg. Co., Inc.
Trionics Corp.

SINS, ENCAPSULATING

Adhesive Engrg., Div.—Hiller Aircraft Corp.
American Rocket Co.
Aries Laboratories, Inc.
Armstrong Products Co.
Carl H. Biggs Co.
Borden Chemical Co.
Ciba Products Corp.
DBM Research Corp.
Dayton Rubber Co., The
Dennis Chemical Co.
Devcon Corp.
Double E Products Co.
***DOW CORNING CORP.**
E. I. Du Pont de Nemours & Co. Inc.
Emerson & Cuming, Inc.
Furane Plastics, Inc.
Grant Chemical Co., Inc.
Haveg Industries, Inc.
Houghton Laboratories, Inc.
Lamtex Industries, Inc.
Lebec Chemical Corp.
Minnesota Mining & Mfg. Co.
National Engrg. Products, Inc.
Permacel
Products Research Co.
Reichhold Chemicals, Inc.
Reinhold Engrg. & Plastics Co.
Milton Ross Metals Co., The
Shell Chemical Corp., Industrial Chemicals Div.
Silicones Div.—Union Carbide Corp.
Smooth-On Mfg. Co.
Topper Mfg. Co., Inc.
Trionics Corp.
United States Rubber Co.
Westinghouse Electric Corp.

SINS, POTTING

Adhesive Engrg., Div.—Hiller Aircraft Corp.
American Rocket Co.
Aries Laboratories, Inc.
Armstrong Products Co.
Carl H. Biggs Co.
Borden Chemical Co.
Ciba Products Corp.
DBM Research Corp.
Dayton Rubber Co., The
Dennis Chemical Co.
Devcon Corp.
Double E Products Co.
***DOW CORNING CORP.**
Emerson & Cuming, Inc.
Furane Plastics, Inc.
Grant Chemical Co., Inc.
Haveg Industries, Inc.
Houghton Laboratories, Inc.
Lamtex Industries, Inc.
Lebec Chemical Corp.
Minnesota Mining & Mfg. Co.
National Engrg. Products, Inc.
Permacel
Products Research Co.
Reichhold Chemicals, Inc.
Reinhold Engrg. & Plastics Co.
Milton Ross Metals Co., The
Shell Chemical Corp., Industrial Chemicals Div.
Silicones Div.—Union Carbide Corp.
Smooth-On Mfg. Co.
Topper Mfg. Co., Inc.
Trionics Corp.
United States Rubber Co.
Westinghouse Electric Corp.

Grant Chemical Co., Inc.
Haveg Industries, Inc.
Houghton Laboratories, Inc.
Lamtex Industries, Inc.
Lebec Chemical Corp.
Minnesota Mining & Mfg. Co.
National Engrg. Products, Inc.
Nopco Chemical Co.
Pennsalt Chemicals Corp.
Permacel
Products Research Co.
Reichhold Chemicals, Inc.
Reinhold Engrg. & Plastics Co.
Milton Ross Metals Co., The
Shell Chemical Corp., Industrial Chemicals Div.
Silicones Div.—Union Carbide Corp.
Smooth-On Mfg. Co.
Special Projects Lab., Food Machinery & Chemical Corp.
Topper Mfg. Co., Inc.
Trionics Corp.
Westinghouse Electric Corp.

RESINS, SYNTHETIC

Adhesive Engrg., Div.—Hiller Aircraft Corp.
American Rocket Co.
Aries Laboratories, Inc.
Aristocrat Plastics, Inc.
Carl H. Biggs Co.
Bio-Rad Labs.
Borden Chemical Co.
Catalin Corp. of America
Ciba Products Corp.
DBM Research Corp.
Double E Products Co.
Dow Chemical Co., The
***DOW CORNING CORP.**
E. I. Du Pont de Nemours & Co., Inc.
Durez Plastics Div.—Hooker Chemical Corp.
Emerson & Cuming, Inc.
Furane Plastics, Inc.
Grant Chemical Co., Inc.
Haveg Industries, Inc.
Hercules Powder Co.
Houghton Laboratories, Inc.
Lebec Chemical Corp.
Minnesota Mining & Mfg. Co.
Permacel
Polymer Corp., The
Reichhold Chemicals, Inc.
Reinhold Engrg. & Plastics Co.
Shell Chemical Corp., Industrial Chemicals Div.
Silicones Div.—Union Corbide Corp.
Smooth-On Mfg. Co.
Topper Mfg. Co., Inc.
Trionics Corp.
United States Rubber Co.

RIVETS

Abbott Screw & Mfg. Co.
Aluminum Co. of America
American Hinge Corp.
Century Fasteners Corp.
Chase Brass & Copper Co., Inc.
Chicago Rivet & Machine Co.
Cooper Industries, Inc.
Corbin Products Div.
Deringer Metallurgical Corp.
Division Lead Co.
Emmco Plastic Fabricators—Div.—E. M. McCarthy Machine Co.
B. F. Goodrich Aviation Products
John Hassall, Inc.
Huck Mfg. Co.
Metals & Controls Corp., General Plate Div.
National Screw & Mfg. Co., The
Republic Steel Corp.
Screw Corp.
Edwin B. Stimpson Co., Inc.
***TOWNSEND CO., CHERRY RIVET DIV.**

RODS, TUNGSTEN

Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
Associated Engrg. & Mfg. Corp.
Bram Metallurgical & Chemical Co.
Delta Chemical Works, Inc.
Eisler Engrg. Co., Inc.
Electronic Parts Mfg. Co., Inc.
Elmet Div.—North American Philips Co., Inc.
General Electric Co., Lamp Metals & Components Dept.
***MALLORY-SHARON METALS CORP**
Sylvania Electric Products Inc., Chemical & Metallurgical Div.
Universal-Cyclops Steel Corp.
Westinghouse Electric Corp., Lamp Div.

RUBBER

a. Conductive
b. Hard
c. Insulation
d. Natural
e. Synthetic

Abesto Corp., **a thru e.**
Acme Mfg. & Gasket Co., **d, e.**
Aero Gasket Corp., **a, c, d, e.**
Amatom Electronic Hardware Co. Inc., **c.**
American Latex Products Corp., **c, d, e.**
Auburn Mfg. Co., The, **a thru e.**
Bellofram Corp., **e.**
Chicago Rawhide Mfg. Co., **e.**
Chicago-Allis Mfg. Corp., **e.**
Colonial Rubber Co., **a, c, d, e.**
Connecticut Hard Rubber Co., The, **c, e.**
Continental Rubber Works, **a, c, d, e.**
Dayton Rubber Co., The, **a thru e.**
Delta Chemical Works, Inc., **e.**
Devcon Corp., **c, e.**

***DOW CORNING CORP., e.**
Dresser Industries, Inc., **a, c, e.**
E. I. Du Pont de Nemours & Co. Inc., **a, c, d, e.**
Electrical Insulation Co., Inc., **b.**
Emerson & Cuming, Inc., **a.**
Firestone Tire & Rubber Co., The, Guided Missile Div., **d, e.**
General Gasket Inc., **a, d, e.**
B. F. Goodrich Aviation Products, **a thru e.**
B. F. Goodrich Industriol Products Co., **a, b, d, e.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **a thru e.**
Goshen Rubber Co., Inc., **a, d, e.**
Hewitt-Robins, Inc., **b, c, d.**
E. F. Houghton & Co., **e.**
Huntington Rubber Mills, **a thru d.**
Johns-Manville, **c, d, e.**
Mica Fabricating Co., **c.**
Minnesota Mining & Mfg. Co., **e.**
J. J. Monoghan Co., Inc., **a, e.**
Newth Rubber Co., **a, b, d, e.**
Orchard Industries, Inc., Actionflex Div., **e.**
Pacific Moulded Products, **a, b, d, e.**
Roybestos-Manhottan, Inc., **a thru e.**
Raybestos-Manhottan, Inc., Po., **d, e.**
Fred T. Roberts & Co., **d, e.**
Roberts Toledo Rubber Co., The, **a thru e.**
Rubber Teck Inc., **a thru e.**
Rubbercraft Corp. of California, **a thru e.**
Roy A. Scharer & Co., **a thru e.**
Silicones Div.—Union Carbide Corp., **a, b, c, e.**
Smooth-On Mfg. Co., **e.**
United States Rubber Co., **a, c, d, e.**
Western Felt Works & Acadia Synthetic Products Div., **a, b, c, e.**

SILICON

Abesto Corp.
Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
Belmont Smelting & Refining Works, Inc.
Bios Labs., Inc.
Bram Metallurgical & Chemical Co.
Colonial Rubber Co.
Devcon Corp.
E. I. Du Pont de Nemours & Co. Inc.
Eagle-Picher Co., The
Foote Mineral Co.
Knapic Electro-Physics
Matheson Co., Inc., The
Merck & Co. Inc., Electronic Chemicals Div.
Motorola Inc., Military Electronics Div.
National Metallurgical Corp
National Utilities Corp.
Ohio Precision Castings, Inc.
Plastic Age Sales, Inc.
Sylvania Electric Products Inc., Chemical & Metallurgical Div.
Union Carbide Metals Co., Div.—Union Carbide Corp.

SILICONE GREASES

Anderson Chemical Co., Div.—Stauffer Chemical Co.
***DOW CORNING CORP.**
Ed-Berl Products, Inc.
Merix Chemical Co.
National Engrg. Products, Inc.
Silicones Div.—Union Carbide Corp.

SILICONE OILS

Anderson Chemical Co., Div.—Stauffer Chemical Co.
Chicago Rawhide Mfg. Co.
***DOW CORNING CORP.**
Ed-Berl Products, Inc.
Hewitt-Robins, Inc.
Merix Chemical Co.
Silicones Div.—Union Carbide Corp.
Western Felt Works & Acadia Synthetic Products Div.

SILICONE RUBBER

Abesto Corp.
Acme Mfg. & Gasket Co.
Aero Gasket Corp.
Alloys Unlimited Inc.
Auburn Mfg. Co., The
Bellofram Corp.
Chicago-Allis Mfg. Corp.
Colonial Rubber Co.
Connecticut Hard Rubber Co., The
Continental Rubber Works
Deringer Metallurgical Corp.
***DOW CORNING CORP.**
E. I. Du Pont de Nemours & Co. Inc.
General Gasket Inc.
B. F. Goodrich Aviation Products
B. F. Goodrich Industriol Products Co.
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Goshen Rubber Co., Inc.
Greene, Tweed & Co.
Haveg Industries, Inc.
Huntington Rubber Mills
Metaplast Co. Inc.
Newth Rubber Co.
Orchard Industries, Inc., Actionflex Div.
Pacific Moulded Products
Permacel
Products Research Co.
Raybestos-Manhattan, Inc.
Raybestos-Manhattan, Inc., Po.
Fred T. Roberts & Co.
Rubber Teck Inc.
Rubbercraft Corp. of California
Roy A. Scharer & Co.
Silicones Div.—Union Carbide Corp.

SOLVENTS

***ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.**
Allied Research Products, Inc.
Aries Laboratories, Inc.
J. T. Baker Chemical Co.

Carl H. Biggs Co.
Bios Labs., Inc.
Cooper Industries, Inc
Dow Chemical Co., The
E. I. Du Pont de Nemours & Co. Inc.
Esso Standard Oil Co.
Fisher Scientific Co.
London Chemical Co., Inc.
Maas & Waldstein Co.
Matheson Co., Inc., The
Micro-Circuits Co.
Penetone Co., The
Shell Chemical Corp., Industrial Chemicals Div.
Trio Chemical Works, Inc.
Turco Products, Inc.

SPINNINGS, METAL

Amatom Electronic Hardware Co. Inc.
Associated Engrg. & Mfg. Corp.
Benson Mfg. Co., The
Brighton Corp.
Brooks & Perkins, Inc.
Dresser Industries, Inc.
Elzee Metal Products Co., Inc.
Hufford Corp., The
Jan Hardware Mfg. Co., Inc.
Kaiser Metal Products, Inc.—Fleetwings Div
C. B. Kaupp & Sons, Inc.
Kling Metal Spinning & Stamping Co.
Lukens Steel Co.
***LYCOMING DIV., AVCO MFG. CORP.**
Superior Spinning & Stamping Co.
Roland Teimer Co., Inc.
United States Chemical Milling Corp.

STEEL, ELECTRIC

Acme-Newport Steel Co.
Allegheny Ludlum Steel Corp.
American Brake Shoe Co.
Armco Steel Corp
Baker Steel & Tube Co.
Byrne Doors Inc.
Cannon-Muskegon Corp.
Carpenter Steel Co., The
Clark Equipment Co.
Crucible Steel Co. of America
Damascus Tube Co.
Electric Steel Foundry Co.
Firth Sterling Inc.
Lucas Aircraft Supply Co.
Lukens Steel Co.
***MALLORY-SHARON METALS CORP.**
National Forge Co.
Peerless Machine Co
Perfecto Cast
Precision Shapes, Inc.
Republic Steel Corp.
Joseph T. Ryerson & Son, Inc
Sharon Steel Corp
Southwire Co.
U. S. Steel Supply Div., United States Steel Corp.
Vanadium-Alloys Steel Co.

STEEL, STAINLESS

Acme Mfg. & Gasket Co.
All Boro Metal Products Co., Inc.
Allegheny Ludlum Steel Corp.
American Brake Shoe Co.
American Silver Co.
Armco Steel Corp
***AVCO MFG. CORP., NASHVILLE DIV.**
Baker Steel & Tube Co.
Benson Mfg. Co., The
Bond Metal Surplus Co.
Bram Metallurgical & Chemical Co
Bridgeport Brass Co.
Byrne Doors Inc.
Cannon-Muskegon Corp.
Carpenter Steel Co., The
Chase Brass & Copper Co., Inc.
Continental Metals, Inc.
Crucible Steel Co. of America
Damascus Tube Co.
Deringer Metallurgical Corp.
Wilbur B. Driver Co.
Duraloy Co., The
Eastern Stainless Steel Corp.
Electric Steel Foundry Co.
George K. Garrett Co., Inc.
Hamilton Watch Co.
Hamilton Watch Co.—Industrial Div.
Hoskins Mfg. Co.
Industrial Acoustics Co., Inc.
Johnston & Funk Titanium Corp.
Jones & Laughlin Steel Corp., Stainless & Strip Div
Earle M. Jorgensen Co.
Kentucky Metal Products Co
Charles E. Larsan & Sons, Inc.
Lebanon Steel Foundry
Lucas Aircraft Supply Co
***LYCOMING DIV., AVCO MFG. CORP.**
P. R. Mallory & Co. Inc.
Mercast Mfg. Corp
Miniature Precision Bearings, Inc.
National Forge Co.
National-Standard Co.
National Tube Div.,—United States Steel Corp.
Nesor Alloy Products Co
Peerless Machine Co.
Perfecto Cast
Precision Shapes, Inc.
Precision Tube Co., Inc.
Republic Steel Corp
Rodney Metals Inc
Joseph T. Ryerson & Son, Inc.
Ray A. Scharer & Co.
Sharon Steel Corp
Somers Brass Co. Inc
Timken Roller Bearing Co., The
U. S. Steel Supply Div., United States Steel Corp.
Universal-Cyclops Steel Corp.
Vanadium-Alloys Steel Co.
Waimet Alloys Co., Div. Consolidated Foundries & Mfg. Corp.
Wallingford Steel Co.
Washington Steel Corp
Waukesha Foundry Co.

STRONTIUM

Accurate Specialties Co. Inc.
Barium & Chemicals, Inc.
Bram Metallurgical & Chemical Co.
Delta Chemical Works, Inc.
Matheson Co., Inc., The
United Mineral & Chemical Corp.

TANTALUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
Almac Plastics Inc.
American Nickel Alloy Mfg. Corp.
American Silver Co.
Associated Engrg. & Mfg. Corp.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Damascus Tube Co.
Delta Chemical Works, Inc.
Wilbur B. Driver Co.
Hamilton Watch Co.
Hamilton Watch Co.—Industrial Div.
Haynes Stellite Co., Div.—Union Carbide Corp.
Johnston & Funk Titanium Corp.
Kennametal Inc.
***MALLORY-SHARON METALS CORP.**
Metals & Controls Corp., General Plate Div.
National Research Corp.
F. H. Paul & Stein Brothers, Inc.
Somers Brass Co. Inc.
Union Carbide Metals Co., Div.—Union Carbide Corp.
Universal-Cyclops Steel Corp

TEFLON

Aero Bolt & Screw Co., Inc.
Aero Gasket Corp.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Printed Circuits Co., Inc.
Aristocrat Plastics, Inc.
Auburn Mfg. Co., The
Auburn Spark Plug Co., Inc.
Bios Labs., Inc.
Bonny Mfg. Corp.
Chemplast, Inc.
Chicago Gasket Co.
Comco Plastics Inc.
Connecticut Hard Rubber Co., The
Continental Diamond Fibre Corp.
Crystal-X Corp.
Delta Products Div.—Air Accessories, Inc.
Dixon Corp.
E. I. Du Pont de Nemours & Co. Inc.
Electrical Insulation Co., Inc.
Emmco Plastic Fabricators—Div.—E. M. McCarthy Machine Co.
Engineered Plastics, Inc.
Fluorocarbon Co., The
Fluorulon Labs., Inc.
Form-It Products, Inc.
Franklin Fibre-Lamitex Corp.
General Gasket Inc.
Greene, Tweed & Co.
Haveg Industries, Inc.
Hitemp Wires Inc.
Huntington Rubber Mills
Illumitronic Engrg. Co.
Joclin Mfg. Co.
Jodee Plastics Co.
Thomas J. Lang, Inc.
Manshield Fabricators Inc.
Maryland Lava Co.
Mica Fabricating Co.
Peerless Machine Co.
Permacel
Polymer Corp., The
Raybestos-Manhattan, Inc.
Raybestos-Manhattan, Inc., Pa
Reinhold Engrg. & Plastics Co.
Rogers Corp.
Milton Ross Metals Co., The
Sanford Plastics Corp
Schlegel Mfg. Co
Stover Co., Inc., The
Thermech Engrg. Corp.
Topper Mfg. Co., Inc.
Tri-Point Plastics Inc.
Turbo Products, Inc
***WEATHERHEAD CO., THE**
Western International Co.

THORIUM

Accurate Specialties Co. Inc
***AMERICAN POTASH & CHEMICAL CORP.**
Associated Engrg. & Mfg. Corp.
Belmont Smelting & Refining Works, Inc.
Davison Chemical Co.
Delta Chemical Works, Inc
Metal Hydrides Inc.
Metals & Controls Corp., General Plate Div.
New Process Metals, Inc.
United Mineral & Chemical Corp.
Westinghouse Electric Corp., Lamp Div.

TIN & ALLOYS

Accurate Specialties Co. Inc.
Allied Research Products, Inc.
Allays Unlimited Inc.
Alpha Metals, Inc.
American Silver Co.
American Smelting & Refining Co.
Anchor Metal Co. Inc.
J. T. Baker Chemical Co.
Belmont Smelting & Refining Works, Inc.
Bow Solder Products Co., Inc.
Delta Chemical Works, Inc.
National Lead Co.
Nesor Alloy Products Co.
United Mineral & Chemical Corp.

TITANIUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Silver Co.
Belmont Smelting & Refining Works, Inc.
Bond Metal Surplus Co.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Continental Metals, Inc.
Crucible Steel Co. of America
Damascus Tube Co.
Delta Chemical Works, Inc.
Wilbur B. Driver Co.
E. I. Du Pont de Nemours & Co. Inc.
Foote Mineral Co.
Hamilton Watch Co.—Industrial Div.
Harvey Aluminum
Johnston & Funk Titanium Corp.
Kennametal Inc.
***LYCOMING DIV., AVCO MFG. CORP.**
P. R. Mallory & Co. Inc.
***MALLORY-SHARON METALS CORP.**
Matheson Co., Inc., The
Metal Hydrides Inc.
Metals & Controls Corp., General Plate Div.
National Lead Co.
Peerless Machine Co.

TUNGSTEN

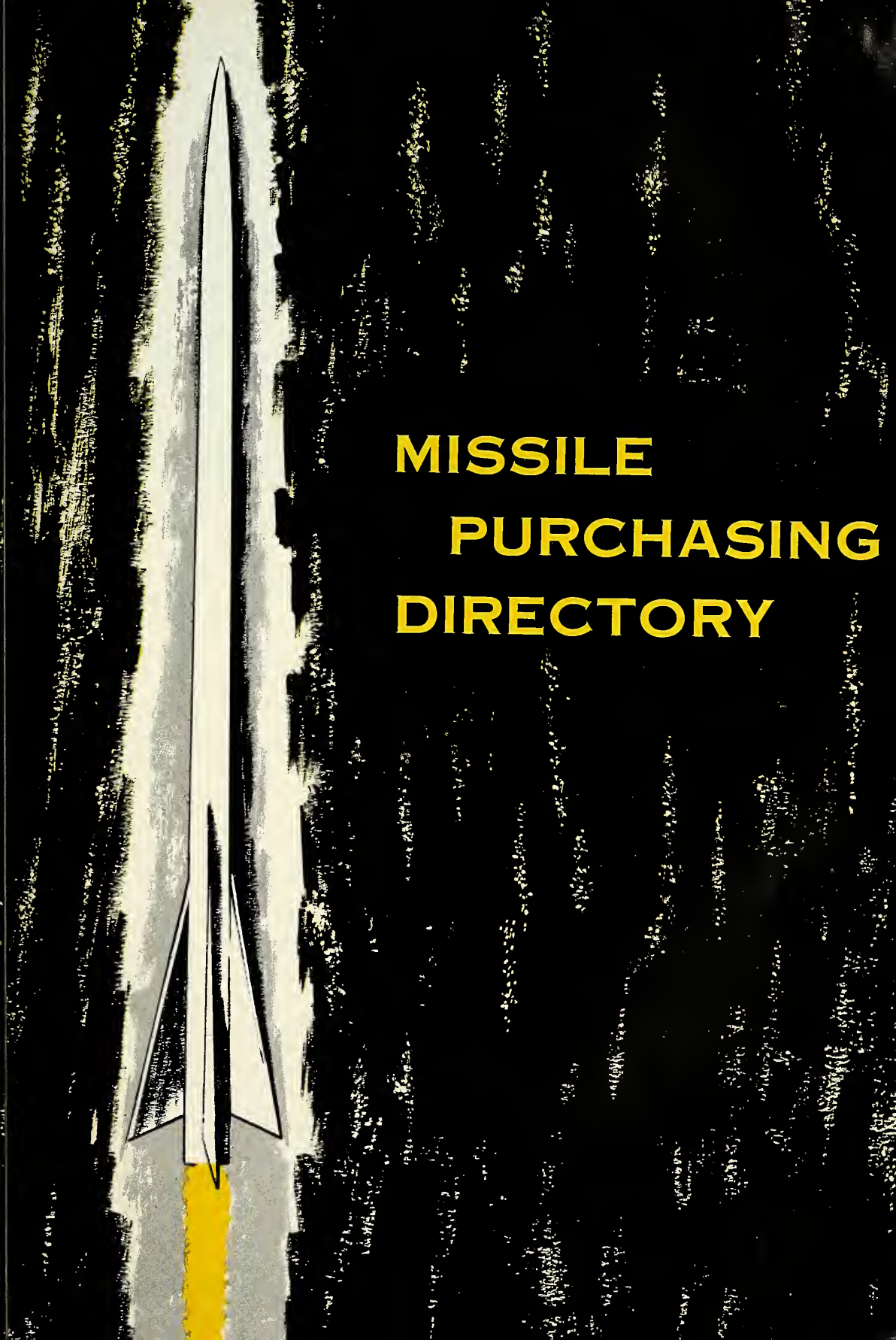
Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
Associated Engrg. & Mfg. Corp.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical & Chemical Co.
Damascus Tube Co.
Delta Chemical Works, Inc.
Eisler Engrg. Co., Inc.
Electronic Parts Mfg. Co., Inc.
Elmet Div.—North American Philips Co., Inc.
General Electric Co., Lamp Metals & Components Dept.
Johnston & Funk Titanium Corp.
Kennametal Inc.
***MALLORY-SHARON METALS CORP.**
Nesor Alloy Products Co.
Rodney Metals Inc.
Superior Carbon Products, Inc.
Sylvania Electric Products Inc., Chemical & Metallurgical Div.
Union Carbide Metals Co., Div.—Union Carbide Corp.
United Mineral & Chemical Corp.
Universal-Cyclops Steel Corp.
Waimet Alloys Co., Div. Consolidated Foundries & Mfg. Corp.
Westinghouse Electric Corp., Lamp Div.
Westinghouse Electric Corp., Metals Plant

ZINC

Accurate Specialties Co. Inc.
Allied Research Products, Inc.
Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
American Silver Co.
American Smelting & Refining Co.
Anchor Metal Co. Inc.
J. T. Baker Chemical Co.
Belmont Smelting & Refining Works, Inc.
Bond Metal Surplus Co
Delta Chemical Works, Inc.
Doehler-Jarvis Div., National Lead Co.
Eagle-Picher Co., The
Illinois Zinc Co
Matheson Co., Inc., The
National Lead Co.
United Mineral & Chemical Corp

ZIRCONIUM

Allays Unlimited Inc.
American Nickel Alloy Mfg. Corp.
American Silver Co
Associated Engrg. & Mfg. Corp.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Damascus Tube Co.
Delta Chemical Works, Inc.
Firth Sterling Inc.
Foote Mineral Co.
Hamilton Watch Co.
Hamilton Watch Co.—Industrial Div
Harvey Aluminum
Johnston & Funk Titanium Corp
P. R. Mallory & Co. Inc.
***MALLORY-SHARON METALS CORP.**
Matheson Co., Inc., The
Metal Hydrides Inc.
Metallizing Co. of Los Angeles Inc.
Metals & Controls Corp., General Plate Div
National Lead Co.
F. H. Paul & Stein Brothers, Inc.
Precision Shapes, Inc.
Roberts Industries Inc.
Rodney Metals Inc
Somers Brass Co. Inc.
United Mineral & Chemical Corp.
Universal-Cyclops Steel Corp.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Westinghouse Electric Corp., Metals Plant


MISSILE
PURCHASING
DIRECTORY



Complete facilities are under one roof



Machine shop. turret lathes. engine lathes



Bore-Matics. milling machines. drill presses

Grinding. hobbing. shaping. broaching machines



Every machined part is inspected



Stator and rotor fabricating shop



EEMCO

QUALITY CONTROL...

begins with this modern, up-to-date plant in Los Angeles, California. • As a specialist in the production of actuators, motors and generators for aircraft and missiles, every step in their manufacture is subjected to the most thorough testing for extreme precision. • EEMCO products have been noted for their reliability for more than 17 years. You can depend on EEMCO quality.

ELECTRICAL ENGINEERING & MANUFACTURING CORP.

4612 West Jefferson Boulevard, Los Angeles 16, California — Telephone REpublic 3-0151

Designers and Producers of High Precision Motors, Actuators, and Related Equipment . . . Exclusively!



Motor, clutch, generator assembly



Actuator and gear box assembly shop



Winding armatures, fields, 400 cycle stators

Every production unit is functionally tested



Safety wire, masking and paint room



Packing and shipping department



MISSILE PURCHASING DIRECTORY

Below are listed over 3,500 companies engaged in the missile business, along with their address, phone number, and key purchasing and sales personnel. Information concerning type of company activity may be determined by the coding at the end of each listing. Codings are explained in the lower right hand corner of every other page. The editors have made every effort to obtain listings for *all* companies active in the missile industry, but in an undertaking such as this, there are bound to be omissions. If we have omitted anyone who should have been included, we are sorry—and hope that our readers will inform us for correction in future editions. Write to: Editor, MISSILE MARKET & PRODUCT GUIDE, American Aviation Publications, 1001 Vermont Ave., N.W., Washington, D.C.

C ELECTRONICS DIV., GENERAL MOTORS CORP.
1925 E. Kenilworth Pl., Milwaukee 1, Wis. (Tel. BR 3-1120)
Purch. Dir.: Jock Briner
Sales & Adv. Mgr.: M. B. Price PS, GS, GE, TS
(See Page 48 for Advertisement)

F INDUSTRIES INC.
50 Third Ave., New York 17, N. Y. (Tel. YUkon 6-8600)
. P.-Purchases: Philips B. Hoyt
. P.-Mktg: Henry A. Correo
urch. Agent (Avion Div.): H. H. Parnell (Tel. COlfax 1-4100, Paramus, N. J.)
urch. Agent (Erco Plant): P. C. Nill (Tel. WArfield 7-4444, Riverdale, Md.)
urch. Agent (Reactor Engr.): E. L. Phillips (Tel. TUckerman 2-9650, Washington, D. C.)
urch. Agent (Albuquerque Plant): H. V. Wood (Tel. CHapel 7-0361, Albuquerque, N. Y.)
urch. Agent (WKM Div.): N. F. Slay (Tel. 4611, Stofford, Texas)
cting Purch. Agent (ACF Electronics): W. O. Spriggs (Tel. KIng 8-4400, Alexandria, Vo.)
ir.-Purch. (Carter Cars Div.): O. G. Teosdole (Tel. JEfferson 1-2950, St. Louis, Mo.)
MF, WN, GS, GH, GE, CO, TS, TR, R&O

A DIV., ELASTIC STOP NUT CORP. OF AMERICA
27 Newark Ave., Elizabeth 3, N. J. (Tel. ELizabeth 2-2900)
urch. Agent: R. E. Joubert
les Mgr.: W. A. Feitner

A INC.
senhower Blvd., Harrisburg, Po. (Tel. JOrdan 4-0101)
r.-Purch: George A. Beck
P.-Soles: G. Earle Walker
MF, GS, GE, CO, TS, TR

A. W. CORP.
50 N. 9th St., Elwood, Ind. (Tel. FEderol 2-3346)
urch. Agent & Prod. Mgr.: Roy M. Riske
en. Sales Mgr.: Ted Nemes

A METAL PROOUCTS MFG. CORP.
1 Bloomingdale Rd., Hicksville, L. I., N. Y. (Tel. WElls 1-1575)
urch. Agent: L. J. Wepy GS, GH

A. M. CORP.
2 Howthorne Ave., Yonkers 5, N. Y. (Tel. YOnkers 8-2010)
urch. Agent: Cloy Brandt
les Mgr.: Riva Solins MF, GS, GH, MM
es.-Soles: Michael C. Presnick

A. W. CO.
W. Main St., Rockaway, N. J. (Tel. OAkwood 7-0643)
rch. & Soles: Arthur Pfeil
les Repres.: Henry J. Abbott GE, TS

AR-ON PRECISION MFG. CORP.
0 Cosonovo St., New York 59, N. Y. (Tel. LUdlow 9-5682)
rch. Agent: Lon Orent GE

ABOTT SCREW & MFG. CO.
28 W. Walnut St., Chicago 12, Ill. (Tel. CHesopeoke 3-3500)
rch. Agent: Joseph H. Spiegel
P.-Soles: Max Cordell MF, WN, PS, GH, MM

ABSTO CORP.
Ackerman St., Bloomfield, N. J. (Tel. ED 8-6814)
W. Krumscheid MM

ABAMS INSTRUMENT CORP.
6 E. Shiowassee St., Lonsing 1, Mich. (Tel. Vanhoe 4-9441)
rch. Agent: C. E. Adoms
st. Purch. Agent: E. Conner
P.-Soles: C. J. Arksey
PS, GS, GH, GE, CO, TS, TR

Fill in No. 40 on Subscriber Service Card.

ABRASIVE ORESSING TOOL CO.
14528 Second Blvd., Oetroit 3, Mich. (Tel. TOwnsend 8-6000)
Pres.: Jerry Krondoll
Sales Mgr.: R. C. McCullough MM

ACCESSORY CONTROLS & EQUIPMENT CORP.
805 Bloomfield Ave., Windsor, Conn. (Tel. MUrdock 8-4986)
Purch. Agent: C. A. Putini
V. P.-Engrg.-Sales: John J. Kordys
MF, WN, PS, GS, GH, TS

ACCESSORY PROOUCTS CO., DIV.-TEXTRON INC.
616 W. Whittier Blvd., Whittier, Colif. (Tel. OXbow 3-3747)
Purch. Agent: Jerry Hudson
Sales Mgr.: O. A. Cordes
WN, PS, GS, GH, CO, R&O

ACCO EQUIPMENT DIV., AMERICAN CHAIN & CABLE CO., INC.
1110 E. Princess St., York, Po. (Tel. 7313)
Purch. Agent: W. E. Speck
Buyers: N. A. Husson & P. I. Polt
Sales Mgr.: E. C. Mabbs GS, GH, MM

ACCURATE ELECTRONICS CORP., Dept. O
169 S. Abbe Rd., Elyria, O. (Tel. EMerson 6-7925)
Pres.: J. F. Seybold
Plt. Engr.: T. J. Lokocy GE

ACCURATE INSTRUMENT CO.
2422 Branard St., Houston, Texos (Tel. JAckson 3-2712)
Treas.: E. E. Hopf
V. P.-Soles: J. G. Seors GE, TR

ACCURATE MFG. CO.
Hepworth Ploce, Gorfield, N. J. (Tel. GRegory 3-2900)
Pres.: V. A. DeMattio
Oir.-Soles: A. W. Rista

ACCURATE SPECIALTIES CO. INC.
37-11 57th St., Woodside, N. Y. (Tel. TWining 9-5757)
Purch. Agent: Lawrence Oiomond
Asst. Purch. Agent: Irving M. Solotoff
Buyer: Robert Moclsooc
Sales Mgr.: Nathon Zimmer MM

ACE COIL & ELECTRONICS CO.
917 Lincoln Hwy., Metuchen, N. J. (Tel. LIberty 8-3580)
Purch. Agent: A. O. Meyer
Buyer: I. M. MocOonold
Sales Mgr.: Fred Sompson GE, CO, TS, TR

ACE ORILL BUSHING CO. INC.
5407 Fountoin Ave., Los Angeles 29, Colif. (Tel. HO 9-8253)
V. P.-Mfg.: George Clement
V. P.-Soles: George T. Smith PS

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover St., Somerville 44, Moss. (Tel. SOmerset 6-5130)
Purch. Agent: Oick Mizzoni
Sales Admin.: John J. Kennedy
Sales Mgr.: George Berman GE, R&D

ACE ENGRG. & MACHINE CO., INC.
Tomlinson Rd., Huntingdon Valley, Po. (Tel. WIlson 7-1900)
Purch. Agent: Charles E. Kienzle
Sales Mgr.: Chorles C. Borden

ACE PROOUCTS CO.
1820 N. 12th. S., P. O. Box 784, Toledo 1, O. (Tel. CHerry 3-6513)
Purch. Mgr.: Emory A. Foll

ACE SPRING MFG. CO., INC.
148 32nd St., Brooklyn 32, N. Y. (Tel. Sterling 8-0100)

ACHESON COLLOIDS CO., OIV.-ACHESON INDUSTRIES, INC.
1952 Woshington Ave., Port Huron, Mich. (Tel. YUkon 4-4171)
Sales Mgr.: Arthur T. Olsson
Purch. Agent: Lester H. Miller MM

***ACK RADIO SUPPLY CO.**
3104 4th Ave. South, Birmingham 5, Alo. (Tel. FA 2-0588)
Pres.: E. C. Atkerson
Gen. Mgr.: William F. Harmon
Sales Mgr.: Edwin W. Thomos
*(See Poge 66 for Advertisement)

ACKERMAN ENGRAVERS, INC.
458 Broodwoy, New York 13, N. Y. (Tel. BArcloy 7-1479)
Pres.: Bernord Strionese
Gen. Mgr.: Michael Strionese GE, CO, TS, R&D

ACKERMAN JOHNSON CO.
625 W. Jockson Blvd., Chicogo 6, Ill. (Tel. RAndolph 6-2816)

ACME BRASS FOUNORY CO. OF SAN ANTONIO, INC.
716 Wyoming St., San Antonio 3, Texos (Tel. CApitol 7-4601)
Gen. Mgr.: Steve Margozewitz
Sales Mgr.: Mrs. Agnes M. Mahulo

ACME ELECTRIC CORP.
20 Water St., Cubo, N. Y. (Tel. Cubo 4)
Dir.-Purch.: A. J. Rudy
Dir.-Soles: J. O. Holl GE, TS, R&O

ACME INDUSTRIAL CO.
200-222 N. Loflin St., Chicogo 7, Ill. (Tel. MOnroe 6-4122)
Purch. Agent: Ronald Farrell
V. P.-Soles: Warner T. Brocken
MF, PS, GS, GE, CO, TS

ACME MFG. & GASKET CO.
738-40 N. 41st St., Philadelphio 4, Po. (Tel. EVergreen 6-8622)
Gen. Mgr.: Harry E. Wagenseller MF, PS

ACME WIRE CO.
1253 Oixwell Ave., New Hoven 14, Conn. (Tel. LO 2-2171)
Purch. Agent: Wolter Rousch
Asst. Purch. Agent: Robert Kowalchell
Pres.: H. A. Bossett MM

ACME-NEWPORT STEEL CO.
9th & Lowell Sts., Newport, Ky. (Tel. COlonial 1-5620)
Dir.-Purch.: H. M. Baker
V. P.-Soles: C. M. Riefkin MM

ACORN BEARING CO.
66 Stanley, New Britoin, Conn. (Tel. BA 9-0839)
Dir.-Soles: O. E. Malone

ACORN TOOL & MFG., INC.
York & John Sts., Cincinnati 14, Ohio (Tel. CHerry 1-2330)
V. P.: Ed Stern
Soles: Ed Krabocher MF, WN, PS

ACOUSTICA ASSOCIATES, INC.
26 Windsor Ave., Mineola, N. Y. (Tel. Pioneer

CODING
Missile Frome MF
Worhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Moteriols & Metals MM

7-7900)
Purch. Agent: Arthur Baumach
V. P.-Sales: Ralph Reynolds
PS, GS, GH, GE, CO, TS, TR

ACRO DIV., ROBERTSHAW-FULTON CONTROLS
2040 E. Main St., Columbus 16, O. (Tel. CL 3-8S31)
Purch. Agent: A. Lafferty
Mktg. Mgr.: M. S. Feltz

ACROMAG INC.
22S19 Telegraph Rd., Detroit 41, Mich. (Tel. ELgin 6-7211)
Purch. Agent: Robert G. Hennings
V. P.-Sales: T. N. Jones GE, CO, TS, TR, R&D

ACROMARK CO., THE
445 Marrell St., Elizabeth 4, N. J. (Tel. ELizabeth 2-6500)
Purch. Agent: M. A. Palmiere
Gen. Sales Mgr.: W. R. Heine, Jr.

ACTON LABORATORIES INC.
S33 Main St., Acton, Mass. (Tel. CDlonial 3-77S6)
Prod. Mgr.: Richard Hall
Sales Mgr.: Leroy C. Bower, Jr. GE, TS, TR, R&D

ACTUATION RESEARCH CORP.
416 N. Glendale Ave., Glendale 6, Calif. (Tel. CHapman S-6866)
Mat. Coordinator: B. G. Mueller
Sales Mgr.: E. H. Mitchell GS, R&D

ACTUATOR PRODUCTS DIV., GEARTRONICS CORP.
10 Nashua St., Waburn, Mass. (Tel. WElls 3-1400)
Purch. Agent: Albert N. Galante
Sales Mgr.: John H. Lyman
MF, GS, GH, GE, CO, TS, TR

ADAM METAL SUPPLY INC.
4-63 48th Ave., Long Island City 1, N. Y. (Tel. STillwell 6-7737)
V. P.-Purch.: Jules Brody
Sales Mgr.: Al Bernard MM

R. P. ADAMS CO., INC.
Dept. M & R, Box 14S, Kenmore Branch, Buffalo 17, N. Y. (Tel. Victoria 2608)
Purch. Agent: T. J. Wintermute
Gen. Sales Mgr.: L. M. Rawlings

ADAMS RITE MFG. CO.
540 W. Chevy Chase Dr., Glendale 4, Calif. (Tel. CHapman S-1096)
Dir.-Purch.: J. Rocca
Dir.-Dev. & Chief Sales Engr.: Donnell Grizzard GS

AOEL PRECISION PRODUCTS, DIV.-GENERAL METALS CORP.
1444 Washington Ave., Huntington, W. Va. (Tel. JA 2-734S)
Purch. Agent: D. V. Reynolds
Sales Mgr.: H. G. Shy MF, GS, GH, TS

ADEL PRECISION PRODUCTS OF CALIF., DIV.-GENERAL METALS CORP.
10777 Vanowen St., Burbank, Calif. (Tel. STanley 7-2611)
Purch. Agent: A. Haines
Gen. Mgr.: L. P. Wansink GS, GE

ADEPT INDUSTRIES INC.
1636 W. Hunting Park Ave., Philadelphia 40, Pa. (Tel. DAvenport 4-6800)
Purch. Agent: Sidney Whitman
Sales: John F. Sohl
MF, WN, PS, GS, GE, CO, TS, TR

ADHESIVE ENGRG. DIV.-HILLER AIRCRAFT CORP.
1411 Industrial Rd., San Carlos, Calif. (Tel. LYtell 1-2686)
Purch. Agent: W. E. Schneider
V. P.-Sales: John L. Morrill MF, MM, R&D

ADLER ELECTRONICS, INC.
1 Le Fevre Lane, New Rochelle, N. Y. (Tel. NE 6-1620)
Purch. Agent: Eugene Laks
V. P.-Sales: Alfred Strogoff GS, CO, TS, TR, R&D

ADVANCE CARBON & ELECTRIC MFG. CO.
2S05 Mariposa St., San Francisco 10, Calif. (Tel. HEmlock 1-4034)
Dir.-Purch.: Boyd Bithell
Sales Mgr.: W. J. Crader GE, CO, TS, TR, MM, R&D

ADVANCE GEAR & MACHINE CORP.
58S1 Holmes Ave., Los Angeles 1, Calif. (Tel. LUdlow 7-8103)
Purch. Agent: Stan Jackson
Sales Mgr.: Raymond L. Seitz PS, GE, TS, TR

ADVANCE RELAYS, ELECTRONICS DIV., ELGIN NATIONAL WATCH CO.
2435 N. Noomi St., Burbank, Calif. (Tel. VI 9-1446)
Purch. Agent: J. Shrieber
Natl. Sales Mgr.: Gene Straube
GS, GH, GE, CO, TS, TR

ADVANCED ELECTRONICS, INC.
94 Silas Deane Hwy., Rocky Hill, Conn. (Tel. JAckson 9-6881)
Purch.: Alfred Dinunzio
Sales: Sam Friedman MF, PS, GS, GH, GE, CO, TS

ADVANCED ELECTRONICS MFG. CORP.
2116 S. Sepulveda Blvd., Los Angeles 2S, Calif. (Tel. GRanite 8-9220)
Pres.: Dovid Rutland
V. P.-Sales: B. F. Ambrosio GS

ADVANCEO PRODUCTS CO., THE
S9 Broadway, North Haven, Conn. (Tel. CEdar 9-1664)
Treas.: Arthur Hostoge
MF, WN, PS, GS, GH, GE, CO, TS, TR

AD-YU ELECTRONICS LAB., INC.
249 Terhune Ave., Passaic, N. J. (Tel. GRegory 2-S622)
Purch. Agent: N. Slinger TS, R&D

AER, INC.
871 E. Washington St., Pasadena, Calif. (Tel. SY 4-972S)
Dir.-Purch.: L. E. Pritchard
Dir.-Res.: Dr. A. J.A. Morgan R&O

AERO BOLT & SCREW CO., INC.
2S W. Hartsdale Ave., Hartsdale, N. Y. (Tel. RDckwell 1-0210)
Purch. Agent: F. DiBiase
Sales Mgr.: A. Oliver

AERO ELECTRONICS CORP.
16S7 W. 134th St., Gardena, Calif. (Tel. FAculty 1-2196)
Gen. Mgr.: Stephen E. Taylor
Chief Engr.: James X. Green
Prod. Mgr.: Gracia Green TR

AERO GASKET CORP.
763 Hanover Rd., Meriden, Conn. (Tel. BEverly S-3361)
Dir.-Purch.: Rhoda Hurwitz
Dir.-Sales: Raymond C. Schmitt PS

AERO INSTRUMENT CO.
11423 Vanowen St., North Hollywood, Calif. (Tel. STanley 7-S433)
Pres.: T. O. Cox
Asst. Secy.: Mrs. L. Hough

AERO INSTRUMENT CO., INC.
S10S Denison Ave., Cleveland 2, O. (Tel. WOodbine 1-SS74)
Gen. Mgr.: Emil Daiber GE

AERO LEATHER PRODUCTS CO.
1740 W. S9th St., Los Angeles 47, Calif. (Tel. PLeasant 3-1461)
V. P.-Purch.: C. E. Seymour
Gen. Sales Mgr.: W. E. Seymour MF, PS, GE, TR

AERO RESEARCH INSTRUMENT CO. INC.
31S N. Aberdeen St., Chicago 7, Ill. (Tel. TAylor 9-6400)
Purch. Agent: D. Bernstein
Gen. Mgr.-Sales: Arthur Anderson TS, TR, R&D

AERO SUPPLY MFG. INC.
611 W. Main St., Corry, Pa. (Tel. 2-8261)
Purch. Agent: P. E. Dwyer
Buyer: Dean Houser
V. P.-Sales & Engrg.: E. F. Pain
MF, WN, PS, GS, GH, GE, CO, TS, R&D

AEROCHEM RESEARCH LABS., INC.
P. O. Box 12, Princeton, N. J. (Tel. WAlnut 1-7070)
Gen. Mgr.: George R. Bent, II R&D

AERODEX, INC.
P. O. Box 123 (Airport Br.), Miami 48, Fla. (Tel. TUxedo 5-2411)
Purch. Agent: A. Van Wagner
Buyer: Ralph LaPerche
Sales & Serv. Mgr.: Hermann Waker, Jr. MM

AEROFLEX CORP., THE, AEROFLEX LABS. DIV.
34-06 Skillman St., Long Island City 1, N. Y. (Tel. STillwell 4-7000)
V. P.-Sales: R. G. Sanders MF, GS, GE, TS, TR

AEROIL PRODUCTS CO., INC.
69 Wesley St., South Hackensack, N. J. (Tel. Diamond 3-S200)
Sales Dir.: M. M. Yarrington

AEROJET-GENERAL CORP.
63S2 N. Irwindale Ave., Azusa, Calif. (Tel. CUmberland 3-6111)
Purch. Agent: John Roth
WN, PS, GS, GE, CO, TS, R&D

AEROLAB DEVELOPMENT CO.
330 W. Holly St., Arcadia, Calif. (Tel. SYcamore 3-1184)
Works Mgr.: A. C. MacMillan
Purch. Agent: A. Grenon
Sales & Contracts Mgr.: J. W. Reed
MF, PS, GS, GE, R&D

AEROLITE ELECTRONICS CORP.
2207 Summit Ave., Union City, N. J. (Tel. UNion 3-29SS)
Purch. Agent: V. G. Matto
MF, WN, PS, GS, GH, GE, CO, TS, TR

AERONAUTICAL & INSTRUMENT DIV., ROBERTSHAW-FULTON CONTROLS CO.
Santa Ana Freeway at Euclid Ave., Anaheim, Calif. (Tel. KEystone 5-81S1)
Purch. Agent: L. L. Moloney
Asst. Purch. Agent: W. Houseworth
Buyers: W. Hamilton & J. Krause
Mgr.-Field Engrg. & Sales: R. H. Heller GS, CO

AERONCA MFG. CORP.
1712 Germantown Rd., Middletown, O. (Tel. GArden 2-27S1)
Dir.-Purch.: R. M. Paul
Dir.-Material Negotiation Section: Thomas Brunjes
V.P.-Tech. Services Div.: Ray F. Hermes MF, GS

AERONCA MFG. CORP.-BALTIMORE FACILITY
Hilltop & Frederick Rds., Baltimore 29, Md. (Tel. RIdgeway 7-0200)
Purch. Agent: G. M. Swesey
Dir.-Sales: J. W. Colleran GS, CO, R&D

AERONUTRONIC SYSTEMS, INC., SUB.-FORO MOTOR CO.
Ford Rd., Newport Beach, Calif. (Tel. DRiole 3-2S20)
Mgr.-Purch.: C. D. Graef
Purch. Agent, Computer Div.: Gregory S. Cadice
Dir.-Mktg., Computer Div.: S. D. Wanlass
Dir.-Mktg., Space Tech.: C. G. Gant
Dir.-Mktg., Range Systems: J. R. Ambrose
MF, WN, PS, TS, TR, MM, R&D

AEROPRODUCTS OPERATIONS, ALLISON DIV., GENERAL MOTORS CORP.
Municipal Airport, Dayton, O. (Tel. TWinoaks 8-4661)
Mgr.-Purch.: J. E. Baird
Asst. Purch. Agent: W. S. Neff
Purch. Parts Buyer: F. A. White
Mgr.-Sales, Serv. & Contracts: C. E. Dixon
WN, PS, GS, GE, TS

AEROQUIP CORP., JACKSON DIV.
300 S. East Ave., Jackson, Mich. (Tel. STate 2-0361)
Purch. Mgr.: Lewis A. Greene
Gen. Sales Mgr.: F. W. Schwier
MF, PS, GS, GH, GE

AEROSCIENCE, INC.
3155 N. Rosemead Blvd., Rosemead, Calif. (Tel. ATlantic 0-2112)
Purch. Agent: S. R. Young
Dir.-Sales: T. M. Morrow PS, GH, TS, R&D

AEROTEC CORP., THE
Pemberwyck Rd., Greenwich, Conn. (Tel. JEfferson 1-8400)
Dir.-Planning & Procurement: Harold Anderson
Sales Mgr.: Thomas Walker
MF, WN, PS, GS, GH, GE

AEROTEST LABORATORIES, INC.
129-11 18th Ave., College Point S6, N. Y. (Tel. INdependence 1-7272)
Purch. Agent: S. Liebtreund
Sales Mgr.: L. Permut CO, T

AEROVOX CORP.
740 Belleville Ave., New Bedford, Mass. (Tel. WYman 4-9661)
Purch. Agent: Robert Crabbe
Buyers: Edward Hickey, John Warren, Fred Graeben, Joe Desjarins G
V. P.-Sales: Frank Marshall

AETNA ELECTRONICS CORP.
Readington Rd., North Branch, N. J.
Purch. Agent: Robert McDonald
Dir.-Sales: Henry J. Buser, Jr. T

AINSLIE CORP.
312 Quincy Ave., Quincy 69, Mass. (Tel. GRanite 2-8747)
Purch. Agent: L. D. Ainslie
Sales: H. W. Ainslie
MF, PS, GS, GE, CO, TS, T

AIR FILTER CORP.
4SS4 W. Woolworth Ave., Milwaukee 18, Wis. (Tel FLagstone 3-S800)
V.P.-Purch.: R. J. Breckheimer GS,
Sales: Rodger J. Clark

AIR FRAME INSPECTION INC.
10801 Sessler St., South Gate, Calif. (Tel. TOpaz 1-6733)
Dir.-Sales: B. H. Smith

IR LOGISTICS CORP.
3600 E. Foothill Blvd., Pasadena, Calif. (Tel. SYcamore 6-7191)
Mgr.-Materiel: G. A. Tietz
Chief Purch. Agent: C. J. Wilson
Supvr.-Buyers: M. F. Hientz
V. P.-Engrg. & Customer Relations: C. J. Breitwieser
GS, GH, CO

IR PRODUCTS, INC.
Allentown, Pa. (Tel. Express 5-3311)
Gen. Purch. Mgr.: F. B. Drake
Purch. Agent: A. Wilson
Gen. Sales Mgr.: D. E. Cummings
PS, GS, GH

IR REDUCTION SALES CO., DIV.-AIR REDUCTION CO., INC.
150 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 2-6700)
Gen. Purch. Agent: R. N. Chopin
Asst. Adv. & Sales Prom. Mgr.: William C. Bettes
MF, PS, GS

R SPEED TOOL CO.
1502 W. Slauson Ave., Los Angeles 47, Calif. (Tel. PLeasant 2-8340)
Gen. Mgr.: H. J. Thiessen
Asst. Gen. Mgr.: R. G. Zimmerman
Purch.: H. L. Johnson
PS, GS, TS

RATERRA
620 Paulo Ave., Glendale 1, Calif. (Tel. CHapman 5-1196)
Purch. Agent: Jack Schroeder
V. P.-Sales: Don Butler
GS, GH, TS, R&D

RBORNE ACCESSORIES CORP.
1414 Chestnut Ave., Hillside 5, N. J. (Tel. MU 8-0250)
Purch. Agent: P. Marantz
Pres. & Gen. Mgr.: W. Cortlyn Rhodes
MF, WN, GS, GH

RBORNE INSTRUMENTS LAB., DIV.-CUTLER-HAMMER, INC.
345 New York Ave., Huntington Station, N. Y. (Tel. MYrtle 2-6100)
Dir.-Procurement: George Hansen
Dir.-Mktg.: M. J. Rowe
GS, CO, TS, R&D

RBORNE RESEARCH & DEVELOPMENT CORP.
1530 San Fernando Rd., Sun Valley, Calif. (Tel. STanley 7-9647)
Purch. Agent: Neil Baren
Sales Mgr.: Richard B. Blythe
MF, WN, PS, GS

COM INC.
54 Main St., Winthrop, Mass. (Tel. OCean 3-3096)
Chief Engr.: Robert A. Rivers
Sales Mgr.: Edward J. Stack
TR, R&D

COM INC. OF NEW JERSEY
89 E. First Ave., Roselle, N. J. (Tel. CHestnut 5-2990)
Asst. Purch. Agent: O. Nodel
P.-Sales: R. LeNoble
GE, CO, TR

CRAFT ARMAMENTS, INC.
Hockeysville, Md. (Tel. VAlley 5-8400)
Chief-Procurement: Bloine M. Swartz
P.-Sales: Robert B. Chapman, III.
WN, GS, GH, CO, TR, R&O

CRAFT COMPONENTS, INC.
25 Woodland Ave., Twin Cities Airport, Benton Harbor, Mich. (Tel. WAlnut 5-8861)
Pres.: C. O. Zollar
Sales Mgr.: C. R. Raines
Asst. Sales Mgr.: R. E. Green

CRAFT CONTROLS CO., DIV., GORN ELECTRIC CO., INC.
25 Main St., Stamford, Conn. (Tel. Fireside 8-7591)
Purch. Agent: A. J. Saraceno
Dir.-Sales Engrg.: A. H. Morgan

CRAFT EQUIPMENT DIV.-CONSOLIDATED DIESEL ELECTRIC CORP.
60 Canal St., Stamford, Conn. (Tel. OAvis 5-2261)
Asst. Dir.-Opns.: J. F. Campbell
Purch. Agent: J. Kistner
Chief, Quotations: C. Ziehl
P.-Sales: Gerald Rosenberg
PS, GS, GH

CRAFT EQUIPMENT TESTING CO., INC.
1212 Fleet St., Baltimore 31, Md. (Tel. ORleans 5-8337)
Pres.: Harry P. Kupiec
TS, R&D

CRAFT FITTING CO., THE
1 N. Federal Hwy., Dania, Fla. (Tel. WAbash 3-2331)
Asst. Purch.: Paul Hummel
Sales Mgr.: H. P. Borger
MF, PS, GS

CRAFT MECHANICS, INC.
200 N. Nevada Ave., Colorado Springs, Colo. (Tel. MElrose 2-7687)
Pres.: Edwin Aro
Engr.: A. S. McConn
MF, GS, GH

CRAFT POROUS MEDIA, INC.
Seo Cliff Ave., Glen Cove, N. Y. (Tel. ORiole 1-4000)
Purch. Agent: N. Friedmon
Sales Mgr.: J. A. Whitwell
GS, GH, GE, CO, TS

AIRCRAFT PRECISION PRODUCTS, INC.
8720 North End Ave., Oak Park 37, Mich. (Tel. JOrdon 4-5830)
Purch. Agent: W. W. Henderson, Jr.
PS, R&O

AIRCRAFT PRODUCTS DIV.-CLINE ELECTRIC MFG. CO.
3405 W. 47th St., Chicago, Ill. (Tel. CLiffside 4-7500)
Production Mgr.: Harold Hicks
GS, GH

AIRCRAFT TOOLS, INC.
9030 Bellanca Ave., Los Angeles, Calif. (Tel. OR 8-3432)
Purch. Agent: William Avey
Asst. Purch. Agent: Paul Dowd
Buyer: D. Jackson
V. P.-Sales: H. W. Dellett
MF, GS, GH

AIROESIGN CORP.
241 Fairfield Ave., Upper Darby, Pa. (Tel. GRonite 4-8000)
Purch. Agent: James LaBelle
Sales Mgr.: Mervin I. Beard
GS, GE

AIROROME PARTS CO.
922 W. Hyde Park Blvd., Inglewood 3, Calif. (Tel. ORegon 8-7133)
Purch. & Prod. Mgr.: Harold O. Stout
Sales Mgr.: Walter J. Parker
MF, GS, GH, TS, R&D

AIRECO, INC.
2323 Second Ave. Corman, Schenectady, N. Y. (Tel. EL 5-6545)
Secy.: F. DiGennaro
Pres.: H. Levine
TS

***AIRESEARCH MFG. OF ARIZONA**
402 S. 36th St., Phoenix, Ariz. (Tel. BRidge 5-6311)
Dir.-Purch.: Leslie Rhuart
Sales Mgr.: Stan Whittaker
PS, GS
*(See Page 43 for Advertisement)

***AIRESEARCH MFG. CO. DIV., THE GARRETT CORP.**
9851 Sepulveda Blvd., Los Angeles 45, Calif. (Tel. SP 6-1010)
Purch. Agent: B. Schindler
Sales Mgr.: P. M. Bartlett
MF, PS, GS, GH, GE, CO, R&D
*(See Page 43 for Advertisement)

AIRFLYTE ELECTRONICS CO.
535 Ave. A, Bayonne, N. J. (Tel. HEmlock 6-2230)
Purch. Agent: Ben Novy
Buyer: O. Pintoura
Sales Dir.: Milton Feinman
GS, GE, TR

AIRGUIOE INSTRUMENT CO.
2210 Wabansio Ave., Chicago 47, Ill. (Tel. HUmboldt 6-3000)
V. P.-Sales: Fred D. Eckert

AIR-MARINE MOTORS, INC.
369 Bayview Ave., Amityville, N. Y. (Tel. AMityville 4-3700)
Purch. Agent: Paul Harrington
Sales Mgr.: David H. Thomas
Sales Mgr. (E/C Div.): William Sly
GS, GE, R&O

AIR-MAZE CORP.
25000 Miles Rd., Cleveland 28, O. (Tel. MOntrose 2-8000)
Dir.-Purch.: James Carson
Sales Mgr.: John M. Clem
PS, GS, GH

AIRPAX ELECTRONICS INC., SEMINOLE DIV.
Fort Lauderdale, Fla. (Tel. LUdlow 3-6160)
Purch. Agent: R. Oondelinger
Gen. Sales Mgr.: J. Sullivan
GS, TS, TR, R&O

AIRTEMP DIV., CHRYSLER CORP.
1610 Webster St., Dayton 1, Ohio (Tel. BAldwin 3-2141)
Purch. Agent: H. M. Coy
Purch. Supvr.: C. L. Buck
GS

AIRTRON INC. DIV.-LITTON INDUSTRIES
200 E. Hanover Ave., Morris Plains, N. J. (Tel. JEfferson 9-5500)
Dir. Purch.: H. Carrin
Sales Mgr.: J. Roveto
GS, GE, TR

AIRTRONICS INTERNATIONAL CORP.
6900 W. Rd. 84, P. O. Box 8576, Ft. Lauderdale, Fla. (Tel. LUdlow 3-4541)
Purch. Agent: Paul Best
Pres.: Robert G. Kramer
GS

AIRWORK CORP.
5245 N. W. 36th St., Miami Springs, Fla. (Tel. TUxedo 8-3467)
Connector Sales: R. R. Read
PS, GS, GE

AKRON BRASS MFG. CO., INC.
Wooster, Ohio (Tel. HOward 2-0070)
Purch. Agent: F. B. Watson
V. P.-Sales: Harold Strain

ALAC, INC.
365 W. Arden St., Glendale, Calif. (Tel. CHapman 5-3787)
Sales Mgr.: Milton Terklo

ALAD ALUMINUM LADDER CORP.
7260 Melrose Ave., Los Angeles 46, Calif. (Tel. WEbster 4-5000)
Gen. Sales Mgr.: F. A. von Baum
GH, GS

ALADDIN ELECTRONICS, DIV.-ALADDIN INDUSTRIES INC.
705 Murfreesboro Rd., Nashville 10, Tenn. (Tel. CH 2-3411)
Prod. Control Mgr.: F. G. Bassler
Purch. Agent: William B. Patterson
V. P. & Gen. Mgr.-Sales: W. W. Stifler
GE, CO, TS, TR, R&D

ALBANO CO. INC.
549-555 W. 54th St., New York, N. Y. (Tel. PLaza 7-5888)

ALBION INDUSTRIES, INC.
816 N. Clark St., Albion, Mich. (Tel. NAtional 9-3965)
Purch. Agent: C. W. Burns
Gen. Mgr.: J. F. Karmolski

ALCAR INSTRUMENTS, INC.
17 Industrial Ave., Little Ferry, N. J. (Tel. HUbbard 9-3040)
V. P.-Purch.: Louis R. Jeffrey, Jr.
PS, GS, GH, GE, CO, TS, TR

ALCD PRODUCTS, INC.
P. O. Box 1065, Schenectady 1, N. Y. (Tel. FRanklin 7-3311)
Dir.-Procurement: E. J. Van Volkenburgh
Sales Mgr., Nuclear & Defense Products: A. T. Lawrence
PS, GH, MM, R&D

ALCO VALVE CO.
865 Kingsland Ave., St. Louis 5, Mo. (Tel. PArkview 5-2460)
Proc. Dir.: W. F. Helfrich
Buyers: Wm. C. Calvin & Jack DeCormier
Mgr.-Aircraft Sales: W. F. Lochmoeller
MF, PS, GS

ALDEN PRODUCTS CO.
154 N. Main St., Brockton, Mass. (Tel. JUniper 3-0160)
Purch. Agent: A. E. Illsley
Sales Mgr.: N. W. Hearn
MF, PS, GS, GH, GE, CO, TS, TR

ALECTRIC MFG. CO.
7842 39th Ave., Kenosha, Wisc. (Tel. OLympic 7-3248)
Owner: J. B. Winther
Plant Mgr.: V. Zens
TS

ALFAX PAPER & ENGRG. CO.
Washington St., Westboro, Mass. (Tel. FOrest 6-4467)
Chief Engr.-Purch.: E. O. Cross
Plant Mgr.-Sales: S. C. Sviokla
TR

AL-FIN DIV., FAIRCHILD ENGINE & AIRPLANE CORP.
Commack Rd., Deer Park, L. I., N. Y. (Tel. DEer Park 2-7211)
Chief Engr.: R. E. Seal
Sales: H. W. Crusey
MF

ALFORD MFG. CO.
299 Atlantic Ave., Boston, Mass. (Tel. HAncock 6-2150)
Purch. Agent: Robert O'Brien
Sr. Engr.-Sales: Harold H. Leach
TS

ALFRED ELECTRONICS
897 Commercial St., Palo Alto, Calif. (Tel. DAvenport 6-6496)
Purch.: Al Jew
Sales Mgr.: Paul N. Fulton
GE, CO, TS, TR

ALL AMERICAN ENGRG. CO.
Box 1247, Wilmington, Del. (Tel. WYman 4-0951)
Purch. Agent: John F. Stocki
Head, Military Proj.: Chuck J. Daniels
Head, Comm. Proj.: Edwin B. Pierce
GS, GH, R&D

ALL AMERICAN TOOL & MFG. CO.
8027 Lawndale Ave., Skokie, Ill. (Tel. ORchard

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

3-7084)
Gen. Mgr.-Purch.: S. K. Hein
Chief Engr.-Purch. & Sales: Robert O. Hein **TS**

ALL BORO METAL PRODUCTS CO., INC.
610 Fenimore Rd., Mamaroneck, N. Y. (Tel. OWens 8-0104)
V. P.-Purch.: H. B. Maxwell
Purch.: J. J. Schnapp & H. M. Sterling **MF, PS, GH**

ALL PRODUCTS CO.
P. O. Box 110, Mineral Wells, Tex. (Tel. FAirfax 5-3301)
Purch. Agent: Harry Opanowitz **GS, TR, R&D**

ALL SPECS CORP.
145 Paterson Ave., Wallington, N. J. (Tel. GR 1-4700)
Pres.: H. London
V. P.-Purch.: H. Mohrwinkel
MF, WN, PS, GS, GH, GE, R&D

ALLEGANY INSTRUMENT CO., INC.
1091 Wills Mountain, Cumberland, Md. (Tel. PArkview 4-1200)
Purch. Agent: Miss Helen Whiteman
Sales Mgr.: Charles K. Johnson **GS, TS**

ALLEGHENY BALLISTICS LAB.
Cumberland, Md.

ALLEGHENY LUDLUM STEEL CORP.
Oliver Bldg., Pittsburgh 22, Pa. (Tel. COurt 1-5300)
V. P.-Purch.: L. H. Bittner
V. P.-Sales: W. B. Pierce **MM**

R. C. ALLEN AIRCRAFT INSTRUMENT DIV., R. C. ALLEN BUSINESS MACHINES, INC.
333 Commerce St., S. W., Grand Rapids, Mich. (Tel. GL 6-8541)
Purch. Agent: F. C. Paterson
V. P.-Sales: Henry A. Greene **GE, TR**

ALLEN AIRCRAFT PRODUCTS, INC.
Rovenna, O. (Tel. AX 6-9621)
Purch. Agent: Russ Lengs
Sales Mgr.: Wm. H. Salladay **PS, GS**

ALLEN MFG. CO.
Orawer 570, Hartford 1, Conn. (Tel. CH 2-8511)
Purch. Agent: Wm. A. MacOonald
V. P.-Sales: W. D. Horner **MF, PS**

ALLEN TOOL CORP.
308 Maltbie St., Syracuse, N. Y. (Tel. GR 2-4426)
Sales: Lawrence C. Miner & Norman C. Thompson
Office Mgr.: Jay J. Amidon **R&D**

ALLENAIR CORP.
255 E. Second St., Mineola, N. Y. (Tel. Ploneer 7-5450)
Purch. Agent: Irving Charm
Sales: A. C. Kelly **PS, GS**

***ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.**
40 Rector St., New York 6, N. Y. (Tel. HAnover 2-7300)
Dir.-Purch.: W. B. Machmer, Jr.
Mgr.-Purch.: J. A. Simpson
Mgr.-Sales: C. P. Berdell **MM**
*(See Page 45 for Advertisement)

ALLIED CHEMICAL CORP., NATIONAL ANILINE DIV.
40 Rector St., New York 6, N. Y. (Tel. HAnover 2-7300)
Sales: P. T. Oertel

ALLIED CHEMICAL CORP., NITROGEN DIV.
40 Rector St., New York 6, N. Y. (Tel. HAnover 2-7300)
Dir.-Industrial Sales: John J. Porter
Dir.-Prod. Dev. & Tech. Sv.: R. M. Jones

ALLIED CONTROL CO., INC.
2 E. End Ave., New York, N. Y. (Tel. BUtterfield 8-7403)
Purch. Agent: Carl Holland
Gen. Sales Mgr.: Edward Bachorik **GS, GE, CO, TS**

ALLIED DECALS, INC.
8400 Hough Ave., Cleveland 3, O. (Tel. SW 1-6863)

ALLIED INTERNATIONAL CO.
230 Park Ave., New York 17, N. Y. (Tel. MU 9-6126)
Asst. Secy.: Ed Nemeth
V. P.-Sales: Oon Marshall

ALLIED PLASTICS SUPPLY CORP.
75 Cliff St., New York 38, N. Y. (Tel. BEekman 3-7377)
Pres.-Sales: Morton B. Mavrick
V. P.-Purch.: Raymond O. Vetter
MF, WN, PS, GS, GE, CO, TS, TR

ALLIED RESEARCH & ENGRG., DIV.-ALLIED RECORD MFG. CO.
6916 Santa Monica Blvd., Hollywood 38, Calif. (Tel. HOllywood 2-1251)
Purch. Agent: Jack Kalk
Sales Mgr.: Bruce C. Jones **GE, R&D**

ALLIED RESEARCH PRODUCTS, INC.
4004 E. Monument St., Baltimore 5, Md. (Tel. PE 2-9070)
Purch. Agent: H. C. Quast
V. P.-Sales: J. A. Cairns **MM**

ALLIED WITAN CO. INC.
12500 Bellair Rd., Cleveland 35, O. (Tel. WInton 1-2800)
Purch. Agent: S. J. Gibel
Sales Mgr.: George Gibel **GH, CD, TS**

ALLIES' PRODUCTS CORP.
P. O. Box 188, Kendall Branch, Miami 56, Fla. (Tel. CEdar 5-5424)
Sales Mgr.: Miss Hazel I. Brown

ALLIS-CHALMERS
Milwaukee 1, Wisc. (Tel. SPring 4-3600)
Dir.-Purch.: K. R. Geist
Dir.-Sales: C. W. Schweers **MM**

ALLISON LABS.
14185 Skyline Or., La Puente, Calif. (Tel. OXford 4-4056)
Dale E. O'Donnell **R&D**

ALLISON STEEL MFG. CO.
19th Ave. & SP Tracks, P. O. Box 6067, Phoenix, Ariz. (Tel. ALpine 8-7731)
Purch. Agent: L. M. Farr
Sales Mgr.: E. J. Peake **GS, GH**

ALLMETAL SCREW PRODUCTS CO., INC.
821 Stewart Ave., Garden City, L. I., N. Y. (Tel. Ploneer 1-1200)
Dir.-Purch.: P. Fishmon
Purch. Agent: J. Segal
Buyer: F. Risteyn
Sales Mgr.: S. R. Marsh **MM**

ALLOY BELLOWS INC.
18123 Roseland Rd., Cleveland 12, O. (Tel. IVanhoe 6-3990)
Dir.-Purch.: E. Fantine
Pres.: R. W. Pettersson

ALLOY STEEL CASTING CO.
202 County Line Rd., Southampton, Pa.

ALLOY STEEL PRODUCTS CO.
1300 W. Elizabeth Ave., Linden, N. J. (Tel. WAbash 5-4600)
Purch. Agent: W. Bugher
Gen. Sales Mgr.: R. E. Boller, Jr. **GS, TS**

ALLOYS UNLIMITED INC.
21 — 01 43rd Ave., Long Island City 1, N. Y. (Tel. STillwell 6-4480)
Purch. Agent: H. Tang
Dir.-Sales: G. Coleman **MM**

ALL-STATE WELDING ALLOYS CO., INC.
249 Ferris Ave., White Plains, N. Y. (Tel. WH 8-4646)
Purch. Dir.: Charles J. Oleson
Sales Mgr.: Lee S. Wade **MF, PS, GE, TR, MM**

ALL-TRONICS, INC.
45 Bond St., Westbury, N. Y. (Tel. EDgewood 3-3090)
Purch. Agent: Theodore Silvia
Sales Mgr.: Stephen E. Bullock, Jr.
GS, GE, TS, TR, R&D

ALMAC PLASTICS INC.
600 Broodway, New York 12, N. Y. (Tel. REctor 2-2275)
V. P.: James Grad **MM**

ALPAR MFG. CORP.
220 Demeter St., Palo Alto, Calif. (Tel. DAvenport 6-8105)
Off. Mgr.: Paul Rochester
Sales Mgr.: R. V. Laustrup **GS, TR**

ALPHA METALS, INC.
56 Water St., Jersey City, N. J. (Tel. HEnderson 4-6778)
Field Mgr.: Martin A. Boyle **MM**

ALPHA MOLYKOTE CORP., THE
65 Harvard Ave., Stamford, Conn. (Tel. FI 8-3724)
V. P.-Purch.: C. E. Sonntag
Dir.-Sales: Oavid M. Noltie **MM**

ALPHA WIRE CORP.
200 Varick St., New York 14, N. Y. (Tel. ALgonquin 5-5400)
Purch. Agent: Sheldon Ellenoff
Asst. Purch. Agent: John Gallagher
Gen. Mgr.-Sales: Howard B. Soltzman
MF, PS, GS, GH, TS, TR

ALPINE ELECTRONIC COMPONENTS, INC.
Wolcott Rd., Waterbury, Conn. (Tel. PLoza 7-1449)
Pres.: Thomas Rowlson
Buyer-Mat.: Joseph Pagano
Asst. Buyer: Ted J. Iorio
V. P.-Sales: Richard Sceery **GE**

ALPITEC, INC.
49 Gleason Ave., Stamford, Conn. (Tel. FIreside 8-7788)
Pres.: P. Piter
Dir.-Sales: I. Peters **GS, TF**

ALSOP ENGRG. CORP.
Milldale, Conn. (Tel. Southington MArket 8-9661)
Purch. Agent: John F. Beatson, Jr.
Gen. Mgr.: Raymon F. Horland **GS, TS, MM, R&D**

ALTAIR INC.
Terryville, Conn. (Tel. LUdlow 3-1343)
Purch. Agent: L. E. Odell
Sales Mgr.: J. J. Mancusi, Jr. **G**

ALTAMIL CORP.
225 Oregon St., El Segundo, Calif. (Tel. EAstgate 2-5520)
Purch. Dir.: Dave Davis
Purch. Agent: Al Ouvall
V. P.-Sales: H. E. Blythe, Jr. **MF, W**

ALTO SCIENTIFIC CO., INC.
855 Commercial St., Palo Alto, Calif. (Tel. OAvenport 1-3434)
Purch. Agent: Miss V. Barrett
Gen. Mgr.-Sales: David Cherry **GS, CO, R&**

ALUMINUM ALLOYS CORP.
6650 W. Walton, Oetroit 10, Mich. (Tel. TYler 8-5300)
V. P. & Gen. Mgr.: Stanley R. Day **MF, P**

ALUMINUM CO. OF AMERICA
1501 Alcoa Bldg., Pittsburgh 19, Pa. (Tel. ATlantic 1-4545)
V.P. & Gen. Purch. Agent: R. O. Keefer
Asst. Gen. Purch. Agent: T. O. English
V.P. & Gen. Sales Mgr.: R. V. Dovies **M**

***ALUMINUM SAFETY PRODUCTS, INC.**
289 Fifth Ave., New York 16, N. Y. (Tel. MU 6-3160)
Asst. Adv. Mgr.: Harry Nix **GS, GH, T**
*(See Poge 78 for Advertisement)

ALWAC CORP.
13040 S. Cerise Ave., Hawthorne, Calif. (Tel. OR 8-5774)
Materials Mgr.: C. A. Pena
Marketing Dir.: M. D. Lester **MF, GE, T**

AMATOM ELECTRONIC HARDWARE CO. INC.
88 Orake Ave., New Rochelle, N. Y. (Tel. BEverly 5-4441)
Asst. to Pres.: R. Mazzulli
Buyer & Stock Control Ch.: C. Damore
V. P.-Sales: N. D. Frank **GS, GE, CO, TS, T**

AMBROID CO. INC.
Box 30, Weymouth 88, Mass. (Tel. EDgewater 5-6658)
Sales & Adv. Mgr.: A. E. Laneau **M**

AMCHEM PRODUCTS INC.
Brookside Ave., Ambler, Pa. (Tel. MItchell 6-1700)
Dir.-Purch.: E. A. Snyder
Purch. Agent: W. M. Wilson
Dir.-Mktg.: J. O. J. Shellenberger **M**

AMELCO, INC.
2040 Colorado Ave., Santo Monica, Calif. (Tel. EXbrook 3-7281)
Purch. dept.: 1131 Olympic Blvd., Santa Monica, Calif. (Tel. EXbrook 3-7206)
Purch. Agent: B. J. Shryock
Buyer (Electronic Assemblies): Harvey Noel (Tel. EXbrook 3-7206)
Buyer (Electronic Components): Ralph Bateman (Tel. EXbrook 3-7206)
Contract Co-ordinator: James Baumgardner & J. A. Burnett
V. P.-Contract Administrator: Frank J. Bretzing
GS, GH, GE, CO, TS, TR, R

AMERAC INC.
Ounham Rd., Beverly, Mass. (Tel. WAlker 2-8610)
Sales Engr.: Owen Haszard **GS, GE, CO, TS,**

AMERICAN AERO PARTS
725 N. Highland Ave., Los Angeles 38, Calif. (Te WEbster 8-3538)
V. P.-Purch: C. Conrad Goodreau
Sales Mgr.: C. Raisin **GH, MM, R**

AMERICAN AEROPHYSICS CORP.
109 Sheldon St., El Segundo, Calif. (Tel. ORegon 8-3789)
Purch. Agent: W. C. Dunlop
Asst. Purch. Agent: H. F. Williams
Sales Mgr.: C. B. Spratt **WN, GS, R**

AMERICAN AGILE CORP.
P. O. Box 168, Bedford, O. (Tel. MO 2-6900)

Purch. Agent: V. S. Balogh
Exec. V. P. & Gen. Mgr.-Sales: C. F. Freedman
MM, R&D

ERICAN AIR FILTER CO., DEFENSE PRODUCTS DIV.
310 3rd St., Rock Island, Ill. (Tel. 8-9311)
Purch. Agent: M. L. Marlaire
Buyers: H. Martin & E. Ramser
Sales: R. Andersen GS, GH, CO, R&D

ERICAN ALUMINUM CO.
230 Sheffield St., Mountainside, N. J. (Tel. ADams 3-3500)
Dir.-Purch.: E. B. Hayden
Exec. V. P.-Sales: M. H. Klausmann MM, R&D

ERICAN BERYLLIUM CO.
P. O. Box 3142, Sarasota, Fla. (Tel. ELgin 5-5105)
Purch. Agent: George A. Adley MM

ERICAN BOSCH ARMA CORP.
Fulton Bldg., Hempstead, N. Y. GS, GE, TS, R&D

ERICAN BRAKE SHOE CO.
230 Fifth Ave., New York 36, N. Y. (Tel. OX 7-7000)
Purch. Agent: F. B. Newbert
MF, WN, GS, GH, MM, R&D

ERICAN BRAKE SHOE CO. ENGINEERED CASTING DIV.
0 Mt. Read Blvd., Rochester 11, N. Y. (Tel. GEnesee 8-6455)
Defense Prod. Mgr.: Richard A. Pinto
ales V. P.: P. H. Clapp MF, WN, PS, GS

ERICAN BRAKE SHOE CO., KELLOGG DIV.
7 Humboldt St., Rochester 9, N. Y. (Tel. BUtler 8-2020)
urch. Agent: D. S. Judd
gr.-Aircraft Prod. Sales: K. C. Binder PS, GE

ERICAN BRASS CO., THE
4 Meadow St., Waterbury, Conn. (Tel. PLaza 4-1121)
n. Purch. Agent: E. A. Lane
n. Sales Mgr.: E. B. Tracy MM

RICAN BRASS CO., AMERICAN METAL HOSE DIV.
8 S. Main St., Waterbury 10, Conn. (Tel. PLaza 4-1121)
v. Purch. Agent: W. S. Edwards MF, PS, GS, GH

RICAN BRAZING ALLOYS CO.
O. Box 11, Pelham, N. Y. (Tel. MO 4-5858)
les Mgr.: Mike Ross MM

RICAN CAR & FOUNDRY DIV., ACF INDUSTRIES, INC.
0 Third Ave., New York 17, N. Y. (Tel. YUkon 6-8600)
P.-Purch.: P. B. Hoyt
P.-Mktg.: J. E. Angst MF, PS, GS, GH, MM, R&D

RICAN CONVEYOR CO.
33 S. Christiana Ave., Chicago 23, Ill. (Tel. LAwndale 1-2144)
rch. Agent: George J. Handa
es Engr.: D. C. Colletti GS

RICAN CYSTOSCOPE MAKERS, INC.
Pelham Pkwy., Pelham Manor, N. Y. (Tel. PE 6-4800)
rch. Agent: F. J. Scotti
.-Sales: R. V. Lange

RICAN ELECTRIC CABLE CO.
1 Appleton St., Holyoke, Mass. (Tel. JEfferson 2-9893)
as.-Purch.: M. A. Feinstein
es Mgr.: H. Shore MM

RICAN ELECTRICAL HEATER CO.
10 Cass Ave., Detroit 2, Mich. (Tel. TRinity 5-2505)
rch. Agent: Helen Wilson
es.-Sales: Robert A. Kuhn

RICAN ELECTRONIC LABS., INC.
N. Seventh St., Philadelphia 6, Pa. (Tel. WAlnut 5-8780)
ad-Purch.: Seymour Kalos
yers: Jack Wojcik, William White
es Mgr.: Robert D. Freedman TR

RICAN ELECTRONICS, INC.
25 W. 7th St., Los Angeles 17, Calif. (Tel. MA 9-9241)
.-Purch.: Dale V. Cropsey GS, GH, TS, R&D

RICAN ELECTRONICS, INCORPORATED
93 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-5581)
yer: C. S. Cormack
g. Services Mgr.: A. S. Izuel GE

RICAN ELECTRONICS, INC., AMERICAN NUCLEAR DIV.
9 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-5471)
Purch. Agent: Mary Wallin
Chief Applic. Engr.: T. J. Smith TS

AMERICAN ELECTRONICS, INC., DATATRONICS DIV.
9463 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-7245)
Head-Purch.: J. Snedaker
Buyer: V. Gillette
Sub-Systems & Controls Chief, Appl. Engr.: Eric Swansson
Data Recording & Processing Chief, Appl. Engr.: Ken Williamson MF, PS, GS, GE, CO, TS, TR

AMERICAN ELECTRONICS, INC., ELECTRIC MACHINERY & EQUIPMENT DIV.
2112 N. Chico Ave., El Monte, Calif. (Tel. CUmberland 3-7151)
Purch. Agent: R. A. Haeuser
Asst. Purch. Agent: Al Glick
Sr. Buyer: Paul McDonough
Buyers: Sid Trowbridge & Frank O'Neil GS

AMERICAN ELECTRONICS, INC., INSTRUMENT DIV.
9503 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-5581)
Buyer: Charles Cormack
Mktg. Service Adm.: Albert Izuel
Mgr.-Field Engrg. & Sales: Jack S. Gasoway GE

AMERICAN ELECTRONICS, INC., TALLER & COOPER DIV.
75 Front St., Brooklyn 1, N. Y. (Tel. ULster 8-0500)
Dir.-Purch.: Arthur Fettig
Dir.-Sales: James Zastro CO, TS, TR, R&D

AMERICAN ELITE, INC.
48–50 34th St., Long Island City 1, N. Y. (Tel. STillwell 6-8713)
V. P.-Sales: Ben Jacobs

AMERICAN FELT CO.
Glenville, Conn. (Tel. JEfferson 1-8700)
Dir.-Pracure.: K. R. Peattie
Gen. Purch. Agent: G. P. McShane
Gen. Sales Mgr.: R. Power Fraser MM

AMERICAN GAGE & MACHINE CO.
5200 W. Kinzie St., Chicago 44, Ill. (Tel. ESTebrook 9-1121)

AMERICAN GAS FURNACE CO.
140 Spring St., Elizabeth, N. J. (Tel. EL 2-2120)
Purch. Agent: W. Mitterman
Sales Mgr.: F. C. Schaefer

AMERICAN HINGE CORP.
88 Porter Ave., Brooklyn 37, N. Y. (Tel. GLenmore 6-7761)
Dir.-Purch.: Harold Shupack
Dir.-Sales: Florence Shupack

AMERICAN INSTRUMENT CO., INC.
8030 Georgia Ave., Silver Spring, Md. (Tel. JUniper 9-1727)
Purch. Agent: T. Good
Sales Mgr.: Harry Huck
Mktg.: Stanley Dosik GS

AMERICAN INSULATED WIRE CORP.
36 Freeman St., Powtucket, R. I. (Tel. PA 6-0700)
MF, PS, GS, TR

AMERICAN INSULATOR CORP.
New Freedom, Pa. (Tel. GLen Rock 4211)
Purch. Agent: A. L. Bertner
Sales Mgr.: Berto L. Attig

AMERICAN LADDER & SCAFFOLD CO., INC.
5505 N. W. 7th Ave., Miami, Fla. (Tel. PLaza 4-2663)
Pres.: Melvin Goldfein
Sales Mgr.: Ruth Brown GS, GH

AMERICAN LA FRANCE CORP.
100 E. La France St., Elmira, N. Y. (Tel. 8181)
Purch. Agent: F. R. Baker
Asst. Purch. Agent: George Hughes
V. P.-Sales: G. J. Halpin GS

AMERICAN LATEX PRODUCTS CORP.
3341 W. El Segundo Blvd., El Segundo, Calif. (Tel. DRegon 8-5021)
Exec. V. P. & Gen. Mgr.: T. P. Dougan
Sales Mgr.: William Gargile WN, MM, R&D

AMERICAN LAVA CORP.
Chattanooga 5, Tenn. (Tel. AMhurst 5-3411)
Purch. Agent: C. R. Hughes
Sales Mgr.: E. D. Bell MF, WN, PS, GE, TS, TR

AMERICAN LIGHT ALLOYS, INC.
1265 McBride Ave., Little Falls, N. J. (Tel. CLifford 6-6000)
Controller: Ernest Cirangle, Jr.
Sales: William Wilson, Jr. MF

AMERICAN MACHINE & FOUNDRY CO.
261 Madison Ave., New York 16, N. Y. (Tel. MUrray Hill 7-3100)
Chrm.: Morehead Patterson
Vice Chrm.: Walter Bedell Smith
Pres.: Carter L. Burgess
Group Exec.-Govt. Products: Fred K. Powell, Jr.
Deputy Group Exec.-Govt. Products: R. W. Cook
Deputy Group Exec.-Govt. Products Group, West Coast Operations: L. C. Craigie

NOTE: All correspondence concerning products listed in this Directory should be addressed to AMF Government Products Group 1701 K Street, N. W., Washington 6, D. C.
GS, GH, R&D

AMERICAN MACHINE & FOUNDRY CO., GOVERNMENT PRODUCTS GROUP
1701 K St., N. W., Washington 6, D. C. (Tel. METropolitan 8-6505)
Dir.-Customer Services: J. H. Blades
WN, PS, GS, GH, R&D

AMERICAN MACHINE & FOUNDRY CO., GREENWICH
11 Bruce Pl., Greenwich 1, Conn. (Tel. NOrmandy 1-7400)
Mgr.-Purch. Dept.: Stephen R. Bradley, Jr.
Purch. Dept.: Walter Dunn
Mgr., Electronics Dept.: D. Pendleton
Mgr., New Programs: J. N. Albaugh, Jr.
GS, GH, CO, TS, TR, R&D

AMERICAN MEASUREMENT & CONTROL, INC.
240 Calvary St., Waltham 54, Mass. (Tel. TWinbrook 4-6212)
V. P.-Purch.: A. E. McCoy
Dir.-Sales: F. B. Cope GE, TS

AMERICAN MISSILE PRODUCTS CO., INC.
15233 Grevillea Ave., Lawndale, Calif. (Tel. OSborne 9-1401)
Purch. Agent: Kathy Potchka
Buyer: Charlotte Ward
Mktg. Mgr.: Bill Caldwell GS, TS, TR, R&D

AMERICAN MOLDED PRODUCTS CO.
2727 W. Chicago Ave., Chicago 22, Ill. (Tel. ARmitage 6-3235)
Purch. Agent: R. Liljeberg
Sales Engr.: A. Weyrich GE, TS, TR, R&D

AMERICAN MONORAIL CO., THE
13107 Athens Ave., Cleveland 7, O. (Tel. LAkewood 1-6000)
Dir.-Purch.: J. C. Roth
V. P.-Mktg.: C. L. Fell GH

AMERICAN NICKEL ALLOY MFG. CORP.
30 Vesey St., New York, N. Y. (Tel. COrtland 7-6420)
Asst. Secy.: W. B. Labbenberg
Secy.: Albert Sulzbach MM

AMERICAN NON GRAN BRONZE CO.
511 Old Lancaster Rd., Berwyn, Pa. (Tel. NIagara 4-0240)
Purch. Agent: Charles H. Morris MF, WN, PS, GE

AMERICAN OPTICAL CO., INSTRUMENT DIV.
Optical Ave., Keene, N. H. (Tel. ELmwood 2-3202)
Purch. Agent: George Howarth
Sales Mgr.: W. E. Folland
WN, GE, TS, TR, MM, R&D

AMERICAN PAULIN SYSTEM
1524 S. Flower St., Los Angeles 15, Calif. (Tel. RIchmond 9-0013)
Dir.-Sales: Arch F. Munter

***AMERICAN POTASH & CHEMICAL CORP.**
3000 W. Sixth St., Los Angeles 54, Calif. (Tel. DUnkirk 2-8231)
Purch. Agent: Manuel Gonsolves, NATIONAL NORTHERN DIV., W. King St., West Hanover, Mass. (Tel. TRiangle 7-1770)
Sales Mgr.: J. A. Haynes TR, MM, R&D
*(See Page 38 for Advertisement)

AMERICAN PRINTED CIRCUITS CO., INC.
104 Forrest St., Metuchen, N. J. (Tel. LIberty 8-5777)
V. P.-Purch.: Mrs. Betty M. Weaver
Pres.-Sales: Howard L. Toft GE, MM

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

AMERICAN RADAR COMPONENTS INC.
45 E. Main St., Denville, N. J. (Tel. DAkwood 7-5530)
Dir.-Purch.: John P. Hundley GE, TR

AMERICAN REFRACTORIES & CRUCIBLE CORP.
345 Washington Ave., North Haven, Conn. (Tel. CEdar 9-1621)
V. P. & Sales Mgr.: George H. Caligan
Purch. Agent: E. R. Crandall

AMERICAN RESEARCH CORP.
Rt. 6, Farmington, Conn. (Tel. ORchard 7-2693)
Dir.-Purch.: Ted Augustyn
Dir.-Sales: Jack Shamroth TS

AMERICAN RESEARCH & MFG. CORP.
920 Halpine Ave., Rockville, Md. (Tel. HAzelwood 7-7116)
Purch. Agent: Robert J. Taylor
MF, PS, GS, GH, GE, CO, TS, TR, R&D

AMERICAN RDCKET CD.
P. O. Box 1112, Wyandotte, Mich. (Tel. LOgan 5-3408)
Pres.: Alfred J. Zaehringer MF, PS, TS, MM, R&D

AMERICAN SCREW CO.
1680 W. Main St., Willimantic, Conn. (Tel. HArrisan 3-6331)
Purch. Agent: Wallace A. Smedley
Gen. Sales Mgr.: J. J. Coy MF, PS

AMERICAN SILVER CO.
36-07 Prince St., Flushing 54, N. Y. (Tel. FLushing 3-8012)
Purch. Agent: L. Chibnik
Sales: M. Sherman MM

AMERICAN SMELTING & REFINING CO.
120 Broadway, New York 5, N. Y.
Adv. Mgr.: Edward Friedlander MM

AMERICAN SOLDER & FLUX CO.
19th & Willard Sts., Philadelphia, Pa. (Tel. BAldwin 6-1800)
Gen. Mgr.: M. H. Matz
Sales Mgr.: J. J. McBride

AMERICAN SPEEDLIGHT CORP.
63-01 Metropolitan Ave., Middle Village 79, N. Y. (Tel. EMpire 6-3000)
Purch. Agent: Pat Tagriella
Pres.: Harry L. Parker

AMERICAN STANDARD PRODUCTS, INC.
3030 Main St., Hartford, Conn. (Tel. CHapel 9-7707)
Purch. Agent: Bernard Cantor
Sales Mgr.: William B. Lindholm
Buyers: George Nelson & Elliot Ginden
MF, WN, PS, GS, GE, MM

AMERICAN STEEL FOUNORIES, HAMMOND OIV.
Hohman & Hoffman Sts., Hammond, Ind. (Tel. WEstmore 1-1900)
Oiv. Purch. Agent: D. L. Kaantz
Oiv. Sales Mgr.: L. L. Phelps
Buyers: Dean Nartan, Ernie Holzwarth, John L. McKittrick MF, WN, GH

AMERICAN STEEL & WIRE DIV.-UNITEO STATES STEEL CORP.
Rockefeller Bldg., 614 Superior Ave., N. W., Cleveland 13, O. (Tel. TOwer 1-2000)
Purch. Agent: R. W. Berrett
Prod. Planning & Dev. Oiv.-Aircraft & Missiles: H. F. Powders
V. P.-Sales: E. A. Murray MF, PS, GH, TS

AMERICAN SUPER-TEMPERATURE WIRES, INC.
34 W. Canal St., Winaaski, Vt. (Tel. UNiversity 2-9636)
Purch. Agent: Charles Bellmare
Sales Mgr.: Richard D. Hoyt
MF, PS, GS, GH, TS, TR, MM

AMERICAN TUBE BENDING CO., INC.
7 Lawrence St., New Haven 8, Conn. (Tel. STate 7-2131)
Purch. Agent: A. L. Shumway
Sales Mgr.: C. T. Novak MF, PS, GS

AMERICAN WELDING & MFG. CO., THE
Dietz Rd., Warren, O. (Tel. EXpress 3253-1)
Purch. Agent: C. A. Miller
Buyers: G. L. Madigan, D. W. Parker
Sales Mgr.: Frank J. Shanaberg
Asst. to Sales Mgr.: Warren Gressle
MF, WN, PS, GS, GH, GE, TS

B. C. AMES CO.
131 Lexington St., Waltham 54, Mass. (Tel. TWinbrook 3-0095)
Purch. Agent: B. C. Ames
Dir.-Sales: H. B. Kruse R&D

AMGLO CORP.
4333 N. Ravenswaad Ave., Chicago 13, Ill. (Tel. BUckingham 1-2727)
Purch.: C. M. Babka GS, GE, CO, TS, TR

AMDCO CHEMICALS CORP.
910 S. Michigan Ave., Chicago 80, Ill. (Tel. HArrisan 7-8886)
Supvr.-Propellant: E. P. Easterday PS

AMPCO METAL, INC.
1759 S. 38th St., Milwaukee 46, Wisc. (Tel. MItchell 5-3750) MF, WN, PS, GH, GE

AMPEX MAGNETIC TAPE
934 Charter St., Redwaad City, Calif. (Tel. EMerson 9-1481)
Purch. Agent: Frank Masi
Sr. Buyers: Glen Zieher, Hal Nelson & John Lovett
Dir.-Gen. Purch.: Bill Haack CO, TS, TR, R&D

AMPHENDL CABLE & WIRE DIV., AMPHENOL-BDRG ELECTRDNICS CDRP.
S. Harlem Ave. at 63rd St., Chicago 38, Ill. (Tel. BIshop 2-1000)
Purch. Agent: Arthur B. Geiger
Sales Mgr.: Robert W. Felber GS, GE, TS, TR

AMPHENOL CONNECTOR DIV., AMPHENOL-BORG ELECTRONICS CDRP.
1830 S. 54th Ave., Chicago 50, Ill. (Tel. BIshop 2-1000)
Purch. Agent: John Leahy
Sales Mgr.: Herbert Matz WN, GS, GE, CO, TS, TR

AMPHENOL WESTERN DIV., AMPHENOL-BORG ELECTRONICS CDRP.
9201 Independence Ave., Chatswarth, Calif. (Tel. Diamond 8-6600)
Buyer: Harold Simpson
District Sales Mgr.: John Kays
WN, GS, GE, CO, TS, TR

AMPLEX DIV.-CHRYSLER CORP.
P. O. Box 2718, Detroit 31, Mich. (Tel. WAlnut 1-6733)
Sales Mgr.: W. L. Martin
MF, WN, PS, GS, GH, GE, TR

AMPLIFIER CORP. OF AMERICA
398 Broadway, New York 13, N. Y. (Tel. WOrth 6-2929)
Purch. Agent: M. R. Ellis
Sales Mgr.: A. J. Gillette GS, GE, CO, TS, R&D

AMTHOR TESTING INSTRUMENT CO., INC.
45 Van Sinderen Ave., Braaklyn 7, N. Y. (Tel. DIckens 6-8841)
Sales Mgr.: Al Littmann CO, TS

ANACHROME CORP.
10647 S. Garfield Ave., South Gate, Calif. (Tel. LO 4-3381)
Oir.-Sales: Joseph E. Trankla MF, WN

ANACONDA METAL HOSE OIV., THE AMERICAN BRASS CO.
698 S. Main St., Waterbury 20, Conn. (Tel. PLaza 4-1121)
Sales Mgr.: W. B. Hammand
Oiv. Purch. Agent: W. S. Edwards MF, PS, GS, GH

ANACONDA WIRE & CABLE CO.
25 Braadway, New Yark, N. Y. (Tel. HA 2-6300)
V. P.-Sales: D. E. Allen

ANAOITE INC.
10630 Sessler St., South Gate, Calif. (Tel. LO 7-0511)
Purch. Agent: Clarence Edwards
Dir.-Sales: Stanley M. Buckley MF

ANAHEIM ELECTRONICS CO., INC.
2259 Falmauth, Anaheim, Calif. (Tel. PRaspect 4-2755)
Mgr.: R. T. Arnald
Asst. Mgr.: J. E. Miller
Sales Mgr.: W. Key

ANALOGUE CONTROLS, INC.
200 Frank Rd., Hicksville, N. Y. (Tel. OVerbraak 1-7300)
Dir.-Purch.: Abe Barbanel
V. P.-Sales: Edward J. Garrett
GS, GE, CO, TS, R&D

ANALYTICAL INSTRUMENTS, INC.
R. F. D. 2, Cedar Lake, Bristal, Conn. (Tel. Bristal, LUdlaw 2-6941)
Pres.: James G. McClure TS, R&O

ANALYTICAL MEASUREMENTS, INC.
585 Main St., Chatham, N. J.
Pres.: Frank G. Paully

ANCHOR COUPLING CO. INC.
342 N. Faurth St., Libertyville, Ill. (Tel. 2-1800)
Sales Mgr.: J. D. Luebkeman MF, PS, GS

ANCHOR METAL CO. INC.
966 Meeker Ave., Braaklyn, N. Y. (Tel. ST 2-7090)
Purch.: Walter R. Cale, Edwin Kent
Sales: H. Drapkin
MF, WN, PS, GS, GH, GE, CO, TR

ANCHOR METAL SPINNING CO., THE
46 Fluhart Ave., Daytan 8, O. (Tel. BAldwin 8-2107)
Purch.: M. Weinel
Sales Mgr.: William Semmelman
MF, WN, PS, GS, GI

ANCHDR PACKING CO., THE
401 N. Braad St., Philadelphia 8, Pa. (Tel. WAlnut 2-1343)
Secy.-Treas.: J. H. Maston
Gen. Sales Mgr.: B. B. Reagan (Tel. Harrison 7-5432, Chicago) MI

ANCHOR PLASTICS CO., INC.
36-36 36th St., Long Island City 6, N. Y. (Tel. RAvenswaad 9-1494)
Pres. & Sales Mgr.: R. A. Fisch M

ANCHDR SPECIALTY MFG. CO. INC.
300 Hollister Rd., Teterbara, N. J. (Tel. AT 8-1935)
Purch.: Wm. Zablacky PS, GS, GH, GE, TS, R&

ANDERSEN LABS.
501 New Park Ave., West Hartford, Conn. (Tel. ADams 3-4491)
Purch. Agent: H. W. Stewart
Pres.: F. E. Baker GE, CO, TS, TR, R&

ANDERSON AIRCRAFT CD.
Spring St., Narth Dighton, Mass. (Tel. VAn Dyke 4-8611)
Purch. Agent: Robert H. Leeming
Dir.-Sales: Albert Gramm

ANDERSON CHEMICAL CD., DIV.-STAUFFER CHEMICAL CD.
Weston, Mich. (Tel. GEneva 6-2322)
Purch. Agent: G. D. Sharpe
Dir.-Sales: H. G. Deters

***ANDERSON, GREENWOOD & CO.**
5425 N. Rice Ave., Houstan 36, Texas (Tel. MAdison 3-2343)
Purch. Agent: C. J. Scallan (Tel. MAdison 3-8956)
Sales Mgr.: W. W. Hering GS, GH, R&
*(See Page 62 for Advertisement)

ANDERSON MACHINE & TDOL CO.
7 Flawer St., Hartford, Conn. (Tel. CH 6-8059)
C. O. Andersan

ANDERSON OIL & CHEMICAL CO., INC.
P. O. Box 111, Portland, Conn. (Tel. DIamond 7-2555)
Purch. Agent: Mrs. H. M. McLean
Gen. Mgr.-Sales: T. M. Purtell

ANDREW CORP.
363 E. 75th St., Chicago 19, Ill. (Tel. TRiangle 4-4400)
Purch. Agent: John Carnyn
Oir.-Mktg.: Rabert P. Lamans
Sales Mgr.: C. Rabert Lane
Buyer: Richard H. Knoll
WN, PS, GS, GH, GE, TS,

ANOROMEOA, INC.
3742 Haward Ave., Kensington, Md. (Tel. LOckwo 5-3775)
Dir.-Purch. & Sales: Ernest F. Ainsworth R

***ANNIN CO., THE**
1040 S. Vail Ave., Montebella, Calif. (Tel. RAymand 3-9351)
Purch. Agent: N. A. Jacobs
Sales Mgr.: H. C. Earle, Jr. GS, GH, TS, R
*(See Page 52 for Advertisement)

R. B. ANNIS CO.
1101 N. Delaware St., Indianapolis 2, Ind. (Tel. ME 5-2838)
Purch. Agent: R. K. Caskey
Dir.-Sales: R. B. Annis

ARTHUR ANSLEY MFG. CO.
New Hape, Pa. (Tel. AXtel 7-2711)
Purch.: Arthur C. Ansley GE,

ANSONIA WIRE & CABLE CO., THE
111 Martin St., Ashtan, R. I. (Tel. PAwtucket 6-6300)
Purch. Agent: I. A. Milner
Gen. Sales Mgr.: A. J. W. Navak
MF, PS, GS, GH, TS,

ANSUL CHEMICAL CO.
1 Stantan St., Marinette, Wisc. (Tel. REdwood 5-7411)
Mgr.-Purch.: Lee O'Leary
V. P.-Sales: L. C. McKesson

ANTENNA & RADOME RESEARCH ASSOCIATES
1 Bond St., Westbury, L. I., N. Y. (Tel. ED 4-87
Oir.-Purch.: J. Berg
Sales Mgr.: E. B. Weissman CO,

ANTENNA SPECIALISTS CO., THE
12435 Euclid Ave., Cleveland 6, O. (Tel. SWeet 1-7878)
Purch. Agent: N. Schraeder
Pres.: M. Friedberg GS

TI-CORROSIVE METAL PRODUCTS CO., INC.
P. O. Box 1894, Albany, N. Y. (Tel. PErshing 2-7711)
V. P.-Purch.: Frank Legnard
Asst. Purch. Agent: David J. Freed
V. P.-Sales Mgr.: Price Berrien MM

TLAB INC.
5330 Proprietors Rd., Worthington, O. (Tel. TUxedo 5-5396)
Purch. Agent: Kenneth L. Riggle
Buyer: Odell H. Wellman TS

TON ELECTRONIC LABS., INC.
226 Flushing Ave., Brooklyn 37, N. Y. (Tel. EVergreen 6-5715)
Purch. Agent: Bernard Neveloff
Dir.-Sales: George Weinman
MF, PS, GS, GH, GE, CO, TS, TR

EX MACHINE & TDOL CO., THE
P. O. Box 952, Dayton 1, O. (Tel. BAldwin 2-7871)
Adv. Mgr.: T. A. Polley

EX REINFDRCED PLASTICS, DIV.-WHITE SEWING MACHINE CORP.
Washington & Elm Sts., Cleveland 13, O. (Tel. CHerry 1-7834)
Purch. Agent: John Clyne
Asst. Purch. Agent: Louis Zak
Chief Sales Engr.: William W. Patterson MM, R&D

PLIED DESIGN CO.
807 Elmwood Ave., Buffalo 7, N. Y. (Tel. DElaware 9595)
Pres.: H. E. Johnson
Purch. Agent: D. J. Stonish
V. P.-Contracts: H. E. Hill WN, GS, GH, GE

PLIED DYNAMICS CORP.
2 N. Main St., Natick, Mass. (Tel. OLympic 3-5271)
V. P.-Purch.: R. G. Ahlquist
Gen. Engr.: C. A. Bentley, Jr. TS, GS

PLIED PHYSICS CORP.
724 S. Peck Rd., Monrovia, Calif. (Tel. HIllcrest 6-7181)
Mgr.-Materiel: Scott Metcalf
Mgr.-Sales: Robert W. Moulton R&D

PLIED RADIATION CORP.
1104 N. Main St., Walnut Creek, Calif. (Tel. YEllowstone 5-2250)
Purch. Agent: Howard D. Layson
Mgr.-Sales & Operations: Warren W. Eukel PS, R&D

ALLIED RESEARCH LABS., INC.
117 Park Place, Glendale, Calif. (Tel. CHapman 5-5524)
Material Mgr.: J. O. McKim (Tel. CHurchill 9-6193)
Buyers: James Reddy & Donald Nadell (Tel. CHurchill 9-6193)
Comm. Sales Mgr.: William E. Davis CD, TS, TR

ALLIED SCIENCE CORP. OF PRINCETON
Princeton, New Jersey (Tel. Swinburn 9-1000)
Mgr.-Procurement: James G. Robinson
Purch. Agent: Wendell S. Hall
Buyers: Robert J. Marcy, Edwin W. Dawson, Timothy K. Donath
Natl. Sales Mgr.: O. S. Samuelson TR, R&D

AMH GEAR WORKS INC.
Holmes St., North Quincy, Mass. (Tel. PR 3-8801)
and 4336 E. 10th Court, Hialeah, Fla. (Tel. MUrray 8-2528)
Purch. Agent, Quincy: R. M. Allen
Purch. Agent, Hioleah: A. E. Carroll
Sales Mgr.: R. W. Gray (Tel. CEdar 5-5296) GE, TR

AMO CO., THE
201 Bessemer Ave., Cleveland 27, O. (Tel. MIchigan 1-1170)
Purch. Agent: Lon Esther
Asst. Purch. Agent: George Otto
Sales Mgr.-Maintenance Sales: Dan G. Kloss
Sales Mgr.-Product Finishes: Ben F. Edman
MF, WN, GE, TS

AMTURUS MFG. CDRP.
401 Lincoln Blvd., Venice, Calif. (Tel. TExas 0-2751)
Purch. Agent: Vern Marlow
Sales Mgr.: Fred Schneller

AME-PORTLAND, INC.
Austin St., Newark 2, N. J. (Tel. Bigelow 8-8500)
Contract Admin.: E. Brummel
Pres.: Dr. I. G. Sage PS, R&D

AMORE PRDDUCTS
15 Shermer Rd., Northbrook, Ill.
Sales Mgr.: Charles W. Jones

ARENBERG ULTRASONIC LAB., INC.
9 Green St., Jamaica Plain 30, Mass. (Tel. JA 3-8640)
Pres.: David L. Arenberg R&D

ARIS CONTRDLS, INC.
2127 Greenleaf St., Evanston, Ill. (Tel. DAvis 8-4700)
Purch. Agent: Fred W. Green
Sales: William Buschart GS, GH

ARIES LABORATORIES, INC.
45-33 Oavis St., Long Island City 1, N. Y. (Tel. RAvenswood 9-9001)
Purch. Agent: H. Grisar
Sales Mgr.: W. Stern MM

ARISTDCRAT PLASTICS, INC.
23-25 Sussex Ave., Newark, N. J. (Tel. Mitchell 3-6110)
Pres.: Arthur Meier MF, PS, GE, TR

ARKWIN INDUSTRIES, INC.
648 Main St., Westbury, L. I., N. Y. (Tel. EOgewood 3-2640)
Purch.: Hank Baufr
V. P.-Sales: Julius Kendall
MF, WN, PS, GS, GH, GE, TS

ARMA DIV., AMERICAN BOSCH ARMA CDRP.
Roosevelt Field, Hempstead, N. Y. (Tel. Pioneer 2-2000)
Mgr.-Procurement: George J. Ryan
Corporate Dir.-Purch.: W. M. Maughan GS, GE, R&D

ARMCO STEEL CORP.
703 Curtis St., Middletown, O. (Tel. GArden 2-2811)
Purch.: J. S. Thomas
Sales: L. T. Johnston MM

ARMEL ELECTRONICS, INC.
840 Fifth Ave., Brooklyn 32, N. Y. (Tel. STerling 8-0422)
Purch. Agent: A. K. Niemi
Sales Mgr.: O. J. Gustafson
GS, GE, CD, TS, TR, R&D

ARMITE LABS.
6609 Broad St., Los Angeles 1, Calif. (Tel. LUdlow 7-7744)
V. P.-Purch.: J. H. Armington
Sales Mgr.: S. A. Chesnutt MF, PS, MM

ARMOUR AMMDNIA DIV.
1355 W. 31st St., Chicago 9, Ill. (Tel. LAfayette 3-7000)
Purch. Agent: Frank Kraft
Purch.: E. Van Eylen, W. Roos, F. Peterson
Sales Mgr.: P. W. Fulford MM

ARMOUR AND CD.
16123 Armour St., N. E., Alliance, O. (Tel. TAlbot 1-3510)
Purch. Agent: H. M. Wilson, Jr.
Gen. Sales Mgr., Coated Abrasives Div.: R. L. Heiniger
Gen. Sales Mgr., Cushioning Prod. Div.: J. P. Coughlin TS, R&D

ARMOUR & CO., ARMOUR ALLIANCE INDUSTRIES
16123 Armour St., N. E., Alliance, O. (Tel. TAlbot 1-3510)
Purch. Agent: H. M. Wilson
Gen. Sales Mgr.-Coated Abrasives: H. R. Heiniger
Gen. Sales Mgr.-Cushion Prod.: J. P. Coughlin
Sales Mgr.-Adhesives Div.: J. H. Keys
Sales Mgr.-Packaging Dept.: J. F. Beckert

ARMSTRONG CORK CD.
W. Liberty St., Lancaster, Pa. (Tel. EXpress 7-0611)
Gen. Purch. Agent: M. L. Lampe
Asst. Gen. Purch. Agent: W. A. Abel
Gen. Sales Mgr.: W. B. Tucker MF, PS

ARMSTRONG PRDDUCTS CD.
P. O. Box I-MG, Warsaw, Ind. (Tel. AMherst 7-3226)
Mgr.: F. E. Harrison MF, WN

ARNAV AIRCRAFT ASSOCIATES, INC.
32 Industrial Ave., Little Ferry, N. J. (Tel. HUbbard 9-8600)
V. P.-Purch.: M. A. Murray
Sales Mgr.: J. M. Muchmikoff
Mgr., West Coast Plant: H. Oeets, 121 Main St., El Segundo, Calif. (Tel. EAstgate 2-4433)
MF, PS, TS

ARND ADHESIVE TAPES, INC.
U. S. 20 at Ohio St., Michigan City, Ind. (Tel. TRiangle 4-3235)
Purch. Agent: R. L. Scholl
Sales Mgr.: D. W. Burke MF, PS, TR

ARNOLO ENGRG. CD., THE
P. O. Box G, Marengo, Ill. (Tel. Chicago ANdover 3-6300; Marengo JOrdan 8-7251)
Purch. Agent: R. L. Pottinger
Buyer: J. Strain
Sales Mgr.: Benjamin Falk MF, PS, GS, GE, TR

ARNOLT CDRP.
Warsaw, Ind. (Tel. AMhurst 7-7111)
Dir.-Purch.: Roger H. Davis
Purch. Agent: Carl D. Schultz
V. P.-Military Liaison: H. M. Henderson GS, GH

***ARNOUX CORP.**
11924 W. Washington Blvd., Los Angeles 66, Calif.
(Tel. TExas 0-5371)
Purch. Agent: George Pesner
Asst. Purch. Agents: Darlene Thompson & Conrad J. Doerr
Dir.-Mktg.: Michael Dodak GS, TR
*(See Pages 50 & 82 for Advertisement)

ARD EQUIPMENT CDRP., THE
Bryan, O. (Tel. 6-1161)
Purch. Dir.: O. M. Nixon
Purch. Agent, Aircraft Div.: C. E. DeGroff
Sales Mgr.-Aircraft: O. W. Orrick, Jr.
MF, PS, GS, GH, GE, TS, TR

ARD, INC.
Tullahoma, Tenn. (Tel. GL 5-2611)
Mgr.-Procurement: J. G. Crigler
Asst. Mgr.-Procurement: Charles M. Solomon R&D

ARRO EXPANSIDN BDLT CO.
N. Boone Ave., Marion, O. (Tel. 3-1154)
Purch. Agent: Ray W. Coy
Sales Mgr.: John J. Dugan

ARRDW TOOL CD. INC.
36 Mill St., Wethersfield, Conn. (Tel. JAckson 9-2507)
V. P.-Purch.: David Oewhurst
Buyer: Joseph Burgess
Sales Mgr.: Robert E. Walsh GS, GH

ARROW-HART & HEGEMAN ELECTRIC CD., THE
103 Hawthorn St., Hartford 6, Conn. (Tel. CHapel 9-8471)
Purch. Agent: N. P. Belcourt
V. P.-Sales: F. L. Mathes

ARROWHEAD PRODUCTS, DIV.-FEDERAL-MOGUL-BOWER BEARINGS, INC.
2300 Curry St., Box 1890, Long Beach 1, Calif. (Tel. NEvada 6-0571)
Purch. Agent: Charles Smith
Sales: Arnold J. Davey MM, R&D

ART SPECIALTY CO.
3720 N. Milwaukee Ave., Chicago, Ill. (Tel. KIldare 5-6607)
Purch. & Sales: Robert Nattenberg

ART WIRE & STAMPING CO.
227 High St., Newark 2, N. J. (Tel. HUmboldt 4-2100)
Purch. Agent: Fred Riedmuller
Sales: Nils Johnson MF, WN, PS, GE

ARTISAN ELECTRONICS CORP.
171 Ridgedale Ave., Morristown, N. J. (Tel. JEfferson 8-8500)
V. P.-Purch.: Sheldon Masser
Sales Mgr.: S. Joseph Carris GS, CO, TS, TR

ARTOS ENGRG. CD.
2757 S. 28th St., Milwaukee 46, Wisc. (Tel. Mitchell 5-6010)
Shop Supt.: Hubert Mueller
Sales Mgr.: Haakon T. Randar MF, PS, GS

ARWOOD PRECISIDN CASTING CORP.
321 W. 44th St., New York 36, N. Y. (Tel. JUdson 2-4210)
Purch. Agent: F. W. Wacker
V. P.-Sales: William O. Sweeny

ASHLAND ELECTRIC PRDDUCTS, INC.
32-02 Queens Blvd., Long Island City 1, N. Y. (Tel. EXeter 2-4010)
Purch. Agent: E. R. Obermann
Sales Mgr.: C. W. McElhiney PS, GH, GE, TR

ASHLAND DIL & REFINING CD.
1409 Winchester Ave., Ashland, Ky. (Tel. EAst 4-1111)
Dir.-Purch.: J. K. Barron
Purch.: J. S. Hannah, D. T. Dunn, Wilburn Caskey
V. P.-Sales: P. C. Talbutt PS, TS, MM, R&D

ASSEMBLY PRDDUCTS, INC.
Wilson Mills Rd., Chesterland, O. (Tel. HAmilton 3-4436)
Purch. Agent: Robert Faltz
V. P.-Sales: Robert H. Pugsley
GS, CD, TS, TR, R&D

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

ASSOCIATE AIRCRAFT TOOL & MFG., INC.
3660 Dixie Hwy., Hamilton, O. (Tel. TWinbrook 3-2812)
Pres.: Henry W. Malhofski
MF, WN, PS, GH, GE, R&D

ASSOCIATED AMERICAN WINDING CO., INC.
750 St. Ann's Ave., New York 56, N. Y. (Tel. CYpress 2-5050)
Chief Purch. Agent: N. Goldmon
Sales Mgr.: G. B. Franklin PS, GS, GH, GE, TR

ASSOCIATED ENGRG. CORP.
65 Kent St., Brookline 46, Mass. (Tel. ASpinwall 7-4664)
Purch. Agent: L. R. Demorkles
Dir.-Sales: F. K. Chin MM

ASSOCIATED ENGRG. & MFG. CORP.
210 M Stone House Rd., Glen Ridge, N. J. (Tel. PIlgrim 3-8899)
Dir.-Purch.: V. B. Fox
Mgr.: Frank Rhodes MM

ASSOCIATED ENGINEERS, INC.
P. O. Box 1628, Springfield, Mass. (Tel. RE 4-6431)
Purch. Agent: A. E. Chalfin
Asst. Purch. Agent: Wayne Palmer
V. P.-Sales: John Flaskamper WN, GS, GH, GE, TS, R&D

ASSOCIATED RESEARCH, INC.
3779 W. Belmont Ave., Chicago 18, Ill. (Tel. COrnelia 7-4040)
Purch. Agent: J. W. Bente
V. P.-Sales: Richard W. Inman GE, CO, TS, TR

***ASSOCIATED TESTING LABS., INC.**
135 Clinton Rd., Coldwell, N. J. (Tel. CApitol 6-7407)
Dir.-Engrg.: William Tonkowich
Chief Product Engr.: John W. Fricke
Sales Mgr.-Engrg.: Bernard Novack PS, GS, CO, TS
*(See Page 32 for Advertisement)

ASTRAVAC CORP.
1011-D Industrial Way, Burlingame, Calif. (Tel. DIamond 2-6048)
Pres.: P. A. Peller
Secy.-Treas.: M. B. Stern GS, GH, GE, CO, TS

ASTRODYNE, INC.
P. O. Box 548, McGregor, Tex. (Tel. GRanite 5-2811)
Chief, Materiol: R. S. Mulligan
Purch. Agent: R. C. Terry
Supvr.-Buying: W. M. St. John PS, R&D

ASTRON CORP.
255 Grant Ave., East Newark, N. J. (Tel. HUmboldt 2-7800)
Purch. Agent: George M. Sexton
Gen. Sales Mgr.: Irving I. Ser WN, GE, R&D

ASTRONAUTICS ENGRG. CO.
500 W. 18th St., Hialeah, Fla. (Tel. TUxedo 7-8114)
Dir.-Purch.: L. M. Gray
Dir.-Sales: Robert W. Wise GS, GH, TS, R&D

ASTRONETICS, INC.
Box 450-C, Red Bank, N. J. (Tel. AT 1-2700)
Dir.-Purch.: T. George
Sales: A. Munchak, Jr.

ATKINS & MERRILL, INC.
Boston Post Rd., South Sudbury, Mass. (Tel. HIlltop 3-8822)
Purch. Agent: Robert Johnson
Buyer: Lee Goodbor
Buyer: Howard Elet (Reinforced Plastics Div., Bartlett St., Marlboro, Mass. (Tel. MArlboro 1114)
Dir.-Sales: Arthur V. Boyce WN, GS, GH, TS, MM, R&D

ATKOMATIC VALVE CO., INC.
545 W. Abbott St., Indianapolis 25, Ind. (Tel. MElrose 8-6545)
Treas.: Robert A. Morris
Sales Mgr.: Mark W. Lowe PS, GS, GH, TS

ATLANTIC ENGRAVERS, INC.
52 Ocean Ave., Amityville, N. Y. (Tel. AM 4-5088)
V. P.-Purch.: Wayne Fajans MF, WN, PS, GE, TS, TR

ATLANTIC INSTRUMENT CORP., SUB.-AMERICAN ELECTRONICS, INC.
90 Broadway, Norwood, Mass. (Tel. NO 7-2638)
Sales Mgr.: D. L. Thomas GE, CO, TS

ATLANTIC METAL HOSE CO., INC.
308 Dyckman St., New York City 34, N. Y. (Tel. LOrraine 9-5400)
Purch. Agent: David M. Fuchs

ATLANTIC RESEARCH CORP.
901 N. Columbus St., Alexandria, Va. (Tel. KIng 9-7500)
Purch. Agent: Wilbur H. Smith
Mgr.-Development: DeWitt O. Myatt
WN, PS, GH, CO, TS, MM, R&D

ATLAS COIL INC.
63 Main St., Ansonia, Conn. (Tel. RE 5-4628)
Purch. Agent: Harold Kaye GE, CO, TS, TR

ATLAS E-E CORP.
47 Prospect St., Woburn, Mass. (Tel. WEIls 3-5390)
Purch. Agent: R. A. Joyce
Mktg. Mgr.: Dan E. Baker GE

ATLAS ENGRG. CO. INC.
176 Blue Hill Ave., Roxbury, Mass. (Tel. HIghlands 5-7100)
Purch. Agent: John Ward
Sales Mgr.: Norman Scotch R&D

ATLAS ENGRG. CORP.
26 Custer St., West Hartford 10, Conn. (Tel. CHapel 6-5651)
Pres.: R. C. Biggers

ATLAS PRECISION PRODUCTS CO.
3801 Castor Ave., Philadelphia 24, Pa. (Tel. JEfferson 5-3700)
Purch. Agent: Robert Stotes
Buyer: Alec Duncan
Gen. Sales Mgr.: Herbert L. Zwirn WN, GS, GH, GE, CO, TS, TR, R&D

ATLAS SCREW & SPECIALTY CO.
450 Broome St., New York 13, N. Y. (Tel. NOrth 6-0600)
Purch. Agent: Irwin Koplan, 396 Jelliff Ave., Newark, N. J. (Tel. BIgelow 8-3000)
V. P.-Sales: V. J. Merz MM

ATMO SEAL CO.
3475 Cardiff Ave., Cincinnoti 9, O. (Tel. TRinity 1-5512)
Co-Owners: W. L. Niswander & R. J. Stoewe GS, GE, TR

ATTLEBORO REFINING CO., INC.
42 Union St., Attleboro, Mass. (Tel. ATtleboro 1-3705)
Plt. Supt. & V. P.-Purch.: Edward F. Towle
Sales Mgr.: John H. Quebman MF, WN, PS, GE, TR

AUBURN MFG. CO., THE
Stack St., Middletown, Conn. (Tel. DIamond 6-6631)
Purch. Agent & Sales Mgr.: M. B. Weiner MF, WN, PS, GS, GE, TR

AUBURN SPARK PLUG CO., INC.
89 York St., Auburn, N. Y. (Tel. 2-9501)
V. P.-Purch.: A. R. Nolin
Supt.: Leo Bates
Sales Mgr.: A. W. DeChord MF, WN, PS, GS, GH, GE, CO, TS, TR

AUDIO DEVELOPMENT CO.
2833 13th Ave. S., Minneapolis 7, Minn. (Tel. PA 9-7386)
Purch. Agent: V. S. Bormon
Asst. Purch. Agent: Ed Rosendale
Dir.-Sales: D. E. Engebretson

AUDIO DEVICES, INC.
444 Madison Ave., New York 22, N. Y. (Tel. PLaza 1-6640)
Purch. Agent: Ellis Moys
V. P.-Sales: Bryce Haynes TR

AUDIO DEVICES, INC.-RECTIFIER DIV.
620 E. Dyer Rd., Santa Ana, Calif. (Tel. KImberly 5-8241)
Purch. Agent: E. C. Fries
Sales Mgr.: A. J. Romano

AUDIO INSTRUMENT CO., INC.
135 W. 14th St., New York 11, N. Y. (Tel. ORegon 5-7820)
Sales Mgr.: C. J. LeBel

AUDIO-MASTER CORP.
17 E. 45th St., New York 17, N. Y. (Tel. OXford 7-0725)
Purch.: Herbert Rosen TR

AUGAT BROTHERS, INC.
33 Perry Ave., Attleboro, Mass. (Tel. 1-2202)
Purch.: Louis H. Young
Sales: Robert S. Laurence MM

AUSTENAL CO., DIV.-HOWE SOUND CO., MICROCAST PRODUCTS
224 E. 39th St., New York 16, N. Y. (Tel. OXford 7-5656)
Dir.-Purch.: Anne D. Repko
Sales Mgr.: R. L. Wiseman
Sales Engr.: E. L. White, Jr. MF, PS, MM, R&D

AUSTENAL INC.
224 E. 39th St., New York 16, N. Y. (Tel. OXford 7-5656)
Purch. Mgr.: A. D. Repko
Asst. Purch. Mgr.: W. Riley
Sales Mgr.: R. L. Wiseman MF, PS

AUSTIN CO., THE, SPECIAL DEVICES DIV.
76 9th Ave., New York 11, N. Y. (Tel. WAtkins 4-3630)
Purch. Agent: H. W. Hunsberger
Sales: W. G. Birkel GS, GE, TS

AUSTIN-WESTERN, CONSTR. EQUIP. DIV.-BALDWIN-LIMA-HAMILTON CORP.
601 N. Fornsworth Ave., Aurora, Ill. (Tel. 7-8753)
Dir.-Purch.: J. D. McMakin
Asst. Gen. Mgr.-Sales: H. P. Lockhart GS, GH

AUTO SPECIALTIES MFG. CO., INC.
St. Joseph, Mich. (Tel. YUkon 3-2521)
Dir.-Procurement: E. Millhouse
Asst. Dir.-Procurement: C. Miller
Buyers: E. Luhrs, K. Bingham, O. Pollas & D. Schuhknecht PS, GS, GH, R&D

AUTO-CONTROL LABS., INC.
333 S. Hindry Ave., Inglewood 1, Calif. (Tel. ORegon 8-4934)
Chief Engr.: Bob Lieberman
Engr. (Environmentol Sec.): Chuck R. Knokey MF, PS, GS, GH, GE, TS

AUTOMATIC ELECTRIC SALES CORP.
Northlake, Ill. (Tel. FIllmore 5-7111)
Gen. Purch. Agent: W. S. Codwell
Pres.: D. H. Deaver GS, GH, GE, CO, TS

AUTOMATIC SWITCH CO.
Honover Rd., Florham Park, N. J. (Tel. FRontier 7-4600, New York City-DIgby 4-3765)
Purch. Agent: Harold W. Hyland
V. P.-Volve Sales: R. F. McCormick
V. P.-Switch Dept.: F. P. Spinelli GS

AUTOMATION DYNAMICS CORP.
255 County Rd., Tenafly, N. J. (Tel. LOwell 7-3232)
Purch. Agent: Mrs. Dorothy Suhre
Sales: Richard A. Bolz TS, TR, R&D

AUTOMATION INSTRUMENTS INC.
401 E. Green St., Pasadena, Calif. (Tel. SY 3-8169)
Purch. Agent: Wes Seeley (Tel. RY 1-6311)
Sales Mgr.: Robert Shafer (Tel. RY 1-6311) TS, TR

AUTOMATION PRODUCTS, INC.
3030 Max Roy St., Houston 24, Tex. (Tel. UN 9-1485)
Purch. Agent: Quin M. Baker

AUTOMETRIC CORP.
1501 Broadway, New York, N. Y. (Tel. BRyant 9-8700)
Purch. Agent: William Matzen

AUTOMOTIVE & AIRCRAFT DIV.-AMERICAN CHAIN & CABLE CO., INC.
601 Stephenson Bldg., Detroit 2, Mich. (Tel. TRinity 5-4104)
Purch.: H. C. Wenpelcke, Adrian, Mich.
V. P.-Sales Mgr.: Harry Williams GH, GE, TS

AUTONETICS, DIV.-NORTH AMERICAN AVIATION, INC.
9150 E. Imperiol Hwy., Downey, Calif. (Tel. SPruce 3-2233)
Material Dir.: C. R. Raftery, 201 W. Manville St., Compton, Calif. (Tel. NEwmark 2-5721)
Purch. Agent: S. D. Zemonsky, Compton, Calif.
Dir.-Mktg.: Charles A. Wolf MF, PS, GS, GH, GE, CO, TS, TR

AUTOTRON, INC.
3629 N. Vermilion St., Donville, Ill. (Tel. 650)
V. P.-Purch.: M. Gieseke PS, GH, GE, CO, TS, TR

AUTOTRONICS INC.
Box 208, Florissont, Mo. (Tel. TEmple 7-3565)
V. P.-Purch. & Sales: E. F. White
Production Mgr.: A. F. Boaus
Chief Engr.: C. A. Jackson
Pres.: A. J. Thompson GS, GE, TR, R&I

AUTO-VALVE INC.
12 Molden Ave., Dayton 27, O. (Tel. AMherst 3-827
Pres.: Anthony P. Borcus GS, GH, R&I

***AVCO MFG. CORP., CROSLEY DIV.**
1329 Arlington St., Cincinnati, Ohio (Tel. KIrby 1-6600)
Dir. Purch.: A. J. Verax
Gen. Sales Mgrs.: T. J. Michel (Bomber Defense System & Communic.), L. E. Benitez (Spoce Missiles, Ordnonce), E. Hopley (Radar & Air Traffic Control) WN, GS, GE, CO, TS, TR, R&
*(See 3rd Cover for Advertisement)

***AVCO MFG. CORP., NASHVILLE DIV.**
Nashville 1, Tenn. (Tel. ALpine 4-9551)
Purch. Agent: D. C. Hergert
Gen. Mktg. Mgr.-Structures: Henry Ritter
V. P.-Mktg., Defense Products: Dr. L. C. Maier, Jr MM, R&
*(See 3rd Cover for Advertisement)

AVCO RESEARCH LAB., DIV.-AVCO MFG. CORP.
2385 Revere Beach Parkway, Everett, Mass. (Tel. DUnkirk 9-2300)
Purch. Agent: Harold Bloom
Exec. Asst. to Dir.: F. C. Durant, III R&D
(See 3rd Cover for Advertisement)

VIATION DEVELOPMENTS INC.
210 S. Victory Blvd., Burbank, Calif. (Tel. Victoria 9-4631)
Dir.-Purch.: John R. Moger
Dir.-Sales: James D. Santocroce
MF, GS, GH, TS, MM, R&D

VIATION TEXTILE ASSOCIATES
17180 Wyoming, Detroit 21, Mich. (Tel. UN 2-3565)
V. P.-Purch.: E. A. Thomson
Pres.: W. T. Greig

VIATORS EQUIPMENT CORP.
143 Main St., Beacon, N. Y. (Tel. BEacon 1570)
Pres.: John E. Liebmann
Purch. Agent: John H. Duffy

VICA CORP.
Newport, R. I. (Tel. VIking 6-9100)
Purch. Mgr.: D. J. Mulhollond
V. P.-Chief Sales Engr.: R. S. Weiss
MF, PS, GS, GH

VIEN, INC.
58-15 Northern Blvd., Woodside 77, N. Y. (Tel. YEllowstone 2-4600)
Mgr.-Purch.: Clifford Napolitano
Mktg. Mgr.: H. H. Georgens GS, CO, R&D

ION DIV., ACF INDUSTRIES, INC.
1 Park Place, Paramus, N. J. (Tel. COlfax 1-4100)
Purch. Agent: Warren Guy GS, GE, CO, TR, R&D

ION FOUNDRY CORP.
P. O. Box 395, Tarpon Springs, Flo. (Tel. VIctor 2-6633)
Pres.: E. R. Huneke
MF, WN, PS, GS, GH, GE, TR, MM

IONICS RESEARCH CORP.
11 E. Colonial Dr., Orlando, Fla. (Tel. GA 5-0547)
Gen. Mgr.: Alan Drucker GS, GE

NET CORP.
5877 Rodeo Rd., Los Angeles 16, Calif. (Tel. TExos 0-6141)
Purch. Agent: Norman Karchem
Sales Mgr.: M. G. Newberger MF, GS, GH

O LTD.
10 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Dir.-Sales: Si Bosworth

ONDALE CO., THE
2160 Happ Rd., Northfield, III. (Tel. AMB 2-0342)
Purch.: Paul Manning
Sales: H. N. Limbock MF, WN, PS, GS, GH, GE

TRON MFG., INC.
10409 Meech Ave., Cleveland 5, Ohio (Tel. MI 1-8310)
Purch. Agent: Thomas Sulzberger GS, CO

EL ELECTRONICS
134-20 Jamaica Ave., Jamaica, N. Y. (Tel. REpublic 9-1700)
Purch. Agent: Robert H. Elkes
Asst. Purch. Agent: Bernard Gollop
Sales Mgr.: Joseph P. O'Donnell GE, TR

LER ASSOCIATES INC.
102-42 43rd Ave., Corona 68, N. Y. (Tel. HAvemeyer 9-7718)
Purch. Agent: K. Hillman
Sales: M. Axler TR, R&O

I & C. INSULATION PRODUCTS, INC.
190 Lincoln Hwy., Iselin, N. J. (Tel. LIberty 8-0815)
Gen. Mgr.: Bernard Sherman MF, PS

I & F INSTRUMENTS, INC.
1644 N. Lawrence St., Philadelphia 40, Pa. (Tel. GA 5-4175)
V. P.-Purch.: C. E. Stufflebeam
Chief Purch. Clk.: B. Snyder TS, TR, R&O

IG CORP., THE
121 Broad Ave., Ridgefield, N. J. (Tel. WHitney 5-8800)
Purch. Agent: Melville Miller
Dir.-Sales & Engrg.: Robert W. Brattvet
MF, WN, PS, GH, TR

IH. AIRCRAFT CO., INC.
Eastern Parkway at Maplewood Ave., Farmingdale, L. I., N. Y. (Tel. CHopel 9-5000)
V. P.-Purch.: Donald F. Baum MF, PS

I & H INSTRUMENT CO., INC.
1479 W. Vickery Blvd., Fort Worth, Tex. (Tel. EDison 6-7243)
Purch. Agent: Dwight Adams
Sales Mgr.: Leon H. Becker CO, TS

BJ ELECTRONICS, BORG-WARNER CORP.
3300 Newport Blvd., Santa Ana, Calif. (Tel. KImberly 5-5581)
Purch. Agent: H. E. Schuyler
Sales Mgr.: H. G. Ayers GS, GH, CO, TS, TR, R&D

B & K INSTRUMENTS, INC.
3044 W. 106th St., Cleveland 11, Ohio (Tel. CLearwater 1-8430)
Office Mgr.: Robert E. Madden
Pres.: James W. Day TS

BABCOCK RADIO ENGRG., INC.
1640 Monrovio Ave., Costa Meso, Calif. (Tel. LIberty 8-7705)
Purch. Agent: Russell Clifton
Dir.-Materiel: Richard T. Liggett
Buyers: Robert Moore, Chas. E. Wilson, Carl Bewlan, Jess Hardy
Asst. V. P.-Sales Engrg.: Normon E. Cima GE, TS

BABCOCK RELAYS, INC.
1640 Monrovia Ave., Costa Mesa, Calif. (Tel. LIberty 8-7705)
Dir.-Material: Richard Liggitt
Purch. Agent: Russ Clifton
V. P.-Sales: Carl L. Martin

BABCOCK & WILCOX CO., TUBULAR PRODUCTS DIV.
Beaver Falls, Pa. (Tel. Beaver Falls 2100)
V. P.: J. S. Anderson MF, PS

SEMON BACHE & CO.
636 Greenwich St., New York 14, N. Y. (Tel. WA 4-2121)
Purch.: Henry Del Tosto
Sales: B. Newton MF, PS, GE

BACON INDUSTRIES, INC.
192 Pleasant St., Watertown 72, Mass. (Tel. WAtertown 4-5000)
Purch. Agent: Kenneth H. Barton
Sales Mgr.: Eldon H. Fay MF, WN, PS

BADGER OIE CASTING CORP.
201 W. Oklahoma Ave., Milwaukee 7, Wis. (Tel. SH 4-6643)
V. P.: Lyle Tuchel MM

BADGER MFG. CO.
363 Third St., Cambridge 42, Mass. (Tel. UNiversity 4-9800)
Purch. Agent: T. J. Eorley
Buyers: E. L. Turner, J. C. Mannix, G. H. Horn, Jr., J. J. Duggan
V. P.-Sales: W. C. Rousseou

N. S. BAER CO.
1-11 Montgomery St., Hillside, N. J. (Tel. MUrdock 8-2250)
Office Mgr.: P. J. Stec
Sales Mgr.: S. W. Nette MF, WN, PS

BAIRD-ATOMIC, INC.
33 University Rd., Cambridge 38, Mass. (Tel. UNiversity 4-7420)
Purch. Agent: John B. Milliken
Sales Mgr.: F. L. Foster GE, TS, TR, R&D

J. T. BAKER CHEMICAL CO.
N. Broad St., Phillipsburg, N. J. (Tel. GLencourt 4-2151)
Dir.-Purch.: John L. Zopf
Buyers: John R. Herd, Thomas W. Mohr, R. H. M. Meir
V. P.-Sales: Ralph A. Clark

BAKER INDUSTRIAL TRUCKS, DIV.-OTIS ELEVATOR CO.
8000 Baker Ave., Cleveland, Ohio (Tel. OLympic 1-3000)
Purch. Agent: E. W. Sonkey
Asst. Purch. Agents: Joseph Petras, K. W. Keyerleber
Gen. Sales Mgr.: Robert J. Laws
Sales Prom. Mgr.: Russell A. Moore GS, GH, R&O

BAKER PERKINS INC.
1000 Hess St., Saginaw, Mich. (Tel. PLeasont 2-4121)
Purch. Agent: R. F. Byrne
V. P.-Sales: K. A. Mack
Asst. Sales Mgr.: W. D. Chapman PS

BAKER STEEL & TUBE CO.
1540 Calzona St., Los Angeles 23, Calif. (Tel. ANgelus 3-7231)
Asst. Gen. Mgr.: C. L. Baker
Sales Mgr.: H. E. Byerrum MM

BALCO RESEARCH LABS., INC., CAPACITOR DIV.
49-53 Edison Place, Newark, N. J. (Tel. MItchell 3-5200)
Purch.: Bob Nobel GE, TR

***BALCRANK INC., MACHINE TOOL DIV.**
Disney St., Cincinnati, Ohio (Tel. RE 1-7200)
Purch. Agent: E. M. Flannery
Sales Admin.: J. A. Weiss GS, MM
*(See Page 71 for Advertisement)

BALDWIN MFG. CO. INC., THE
140 Homer St., Waterbury, Conn. (Tel. PLaza 6-5561)
Pres.: Francis V. Gullo

BALDWIN PIANO CO., THE, INDUSTRIAL PRODUCTS DIV.
1801 Gilbert Ave., Cincinnati 2, Ohio (Tel. MA 1-4300)
Dir.-Purch.: F. X. Shonnon
Dir.-Industrial Sales: John Rotte GS, GE, TR, R&D

BALDWIN-LIMA-HAMILTON CORP., ELECTRONICS & INSTRUMENTATION DIVS.
42 4th Ave., Waltham 54, Moss. (Tel. TW 4-6700)
Purch. Agent: R. A. Welch
Asst. Purch. Agent: R. Lepare
Buyers: C. W. Jiggetts, G. A. Chodwell & R. Lauranzano
Gen. Sales Mgr.: William Kerr
PS, GS, GH, CO, TS, TR

BALL MACHINE PRODUCTS CO., THE
82 Fillmore St., New Haven 11, Conn. (Tel. STate 7-2776)
Sales Mgr.: R. Lane
Buyers: Eric T. Ball, R. B. Ball

BALLANTINE LABS, INC.
Boonton, N. J. (Tel. DEerfield 4-1432)
V. P.-Purch.: Frank R. Zayoc TS, R&O

BALLASTRAN CORP.
1701 N. Calhoun St., Fort Wayne 7, Ind. (Tel. EAstbrook 2285)
Purch.: H. L. Motthias
Chief Engr. & Gen. Mgr.: Wm. Weir
Buyer: Howard D. Carr TR

BALLYMORE CO.
Lincoln & Garfield Aves., West Chester, Pa. (Tel. OWen 6-3250)
Gen. Mgr.: William B. Hart
Sales Mgr.: Harry G. Westerfield GS, GH

BALTEAU ELECTRIC CORP.
P. O. Box 385, 5 New St., Stamford, Conn. (Tel. DA 4-6118)
Div. Mgr., X-Ray Sales: Fred C. Sarchet
V. P.-Purch.: M. Morechal TS

BANNER INDUSTRIES
9501 Inkster Rd., Taylor, Mich. (Tel. WH 1-9800)
Purch. Agent: Richard Olesak
Sales Mgr.: Tom MacDonold

BAR WORK MFG. CO., INC.
1198 Highland Ave., Waterbury, Conn. (Tel. PLoza 3-4103)
Office Mgr.: Floyd Bird
Pres.: Charles H. June, Jr.

ALFREO W. BARBER LABS.
32-44 Froncis Lewis Blvd., Flushing 58, N. Y. (Tel. IN 3-3306)

BARBER-COLMAN CO.
1411-3 Rock St., Dept. Q, Rockford, III. (Tel. WOodlond 8-6833)
Purch. Agent: D. R. Farquhar
Sales Mgr.: Aircraft Controls Div.: R. A. Baird
Sales Mgr., Electrical Components Div.: W. F. Tice
PS, GS, GE, TS, TR

BARCO MFG. CO., INC.
566 N. Hough St., Barrington, III. (Tel. DUnkirk 1-1700)
Purch. Agent: W. F. Donoldsan
V. P.'s: J. O. Heyworth, F. M. Moore PS, GS, GH

BAROEN CORP., THE
33 E. Franklin St., Donbury, Conn. (Tel. Ploneer 3-3885)
Purch. Agent: W. R. Ferguson
Buyer: K. A. Taylor
V. P.-Sales: Alphe G. Jarreou PS, GS, GE

BARIUM & CHEMICALS, INC.
Lake Co. Nat. Bonk Bldg., Willoughby, O. (Tel. WI 2-5151)
V. P.-Chg. of Purch.: Douglas Naylor
V. P.-Sales & Adv.: Albert Povlik, Jr. PS, MM

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

BARKER SALES CO.
339 S. Broad Ave., Ridgefield, N. J. (Tel. WHitney 3-2477)
Purch.: J. Donovan
Sales Mgr.: T. R. Sheron
Sales: T. R. Cox
GS, GE, TR

BARKER & WILLIAMSON INC.
Bristol, Pa. (Tel. STillwell 8-5581)
Purch. Agent: Joseph Fattorini
V. P.-Sales: J. C. Pearce

BARKSDALE VALVES
5125 Alcoa Ave., Los Angeles 58, Calif. (Tel. LUdlow 7-6181)
Purch. Agent: H. Lembke
Gen. Mgr. & V. P.-Sales: M. C. Nelson
GS, GH, TS, R&D

BARNEBEY-CHENEY CO.
Eighth Ave. & North Cassady, Columbus 19, Ohio

BARNES ENGRG. CO.
30 Commerce Rd., Stamford, Conn. (Tel. FIreside 8-5381)
Purch. Agent: James D. Bennett

BARNSTEAD STILL & STERILIZER CO.
2 Lanesville Terr., Boston 31, Mass. (Tel. JA 4-3100)
Purch. Agent: J. C. Mullan
Sales Mgr.: D. G. Miller
PS, GS

BARNUM MACHINE WORKS, INC.
200 Wooster St., New Haven, Conn. (Tel. LOcust 2-2169)
Pres.: Henry G. Halbing

BAR-RAY PRODUCTS, INC.
211 25th St., Brooklyn 32, N. Y. (Tel. SOuth 8-1020)
TS

LEON J. BARRETT CO., THE
1495 Grafton Rd., Worcester, Mass. (Tel. PLeasant 5-4306)
Dir.-Purch.: D. C. Page
Purch. Agent: L. E. Clark
Sales Mgr.: R. B. Ayres

W. L. BARRETT CO., THE
School St., Bristol, Conn. (Tel. LUdlow 2-7487)
Purch. Agent: M. Graham
Sales Mgr.: A. J. Levins
MF, PS, GE, TS, TR

BARRETT-CHRISTIE CO.
118-124 N. Clinton St., Chicago 6, Ill. (Tel. FRanklin 2-9540)
Purch. Agent: R. O. Honson
MM

BARRY CONTROLS INC.
938 Pleasant St., Watertown 72, Mass. (Tel. WAtertown 3-1150)
Purch. Agent: Thomas Foster
Buyers: James Wise, James Writesel
V. P.-Mktg.: Edward A. Johnson
MF, GS, GE, TS, R&D

BARRY ELECTRONICS CORP.
512 Broadway, New York 12, N. Y. (Tel. WAlker 5-700)
Pres.: B. N. Gensler

BART MFG. CORP.
227 Main St., Belleville, N. J. (Tel. PLymouth 9-0200)
Purch. Agent: Edward Mangas
Buyer: Dorothy Durrigan
V. P.-Sales: L. P. Vollmuth
R&D

BARTON INSTRUMENT CORP.
580 Monterey Pass Rd., Monterey Park, Calif. (Tel. CUmberland 3-6501)
Purch. Agent: Sylvia Clingerman
V. P.-Sales: A. I. Thompson

BARWOOD ELECTRONICS INC.
921 E. Broadway, Glendale 5, Calif. (Tel. CHapman 5-4063)
GS

GEORGE BASCH CO., THE
19 Hanse Ave., Freeport, N. Y. (Tel. FReeport 8-8100)
Pres.: George Basch
Gen. Mgr.: Jerome D. Basch
MM, R&D

BASCO METAL PRODUCTS, INC.
7649 San Fernando Blvd., Burbank, Calif. (Tel. ROgers 7-3711)
Purch. Agent: Robert Crawford
Sales Mgr.: Don Lawrie
MF, GS, GH

BASIC & EXPERIMENTAL PHYSICS
Box 689, Falmouth, Mass. (Tel. KImball 8-2175)
Purch. Agent: L. Grafton
Sales Mgr.: J. A. Roberts
R&D

BASIC TOOL INDUSTRIES, INC.
14439 S. Avalon Blvd., Gardena, Calif. (Tel. FAculty 1-2665)
Purch. Agent: Robert F. Rigali
Asst. Purch. Agent: K. S. Frenger
Buyer: H. B. Silbert
Exec. V. P.-Sales: Robert G. Lucas
MF, GS, GH

BASO INC.
730 N. Jackson St., Milwaukee 1, Wisc. (Tel. BRoadway 3-5388)
Purch. Agent: G. C. Winters
Asst. Purch. Agent: F. J. Jens
Mgr.-Relay Sales: D. Weidenfeller

REX BASSETT, INC.
1314 N. E. 17th Ct., Ft. Lauderdale, Fla. (Tel. LOgan 4-3028)

BASSICK CO., THE, DIV.-STEWART-WARNER
3045 Fairfield Ave., Bridgeport 5, Conn. (Tel. FOrest 6-3671)
Dir.-Purch.: George Raiselis
Purch. Agent (Parts): Henry Burr
Dir.-Sales: W. G. Reycroft
GS, GH

CHRISTIE BATLAS, INDUSTRIAL SCALE MODELS
17 Irving Pl., Summit, N. J. (Tel. CR 3-8364)

***BAUSCH & LOMB OPTICAL CO.**
88459 St. Paul St., Rochester, N. Y. (Tel. LOcust 2-3000)
Purch. Agent: C. Buss
V. P.-Sales: A. K. Marsters
Mgr.-Contract Dept.: J. W. Wright
MF, WN, PS, GS, GH, GE, CO, TS, TR
*(See Page 95 for Advertisement)

BAY STATE ABRASIVE PRODUCTS CO.
12 Union St., Westboro, Mass. (Tel. FOrest 6-4433)
Purch. Agent: Frank A. Rossi
V. P.-Mktg.: E. L. Auker
MM

BEACH-RUSS CO.
420 Lexington Ave., New York 17, N. Y. (Tel. OR 9-7636)
Dir.-Purch.: S. Schmanski
V. P.-Sales: A. T. Beach
TS, R&D

MORRIS BEAN & CO.
Yellow Springs, O. (Tel. ROckwell 7-7301)
Dir. Purch.: D. W. Waechter
Purch. Agent: T. E. Charlton
Asst. Purch. Agent: R. E. Pollock
V. P.-Sales: R. H. Hollister
MM

BEARING INSPECTION, INC.
3311 E. Gage Ave., Huntington Park, Calif. (Tel. LUdlow 2-6431)
Pres. & Sales Mgr.: Charles McKnight
Purch. Agent: J. O. Butler
MF, GS, GH, GE, CO, TS, TR, R&D

BEARIUM METALS CORP.
Mill & Commercial Sts., Rochester, N. Y. (Tel. LOcust 2-7700)
Purch. Agent: A. E. Zielke
Sales Mgr.: B. M. Garek
MF, PS, GE

***BEATON & CORBIN MFG. CO., THE**
328 N. Main St., Southington, Conn. (Tel. MArket 8-3636)
V. P.: C. W. Rush, Jr.
MF, PS, GS, GH, GE, TS, TR
*(See Page 100 for Advertisement)

BEATTIE-COLEMAN, INC.
1000 N. Olive St., Anaheim, Calif. (Tel. PRospect 4-4503)
Buyer: John Brewer
Sales Mgr.: J. A. Wilcox
GE, CO

W. A. BEAUCHAINE & SONS INC.
P. O. Box 127, Lakeport, N. H. (Tel. LAkeside 4-5518)
Pres.: A. D. Beauchaine
Sales Mgr.: C. C. Fernald
GE, TR

BEAVER GEAR WORKS, INC.
1025 Parmele St., Rockford, Ill. (Tel. WO 3-9691)
Dir.-Purch. Dept.: R. A. Zwicky
Dir.-Sales Dept.: Charles L. Kessler
GE, TR

BEAVER PRECISION PRODUCTS INC.
651 N. Rochester Rd., Clawson, Mich. (Tel. JOrdan 4-6547)
Purch. Agent: Edw. Smakoski
V. P.-Sales: John A. Hope
GS, GH, GE, TS, TR

BEAVER-ADVANCE CORP.
P. O. Box 792, Ellwood City, Pa. (Tel. PL 8-7571)
Purch. Agent: J. T. Penman
Sales Mgr.: R. B. Cooper
GH

BECCO CHEMICAL DIV.-FOOD MACHINERY & CHEMICAL CORP.
Station B, 34 Sawyer Ave., Buffalo, N. Y. (Tel. BEdford 8300)
Purch. Agent: Herbert J. Newman
Asst. Purch. Agent & Traffic Mgr.: Edward Wheeler
Buyer: Charles Keller
Asst. Buyer: Mrs. Lois Aichinger
Dir.-Sales: A. P. Shutts
PS

BECKMAN INSTRUMENTS, INC., BERKELEY DIV.
2200 Wright Ave., Richmond, Calif. (Tel. LA 6-7730)
Purch. Mgr.: Walter Day
Sales Mgr. (Test & Indsl. Instruments): John W. Scheck
Sales Mgr. (Analog Computers): Karl Sterne
CO, TS, R&D

BECKMAN/SCIENTIFIC & PROCESS INSTRUMENTS DIV.
2500 Fullerton Rd., Fullerton, Calif. (Tel. TRojan 1-4848)
Purch. Agent: K. A. Bruner
Mktg. Mgr.: M. K. Howlett
GH, R&D

BECKMAN/SPINCO DIV.
1117 California Ave., Palo Alto, Calif. (Tel. DAvenport 1-2121)
Purch. Agent: Walter Day
Acting Div. Mgr.: G. F. Clifford

BECKMAN/SYSTEMS DIV.
325 N. Muller Ave., Anaheim, Calif. (Tel. PRospect 4-5430)
Purch. Agent: L. A. Call
Buyers: D. McDowell, T. R. Novis, A. D. Penningtor
Mktg. Mgr.: Frank J. Scheufele
GS, CO, TR, R&D

BECKMAN & WHITLEY, INC., INSTRUMENT DIV.
973 San Carlos Ave., San Carlos, Calif. (Tel. LYtell 3-7824)
Purch. Agent: R. Rader
Camera Prod.: L. R. Teeple
Meteorological Instr.: H. V. Thompson
GE, R&D

BECKMAN & WHITLEY, INC., MISSILE PRODUCTS DIV.
985 E. San Carlos Ave., San Carlos, Calif. (Tel. LYtell 3-7824)
Purch. Agent: J. W. Booth
Subcontracting: R. Fasoletos
Sales: C. R. Newman
MF, WN, PS, GS, GH, GE

BEECH AIRCRAFT CORP.
9709 E. Central, Wichita 1, Kans. (Tel. MUrray 3-4681)
Mgr.-Materials: L. E. Bowery
Asst. Mgr.-Prac.: W. R. Sullivan
Gen. Supvr.-Proc.: L. E. Huffman
Supvr.-Prac.: H. W. Deets & V. M. Melick
V. P.-Contract Admin.: James N. Lew
V. P.-Commercial Sales: Leddy Greever
V. P.-Export Sales: Michael G. Neuburger

BEEDE ELECTRICAL INSTRUMENT CO. INC.
Fisherville Road, Penacook, N. H. (Tel. PLaza 3-6362)
Purch. Agent: William F. Wall

BEEMER ENGRG. CO.
401 N. Broad St., Philadelphia 8, Pa. (Tel. WAlnut 2-0900)
Purch. Mgr.: J. M. Brower
MI

***BEHLMAN ENGRG. CO.**
2911 Winona Ave., Burbank, Calif. (Tel. VIctoria 9-5733)
Purch. Agent: Robert C. Danis
V. P.-Sales: J. M. Schroeder
GS, CO, TS, R&
*(See Page 57 for Advertisement)

BEKINS INDUSTRIAL PACKAGING
12512 Inglewood Ave., Hawthorne, Calif. (Tel. OR 8-7213)
Gen. Mgr.: R. A. Patton
Operations Mgr.: Norman L. Johnson
Dir.-Sales & Engrg.: Noble W. Jones
GH, G

BEL FUSE INC.
198 Van Vorst St., Jersey City, N. J.
Pres.: Elliot Bernstein
Dir.-Sales: H. V. Anderson
R&

BELDEN MFG. CO.
415 S. Kilpatrick, Chicago 44, Ill. (Tel. ESterbrook 8-1000)
Dir.-Purch: William A. Sandy
Gen. Sales Mgr.: Les A. Thayer
MF, PS, GS, GH, GE, CO, TS, T

BELFAB CORP., THE
382 Walnut St., Agawam, Mass. (Tel. STate 8-6247)
Purch. Mgr.: D. J. McCarrall
Sales Mgr.: Robert F. Harrigan
MF, WN, PS, GS, GE,

BELL AIRCRAFT CORP., AIRCRAFT DIV.
Wheatfield Plt., P. O. Box 1, Buffalo 5, N. Y.
Div. Mgr.: J. J. Domonkos
Sales & Engrg. Dir.: J. W. Rane
Works Mgr.: T. M. Nolan
Chief Engr.: G. D. Ray
Mfg. Services: R. W. Varrial

AVIONICS DIV., Wheatfield Plt., P. O. Box 1, Buffal 5, N. Y.
Div. Mgr.: J. van Lonkhuyzen
Dir.-Engrg.: Frank Andrix
Dir.-Mfg.: W. Lawrence

SPACE FLIGHT DIV., Kenmore Plt., P. O. Box 1, Buffalo 5, N. Y. (Tel. BEdford 2373)
Div. Mgr.: William Smith

Dir.-Engrg.: R. D. Rinehart
Dir.-Mfg.: F. H. Walters
Sales Mgr.: J. R. Piselli
Programs Dir.: H. A. Ferullo
MF, WN, PS, GS, GH, GE, CO, TS, R&D

BELL AIRCRAFT CORP., NIAGARA FRONTIER DIV.
P. D. Box 1, Buffalo 5, N. Y. (Tel. Niagara Falls, BUtler 5-7851)
Dir. Procurement: Maurice J. Coughlin TR

BELL & GOSSETT CO.
8200 N. Austin, Morton Grove, Ill. (Tel. DR 3-3700)
Purch. Agent: N. Van Parys
Sales Mgr., Electronics Div.: D. J. Shea, Jr.
GS, GH, GE, TR

BELL & GOSSETT CO., MARLOW PUMPS DIV.
Box 200, Midland Park, N. J. (Tel. GIlbert 4-6900)
Purch. Agent: Miss R. K. Boyd
Govt. Sales: H. L. Kocienski
Gen. Sales Mgr.: A. F. Woods GS, GH

BELL & HOWELL CO.
7100 McCormick Blvd., Chicago 45, Ill. (Tel. AMbassador 2-1600)
Dir. Purch.: S. W. Knobe
Dir. Govt. Sales: Carl J. Stauff GE, TS, TR, R&D

BELL OIL & GAS CO.
National Bank Tulsa Bldg., Tulsa, Okla. (Tel. CHerry 2-7191)
Mgr.-Purch.: M. W. Sullivan
Sales Mgr.: L. H. Deatherage

BELL TELEPHONE LABORATORIES, INC.
463 West St., New York 14, N. Y. (Tel. CHelsea 3-1000)
V. P. & Gen. Mgr.: R. L. Helmreich

BELLOFRAM CORP.
Blanchard Rd., Burlington, Mass. (Tel. MIssion 3-9000)
Sales Mgr.: John F. Taplin
Buyer: Harold Currier PS, GE, R&D

BELMONT SMELTING & REFINING WORKS, INC.
330 Belmont Ave., Brooklyn 7, N. Y. (Tel. DIckens 2-4900)
V. P.-Purch.: Robert V. Henning
MF, WN, PS, GE, CO, TS, TR, MM

BELOCK INSTRUMENT CORP.
112-03 14th Ave., College Point, Queens, N. Y. (Tel. HIckory 5-4200)
Purch. Mgr.: Herbert Helmers
V. P.-Sales: John F. Donato
GS, GE, CO, TS, TR, R&D

BEL-TRONICS CORP.
344 Interstate Rd., Addison, Ill. (Tel. KIngswood 3-7778)
Mgr.-Purch.: Lee Belawich
Purch. Agent: Mrs. E. Wanders
Pres. & Sales Mgr.: Thomas J. Wright

BEMIS BROTHERS BAG CO.
111 N. Fourth St., Box 72, St. Louis 2, Mo. (Tel. CHestnut 1-0900) GS

BENBOW MFG. CORP.
11920 W. Jefferson Blvd., Culver City, Calif. (Tel. EX. 8-5766)
Purch. Agent: Donald R. Lange
V. P.-Sales: Wayne S. Boals GS, TS, R&D

BENDIX AVIATION CORP.
Executive Office: Fisher Bldg., Detroit 2, Mich. (Tel. TRinity 5-5000)
Pres.: M. P. Ferguson

BENDIX AVIATION CORP., ECLIPSE-PIONEER DIV.
Teterboro, N. J. (Tel. ATlas 8-2000)
Dir.-Purch.: J. Quinn
Purch. Agents: Paul Farley & R. E. Rosemund
Dir.-Sales & Serv.: J. P. Buckley
GS, GE, CO, TS, R&D

BENDIX AVIATION CORP., FRIEZ INSTRUMENT DIV.
1400 Taylor Ave., Towson 4, Md. (Tel. VAlley 3-4040)
Purch. Agent: H. J. Grady
Gen. Sales Mgr.: R. B. Stevenson WN, GS, R&D

***BENDIX AVIATION CORP., HAMILTON DIV.**
Fifth St. & Ford Blvd., Hamilton, Ohio (Tel. TWinbrook 3-6181)
Purch. Agent: D. J. MacGregor
Sales Mgr.: S. R. Craig GE
*(See Page 12 for Advertisement)

BENDIX AVIATION CORP., MONTROSE DIV.
South Montrose, Pa. (Tel. Montrose 570)
Purch. Agent: J. B. Wilson
Buyers: R. J. Pope, R. L. Kerr, J. E. Mahon & K. R. Flint
Dir.-Sales & Service: M. G. Douglas PS, GS, GE, TR

BENDIX AVIATION CORP., PIONEER-CENTRAL DIV.
Hickory Grove Rd., Davenport, Iowa (Tel. DAvenport 7-9101)
Dir.-Purch.: George Thomas
Asst. Dir.-Purch.: Vernon Dick
Sr. Buyers: Donald Patrick & William Hiegel
Buyer: Robert Lindsay
Dir.-Sales & Serv.: I. H. MacMillan
MF, WN, PS, GS, GH, GE, CO, TS, TR

BENDIX AVIATION CORP., RED BANK DIV.
Eatontown, N. J. (Tel. LIberty 2-2000)
Purch. Agent: L. Fyfe
Buyer: Wm. Rennick
Gen. Sales Mgr.: N. P. Barny
Mktg. Mgr.-Electron Tubes: J. F. Bozzelli
WN, GS, TR

BENDIX AVIATION CORP., SCINTILLA DIV.
Delaware Ave., Sidney, N. Y. (Tel. LDwell 3-9511)
Purch. Agent: W. B. Wilson
Asst. Purch. Agent: C. L. Kessler
Asst. Purch. Agent-Raw Materials & Castings: C. E. Rodgers
Asst. Purch. Agent-MRO Supp.: L. Johnson
Dir.-Sales: D. B. Morse
MF, PS, GS, GH, GE, CO, TS, TR

BENDIX AVIATION CORP., SEMICONDUCTOR PRODUCTS, RED BANK DIV.
201 Westwood Ave., Long Branch, N. J. (Tel. CApital 2-6220)
Mktg. Mgr.: Robert R. Meijer
Dir.-Purch.: L. D. Fyfe, Eatontown, N. J. (Tel. LIberty 2-2000)
Purch. Agent: Thomas Hackett, Eatontown, N. J. (Tel. LIberty 2-2000)

BENDIX AVIATION CORP., YORK DIV.
York, Pa. (Tel. 47-2611)
Purch. Agent: R. H. Moore
Chief Buyer: P. B. Gross
Sales Mgr.: T. R. Bartlett
MF, WN, PS, GS, GH, GE, CO, TS, TR

BENDIX COMPUTER, DIV.-BENDIX AVIATION CORP.
5630 Arbor Vitae St., Los Angeles 45, Calif. (Tel. Spring 6-2220)
Purch. Agent: R. J. Thelen
Sr. Buyer: M. McCafferty
Buyers: J. Brewer & R. Donovan
Dir.-Mktg.: D. P. Staderman GE, TR

BENDIX FILTER DIV., BENDIX AVIATION CORP.
434 W. Twelve Mile Rd., Madison Hgts., Mich. (Tel. JOrdon 6-2380)
Purch. Dept.: D. S. Kinsman
Buyer: Ivon Papin
Dir.-Sales: W. N. Caldwell, Jr.
Sales Mgr.: G. T. Grimstad
PS, GS, GH, GE, CO, TS, MM, R&D

BENDIX FOUNDRIES, BENDIX AVIATION CORP.
Teterboro, N. J. (Tel. ATlas 8-2000)
Foundry Mgr.: R. D. Ferguson
Foundry Purch. Agent: G. F. Cartier
Sales Mgr.: L. Eigenrauch MF, PS

***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
401 Bendix Dr., South Bend, Ind. (Tel. CEntral 3-4141)
Dir.-Purch.: C. E. Budd
Sales: K. L. Mulholland PS, GS, GH, CO, MM, R&D
*(See Page 47 for Advertisement)

BENDIX PRODUCTS DIV.-MISSILES, BENDIX AVIATION CORP.
400 S. Beiger St., Mishawaka, Ind. (Tel. BL 5-2111)
Dir.-Procurement: Daniel J. Youngerman
Supvr. Subcontract Section: Roger D. Weller
Asst. Purch. Agent: Fred R. Glassman
Contracts Mgr.: M. R. Balis

BENDIX RADIO DIV. BENDIX AVIATION CORP.
E. Joppa Rd., Baltimore 4, Md. (Tel. VAlley 3-2200)
Govt. Prods. Materials Mgr.: J. L. Winchester
Govt. Prods. Sales Mgr.: E. A. King
GS, GE, CO, TR, R&D

BENDIX UTICA DIV., BENDIX AVIATION CORP.
211 Seward Ave., Utica, N. Y. (Tel. SWift 7-2500)
Dir.-Purch.: Alan J. Dodd
Senior Buyers: P. B. Huested, G. R. Didio, R. V. Douglas
Buyer: R. C. Mallory
Dir.-Sales & Service: D. S. Tilden GS, CO, TS

BENDIX-PACIFIC DIV., BENDIX AVIATION CORP.
11600 Sherman Way, N. Hollywood, Calif. (Tel. PDplar 5-1010)
Dir. Purch.: R. R. Zimmerman
Asst. Dir.-Purch.: R. N. Huntoan
Electro-mechanical Sales Mgr.: C. J. Robinson
Electronics Sales Mgr.: H. D. Wilkinson
Hydraulics Sales Mgr.: J. G. Weldan
Telemetering Sales Mgr.: E. W. Copeland
GS, GH, GE, CO, TS, TR, R&D

BENSON MFG., CO., THE
1811 Agnes Ave., Kansas City, Mo. (Tel. BE 1-8300)
Dir.-Purch.: Ralph Bure
Buyers: Dick Stuessi, Lawrence Davis, Jim Mitchell, Earl Miller
Pres.: A. J. Benson MF, WN, GS, GH, MM

BENSON-LEHNER CORP.
11930 W. Olympic Blvd., Los Angeles 64, Calif. (Tel. BRadshow 2-3484)
Head-Purch.: Everett Case
Buyers: John Dudas, Richardson Hill, George Sharp
V. P.-Appl. Engrg.: Donald B. Prell
MF, PS, GS, GH, GE, CO, TS, TR, R&D

BENTON HARBOR ENGRG. WORKS, INC.
622 Langley Ave., St. Joseph, Mich. (Tel. YUkon 3-5523)

BERGEN CARBIDE CO.
P. D. Box 531, Fair Lawn, N. J. (Tel. GRegory 1-3538)
Gen. Mgr.: Charles Dpenden
MF, WN, PS, GS, GE, TR

BERGEN LABS., INC.
247 Crooks Ave., Clifton, N. J. (Tel. GRegory 3-7800)
Purch. Agent: D. Mierop
Sales Mgr.: M. Haberman TS, R&D

BERGEN WIRE ROPE CO.
11 Gregg St., Lodi, N. J. (Tel. HUbbard 7-3521)
Purch. Agent: Jack Harper
Dir.-Sales: Robert Ernst MF, GS, GH, TS

BERGER BROTHERS CO., THE
135 Derby Ave., New Haven, Conn. (Tel. MAin 4-0131)
Purch. Agent: Donald MacDonald
Assoc. Purch. Agent: Richard Wallace
Dir.-Special Prod.: Fred D. Moller
GS, GH, TS, TR, R&D

BERKSHIRE ELECTRIC CABLE CO.
River Rd., Leeds, Mass. (Tel. Northampton-JUstice 4-3853)
Treas.: Garson R. Feinstein
MF, PS, GS, GH, CO, TS, TR

BERNCO ENGRG. CORP.
2320 S. Tibbs Ave., P. D. Box 41037, Indianapolis 41, Ind. (Tel. CHapel 1-2871)
Purch. Agent & Plant Mgr.: E. F. Winterfeldt
Pres. & Sales Mgr.: Orban H. Reich GS, CO

BERYLLIUM CORP., THE
P. D. Box 1462, Reading, Pa. (Tel. WAlker 9-0781)
Purch. Agent: T. Blessing
V. P.-Sales: L. F. Boland MM, R&D

CHARLES BESELER CO.
219 S. 18th St., East Orange, N. J. (Tel. DR 6-6500)
Purch. Agent: J. Prager
Sales Mgr.: M. F. Myers GH

BEST AIRCRAFT CORP.
711 Sip St., Union City, N. J. (Tel. UNion 5-1681)
Sales Mgr.: F. Gebhardt
Gen. Mgr.: C. J. Higgins MF, GS, GH, MM

BEVA LAB., INC.
22 Parker Ave., Trentan 9, N. J. (Tel. EXport 4-4074)
Mgr.: W. Hartig
Secy.: L. A. Hartig CO, TS, R&D

JAMES G. BIDDLE CO.
1316 Arch St., Philadelphia 7, Pa. (Tel. LD 4-1620)
Purch. Agent: Lester Markham
Chief Engr.: E. B. Curdts
Sales Mgr.: P. E. Sellers TS

A. BIEDERMAN, INC.
1045 Air Way, Glendale 1, Calif. (Tel. CItrus 6-2421)
Purch. Agent: Frank A. Herle
Dir.-Sales: Herbert J. Pyle GS, CO, TS, R&D

CARL H. BIGGS CO.
1547 14th St., Santa Monica, Calif. (Tel. GR 8-0461)
Purch. Agent: G. Hert
Dir.-Sales: D. N. Lott MM

BIL-JAX INC.
Wyse Rd., Archbold, Ohio (Tel. 2045)
Purch. Agent: Wilbur M. Wyse GS, GH

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

BILLINGS & SPENCER CO., THE
1 Laurel St., Hartford, Conn. (Tel. JAckson 7-5181)
Purch. Agent: Wm. V. Pilan
Sales Mgr., Spec. Forgings Div.: E. A. Cracker MM

BINKLEY MFG. CO.
Warrentan, Mo. (Tel. GLadstone 6-3455)
Purch. Agent: M. D. Coleman
Gen. Sales Mgr.: Frank A. Bornmann

BIO-RAD LABS.
32nd & Griffin Ave., Richmond, Calif. (Tel. BEacon 4-4130)
Purch. Agent: A. S. Klein
Sales Mgr.: David Schwartz MM, R&D

BIOS LABS., INC.
17 W. 60th St., New York 23, N. Y. (Tel. PLaza 7-8171)
Asst. Dir.-Purch.: H. Brodie
Dir.-Sales: Fred Linsker MF, WN, PS, GS, TS, TR

RICHARD H. BIRD & CO., INC.
1 Spruce St., Waltham 54, Mass. (Tel. TWinbrook 4-0160)
Supt.: C. F. Whittemare GE, TR

BIRDAIR STRUCTURES, INC.
290 Larkin St., Buffalo 10, N. Y. (Tel. MDhawk 6520)
Purch. Agent: Warren K. Harey
Sales Mgr.: Alvin C. Smith

BIRMA MFG. CO. INC.
525 Hertel Ave., Plant #1, Buffalo, N. Y. (Tel. VIctory 7000)
Purch. Agent: Dan West
Sales Mgr.: George H. Nelson MM, R&D

BIRNBACH RADIO CO., INC.
145 Hudson St., New York 13, N. Y. (Tel. WAlker 5-6980)
Sales Mgr.: Aaron D. Danziger
Pres.-Purch.: M. Birnbach MM

BIRTCHER CORP., THE
4371 Valley Blvd., Los Angeles 32, Calif. (Tel. CApitol 2-9101)
Purch. Mgr.: Mrs. Jessie Matranga
Sales Mgr., Indsl. Div.: Charles F. Baaher TR

J. BISHOP & CO., PLATINUM WORKS
E. King St., Malvern, Pa. (Tel. Niagara 4-3100)
Dir.-Purch.: J. Cartez
V. P.: J. J. Buckley
Sales Coordinator: H. S. Roberts
Mgr., Platinum Divs.: Lee Maules
MF, WN, PS, TS, MM, R&D

BISHOP MFG. CORP.
10 Canfield Rd., Cedar Grove, N. J. (Tel. CEnter 9-2400)
Purch. Agent: Mrs. Alice F. Cook
Sales Mgr.: F. X. McCormack

BJORKSTEN RESEARCH LABS. FOR INDUSTRY, INC.
P. O. Box 1175, Madison 1, Wis. (Tel. ALpine 6-5581)
Purch. Agent: David B. Bennett
V. P.-Sales: James E. Henning R&D

BLACK & DECKER MFG. CO., THE
E. Pa. Ave., Towson 4, Md. (Tel. VA 3-4400)
Purch. Mgr.: Alex Dahl
V. P.-Mktg.: R. G. Horner GS, GH

BLACK, SIVALLS & BRYSON, INC.
7500 E. 12th St., Kansas City 26, Mo. (Tel. BEntan 1-7200)
V. P.-Purch.: William F. Gates
Mgr., Safety Head Soles: James F. Myers
PS, GS, GH, TS, R&D

BLACKHAWK MFG. CO.
5325 W. Rogers St., Milwaukee 46, Wisc. (Tel. ORchard 1-4000)
Purch. Agent: T. A. Clark
Buyers: R. C. Newman, E. F. Larsen
Mgr.-Dist. Sales: Wes Kiley MF, GH, MM

BLACKMER PUMP CO.
1809 Century Ave., S. W., Grand Rapids 9, Mich. (Tel. CHerry 1-1611)
Purch. Agent: Darcey Mahan
Dir.-Sales: E. H. Lanthorn PS, GS, GH

BLACKSTONE CORP.
1111 Allen St., Jamestown, N. Y. (Tel. 5-1121)
Dir.-Purch.: J. P. Milham
Products Mgr.: G. A. Gustafson

BLACO MFG. CO.
6541 Euclid Ave., Cleveland 3, O. (Tel. EXpress 1-0497)
Purch.: S. J. Horetik MF, WN, GS, GH, GE, TR

WHITNEY BLAKE CO.
1565 Dixwell Ave., New Haven 14, Conn. (Tel. CHestnut 8-5515)
Purch. Agent: D. C. McKean
Gen. Sales Mgr.: R. H. Beisswenger
GE, CC, TS, TR, MM, R&D

ERNEST E. BLANCHE & ASSOCIATES, INC.
10425 Fawcett St., Kensington, Md. (Tel. LOckwood 4-7527)
Chief-Purch.: Mrs. Irene Van Yuga TR, R&D

BLAND BURNER CO., THE
83 Woodbine St., Hartford 6, Conn. (Tel. CHapel 9-8651)
Purch. Agent: Jerry Glassman
Sales Mgr.: Joel Livingston MM

BLAW-KNOX EQUIPMENT, DIV.-BLAW-KNOX CO.
P. O. Box 1198, Pittsburgh 1, Pa. (Tel. STerling 1-2700)
Div. Purch. Agent: Phillip H. Rollings
Gen. Sales Mgr.: H. Russell Laxterman GE, TR

E. W. BLISS CO.
1375 Raff Rd., S. W., Canton, Ohio (Tel. GReenwood 7-3421)
Purch. Mgr.: F. R. Mayer
Buyers: W. B. Boyd, G. W. Baker, J. M. Baylor, J. Tucker
Sales Mgr.-Govt. Contracts: R. E. Reilly
MF, WN, PS, GS, GH

BLISS ELECTRONIC CORP.
Box 366, Sussex, N. J. (Tel. SUssex 2-3000)
Dir.-Purch.: Gilbert Coates
Dir.-Sales: Robert Kaiser GS, TS

BLONDER-TONGUE LABS., INC.
9 Alling St., Newark 2, N. J. (Tel. MArket 2-8151)
Purch. Agent: David Rubin
Asst. Purch. Agent: John Fahey
Component Purch.: George Faccone
Govt. Sales Mgr.: Irv Faye
Sales Mgr.: Joseph H. Kerner GE, TR, R&D

BLOOMINGDALE RUBBER CO.
Roosevelt & Grant Aves., Aberdeen, Md. (Tel. Aberdeen 2050)
Prod. Mgr.-Purch. Dept.: LaVerne R. Brittan, R. #40 & Plater St., (Tel. Aberdeen 2370)
Chief Engr.-Sales: R. B. Krieger, Jr. (Tel. Aberdeen 2050) MM

BLDSSDM MFG. CO. INC.
2337 McDonald Ave., Brooklyn 23, N. Y. (Tel. DEwey 6-5555)
Dave Schaenfeld MF, PS

BLOWERS INC.
12655 S. Western Ave., Blue Island, Ill. (Tel. FUlton 8-3060)
Purch. Agent: S. A. Witte MF, WN, GS, GH, CO

BLUE M ELECTRIC CO.
138th & Chatham St., Blue Island, Ill. (Tel. FUlton 5-9000)
Purch. Agent: W. F. Wilde
V. P.-Sales: Angelo Lazzaro TS, R&D

BOBRICK MFG. CORP.
1839 Blake Ave., Los Angeles 39, Calif. (Tel. NOrmandy 2-3188)
Purch. Agent: R. L. Blaugh
V. P.-Sales: Arnold A. Cowan R&D

BDDINE ELECTRIC CO.
2500 W. Bradley Pl., Chicago 18, Ill. (Tel. IR 8-3515)
Exec. V. P.-Purch.: E. W. Larsan
Asst. Purch. Mgr.: H. G. Andersan
Sales Mgr.: W. M. Yagerst PS, GE, TS, TR

BOEING AIRPLANE CO., PILOTLESS AIRCRAFT DIV.
Seattle, Wash. (Tel. JUniper 6-2121)
Materiel Mgr.: N. W. Grigg (Tel. MU 2-1760)
Sales Mgr.: Fred Young (Tel. JU 6-4611)
MF, GS, GH, GE, CD, TS, TR, R&D

BDGART MFG. CORP.
315 Seigel St., Brooklyn 6, N. Y. (Tel. HY 7-4972)
Supvr.: H. Schoenfeld
Purch. Agents: W. Edgar & A. Levinsan
Expeditar: R. Goldberg
Mgr.-Engrg. Sales: Lee N. Blatt R&D

BDGEN-PRESTO CO., DIV.-THE SIEGLER CORP.
P. O. Box 500, Paramus, N. J. (Tel. DIamand 3-5700)
Dir.-Purch.: Abe Morin
Purch. Agents: Ted Neher, Paul Lesh, Jim Gaddy
Sales Mgrs.: M. S. Sumberg & T. L. Aye

BDGUE ELECTRIC MFG. CO.
52 Iowa Ave., Paterson 3, N. J. (Tel. LAmbert 5-2200)
Purch. Agent: Miss A. Schinman
Purch. Dept.: J. Whitcomb
Sales Mgr.: Joseph Rambusek WN, PS, GS, GH, CO

BDMAC LABDRATORIES, INC.
Salem Rd., Beverly, Mass. (Tel. WAlker 2-6000)
Purch. Agent: William H. Gyson
Buyer-Microwave Components: Dexter W. Rundlett
Buyer-Prod. Machine Parts: George W. Pickering
Buyer-Engrg. Machine Parts: John P. White
Sales Mgr.: E. D. Benson TR, R&D

BOND METAL SURPLUS CO.
321 Canal St., New York 13, N. Y. (Tel. CA 6-2928)
Sales Mgr.: Jack Cooper MM

BONNY MFG. CORP.
146 Main St., Maynard, Mass. (Tel. TWin Oaks 7-9311)
V. P.-Sales: John A. Crawe TR

BOOKER-COOPER, INC.
6940 Farmdale Ave., North Hollywood, Calif. (Tel. ST 7-7105)
Sales Dir.: Ray Smith MF, PS, GH, GE, MM

BODNTON RADIO CORP.
50 Intervale Rd., Baantan, N. J. (Tel. DEerfield 4-3200)
Purch. Agent: R. W. Laughlin
Sales Mgr.: H. J. Lang TR

BOOTH FELT CO., INC., THE
1724 10th Ave., Brooklyn 15, N. Y. (Tel. STerling 8-5700)
Purch. Agent: Harold T. Kenyon MM

BDDTS AIRCRAFT NUT CDRP.
Newtown Turnpike, Norwalk, Conn. (Tel. VIctor 7-2446)
Purch. Agent-Material: A. T. Carlsan
Purch. Agent-Gen.: C. A. Miltan
Sales Mgr.: Frank Lawn MF, PS, GS, GE

BORDEN CHEMICAL CO.
350 Madisan Ave., New York 17, N. Y. (Tel. MUrray Hill 7-4100)
Purch. Agent: Wayland P. Marse
Chem. P. A.: Richard J. Magner
Exec. V. P.-Sales: E. J. Sullivan MM, R&D

BDRDEN CHEMICAL CO., THE RESINITE DEPT.
P. O. Box 1589, 436 E. Gutierrez St., Santa Barbara, Calif. (Tel. WDadland 3134)
Purch. Agent: Robert W. Hull
Purch.: H. L. Bartlett, 1 Clark St., North Andaver, Mass. (Tel. MUrdock 7-7131)
MF, WN, PS, GE, TS, TR

BORG EQUIPMENT DIV., AMPHENOL-BORG ELECTRONICS CDRP.
120 S. Main St., Janesville, Wisc. (Tel. PLeasant 4-6616)
Sales Mgr.: R. K. Jahnsan GS, GE

BORG-WARNER CORP.
200 S. Michigan Ave., Chicago 4, Ill. (Tel. WA 2-7700)
Pres. & Chief Exec.: Robert S. Ingersall

GEORGE C. BORTHIG CO. INC.
242 Patersan Ave., P. O. Box 115, East Rutherford, N. J. (Tel. WEbster 9-9260)
Purch. Agent: David M. Kelly

BOSTDN AUTO GAGE CO., THE
70 West St., Pittsfield, Mass. (Tel. HIllcrest 5-5691)
Purch. Agent: J. H. Mattaan
Sales: T. C. Nelson GS, GI

BOSTON FELT CO.
210 Sauth St., Bastan, Mass. (Tel. LIberty 2-8897)

BOSTON GEAR WORKS
14 Hayward St., Quincy 71, Mass. (Tel. PResident 3-0400)
Purch. Agent: William MacRae
Mgr.-Field Sales: William J. Jahnson
Mgr.-Inside Sales: Edward P. Williams

BOSTDN INSULATED WIRE & CABLE CO.
64 Bay St., Bastan, Mass. (Tel. COlumbia 5-2104)
Purch. Agents: Alden C. Davis, Hachig Aghjayan
GS, GI

BOULIN INSTRUMENT CORP.
10 First St., Pelham, N. Y. (Tel. PElham 8-3966)

BOUND BRDDK DIL-LESS BEARING CO.
Baund Braak, N. J. (Tel. ELliat 6-0441)
Purch. Agent: Charles Durlach
Sales Mgr.: S. S. Connor MF, WN, PS, GH, GI

BOURNS LABS., INC.
6135 Magnalia Ave., P. O. Box 2112, Riverside, Calif. (Tel. OVerland 4-1700)
Purch. Agent: Brad Stevens
Dir.-Sales (Trimpot Div.): D. P. Vaughan
Dir.-Snles (Instrument Div.): E. J. Goeppinger
Pres.: Marlan E. Baurns

BOW SOLDER PRDDUCTS CO., INC.
251 Freeman St., Braaklyn 22, N. Y. (Tel. EVergreen 9-4863)
Purch. Agent: S. Turkus, Jr.
Sales Mgr.: N. Zimmer MF, PS, GE, T

BOWER ROLLER BEARING DIV.
3040 Hort, Detroit 14, Mich. (Tel. VA 2-7300)
Purch. Agent: Charles Heller
Mgr.-Sales: S. E. Davidson

BOWERS BATTERY & SPARK PLUG CO.
P. O. Box 1262, Reading, Pa. (Tel. WAlker 9-0771)
Purch. Agent: Harold L. Oeprill
Sales: Paul E. Goodrich GS

BOWMAR INSTRUMENT, CORP.
8000 Bluffton Rd., Box 2835, Ft. Wayne, Ind. (Tel. SHerwood 3121)
Purch. Agent: Robert J. Strotman
Gen. Sales Mgr.: George F. McCarthy, Great Neck, N. Y. (Tel. HUnter 2-1750)
PS, GS, GH, GE, CO, TS, TR

BOWSER, INC., DEFENSE DEPT.
1302 E. Creighton Ave., Ft. Wayne, Ind. (Tel. HArrison 2341)
Dir.-Purch.: E. A. Steinhouser
Sales Admin.: O. O. Seely GS, GH, R&D

BRACH MFG. CORP., DIV.-GENERAL BRONZE
200 Central Ave., Newark, N. J. (Tel. HUmboldt 2-1500)
Dir.-Purch.: H. Stople
Specialist Buyers: F. Werner & P. Morino
Mktg. Mgr.: J. Keough
Dir.-Sales: J. Berger GS, TR

BRACKE-SEIB X-RAY CO., INC.
16 Pelham Boy Pork West, Pelham Manor, N. Y. (Tel. PElham 8-4346)
Pres.-Sales Mgr.: Edward H. Brocke
Buyer: William R. Muller

BRADFORD COMPONENTS, INC.
65 South Ave., Solomonco, N. Y. (Tel. 2340)
Pres.: F. G. Schermerhorn GE, TS, TR

BRADLEY SEMICONDUCTOR CORP.
275 Welton St., New Haven, Conn. (Tel. SP 7181)
Purch. Agent: Stewart Wockel
Gen. Sales Mgr.: William J. Gognon TS, TR

W. H. BRADY CO.
727 W. Glendale Ave., Milwaukee 9, Wisc. (Tel. EOgewood 2-8100)
Purch. Agent: Eldon Meier
V. P.-Sales: T. W. Wise MM

C. S. BRAININ CO.
320 Washington St., Mt. Vernon, N. Y. (Tel. 8-5500)
Production Mgr.: G. V. Plachy
Engrg. Salesman: D. A. Colder

BRAM METALLURGICAL CHEMICAL CO.
820 65th Ave., Philadelphia 26, Pa. (Tel. WAverly 4-2121)
Metallurgical-Chemical Exec.: H. H. Bram
Asst.: T. G. Brom MM

WILLIAM BRAND & CO., INC.
North St., Willimantic, Conn. (Tel. HArrison 3-6301)
Purch. Agent: J. R. Garey
Supvr.-Materials & Planning: C. J. Crowford
MRO Buyer: P. Doly
Sales Mgr.: T. M. Sonden MM

BRANSON CORP.
41 S. Jefferson Rd., Whippany, N. J. (Tel. TUcker 7-1100)
Purch. Agent: C. H. Tuttle
Sales Mgr.: C. G. Broun

BRANSON INSTRUMENTS, INC.
37 Brown House Rd., Stamford, Conn. (Tel. DAvis 4-6721)
Purch. Officer: Celso Biogini
Pres.: Peter K. Bloch
Sales Mgr.: John E. Bobbin TS

BRANSON ULTRASONIC CORP.
37 Brown House Rd., Stamford, Conn. (Tel. FIreside 8-7781)
Gen. Mgr.-Purch.: W. J. Bleistein
V. P.: Peter K. Bloch
Sales Mgr.: H. F. Ostermon GS, GH

BREEZE CORPORATIONS, INC.
700 Liberty Ave., Union, N. J. (Tel. MUrdock 6-4000)
Purch. Agent: R. Fuller
Gen. Sales Mgr.: Matthew Lyon
Asst. Gen. Sales Mgr.: J. M. Hearn

BRICHARD O. BREW & CO., INC.
70 Airport Rd., Concord, N. H. (Tel. CApitol 5-6606)
Purch. Agent: Merton H. Tolman
Sales Mgr.: Roy E. Lonnberg GE, TR, R&D

BRIDGEPORT BRASS CO.
30 Grand St., Bridgeport 2, Conn. (Tel. EDison 4-1182)
V. P.-Sales: R. L. Allen
V. P.-Research & Dev.: R. A. Quodt
MF, WN, PS, GS, GE, CO, TS, TR, MM, R&D

BRIDGEPORT THERMOSTAT DIV., ROBERTSHAW-FULTON CONTROLS CO.
155 Hill St., Milford, Conn. (Tel. TRinity 8-1721)
Purch. Agent: H. V. Bosheo
Sales Mgr.: Carl F. Ahlheim
WN, GS, GH, GE, CO, TS

BRIGGS ASSOCIATES, INC.
10 De Kalb St., Norristown, Pa. (Tel. BRoadway 9-0400)
Admin.-Purch.: Joseph F. Boldino
Sales Mgr.: Laurence R. Brown GE, CO, TS, TR

BRIGGS FILTRATION CO., THE
River Rd., Washington 16, D. C. (Tel. OLiver 4-7722)
Purch. Agent: O. H. Hardester
V. P.-Gen. Mgr.: J. H. Nash
Sales: John MacGuffin PS, GS

BRIGHT STAR INDUSTRIES
600 Getty Ave., Clifton, N. J. (Tel. GRegory 1-3200)
Purch. Agent: A. Levy
Sales Mgr.: Leon Kolkut GS

BRIGHTON CORP.
820 State Ave., Cincinnati 4, Ohio (Tel. GRondview 1-4110)
Purch. Agent: C. Johnson
Sales Mgr.: Richard G. Hext PS

BRILHART PLASTICS CORP.
Old Country Rd., Mineola, L. I., N. Y. (Tel. Pioneer 6-0425)
Purch. Agent: William Sheo
Sales Mgr.: Thomas Ackerly

E. W. BRILMAYER LABS., INC.
86 Fulton St., New York 38, N. Y. (Tel. BEekman 3-7914)
Pres.: Eugene W. Brilmoyer TS

BRISCOE MFG. CO.
1055 Gibbard Ave., Columbus 3, Ohio (Tel. AX 4-3376)
Pres.: E. H. Briscoe

BRISTOL BRASS CORP., THE
580 Broad St., Bristol, Conn. (Tel. LUdlow 2-3161)
Purch. Agent: Fred J. Greenleaf
Gen. Sales Mgr.: Donald Gay MM

BRISTOL CO., THE
Waterbury 20, Conn., (Tel. PLaza 6-4451)
Purch. Agent: F. Frohn
V. P.-Sales: H. E. Beone
Sales Mgr., Aircraft Dept.: W. C. Colvert
Purch. Agent: Fred W. Frohn GS, CO

BRISTOL MOTORS DIV.-VOCALINE CO. OF AMERICA, INC.
Coulter St., Old Saybrook, Conn. (Tel. EVergreen 8-3414)
Purch. Agent: Robert B. Cooney
Sales: Charles M. Murphy

BRITTON ELECTRONICS CORP.
213-20 99th Ave., Queens Village 29, N. Y. (Tel. HOllis 8-0940)
Purch. Agent: Doris Fitzsimmons
Pres.: Henry S. Ovrut MM

BROADCAST EQUIPMENT SPECIALTIES CORP.
Box 149, Beacon, N. Y. (Tel. 9-4587)
V. P.: David S. Gibson TS

BROOK MOLDING CORP.
30 Industrial Way, Norwood, Mass. (Tel. NOrwood 7-4715)
Purch. Agent: F. K. Whiting
Sales Mgr.: C. M. Cunninghom MF, WN, PS

BROOK MOTOR CORP.
3302-04 W. Peterson Ave., Chicago 45, Ill. (Tel. INd. 3-6464)
V. P.-Sales: P. L. Loewe MM

BROOKS & PERKINS, INC.
1950 W. Fort St., Detroit 16, Mich. (Tel. TA 5-5900)
Purch. Agent (Mgr.): H. L. Westerdale
Purch. Dept.: John Drypen & Neil McLean
Gen. Sales Mgr.: H. P. Dunne MF, GS, GH, MM

BROOKS ROTAMETER CO.
407 W. Vine St., Hatfield, Pa. (Tel. ULysses 5-5174)
Purch. Agent: Frederick Roethemeier
Exec. V. P.-Sales: Seymour Blechmon TS

BROWN ENGRG. CO., INC.
1320 Meridion St., Huntsville, Ala. (Tel. JEfferson 6-5536)
Purch. & Contracting Officer: George K. Willioms
Supvr. Purch. Agent: William F. Thompson
Purch. Agent: Robert A. Steelman
Buyers: Billy G. Hunter & Wayne Hunter
Sales Mgr.: Oscar M. Hawkins
MF, WN, GS, GH, GE, CO, TS, R&D

BROWN INDUSTRIES DIV., BROWN TRAILERS, INC.
P. O. Box 54, Spokane, Wash.

BRUCE ENGRG. CO.
1633 W. 134th St., Gardena, Calif. (Tel. FAculty 1-2220)
Sales Mgr.: Burr McOowell
Supt.: M. K. Redlin MF, WN, GH

BRUNING CO., THE
601 S. 9th St., Lincoln, Neb. (Tel. 5-3511)
Pres.: E. F. Bruning GS, GH

BRUNSWICK INSTRUMENTS
Box 813, New Brunswick, N. J. (Tel. CHarter 7-5919)
Chief Engr.-Purch.: L. A. Rosenthal
Sales Mgr.: E. J. Horodner GE, CO, TS

BRUSH BERYLLIUM CO., THE
4301 Perkins Ave., Cleveland, O. (Tel. ENdicott 1-5400)
Dir.-Purch.: Richard Anuskiewicz
Purch. Agent: R. A. Cobb
V. P.-Sales: N. W. Bass MF, PS

BRUSH INSTRUMENTS, DIV.-CLEVITE CORP.
37th & Perkins Ave., Cleveland 14, Ohio (Tel. ENdicott 1-3315)
Purch. Mgr.: W. J. Dovid
Gen. Sales Mgr.: Norman R. Klivans
GS, GE, CO, TS, TR, R&D

BRUSH NAIL EXPANSION BOLT CO.
Greenwich, Conn. (Tel. TOwnsend 9-3190)
Pres.: Irving G. Snyder MF, PS

BUCHANAN ELECTRICAL PRODUCTS CORP.
225 Rt. 22, Hillside, N. J. (Tel. WAverly 3-7474)
Plt. Supt. & Purch. Agent: Albert Mittleman
V. P.-Chg. Sales: Paul E. Vance

BUCKEYE IRON & BRASS WORKS
324 E. 3rd St., Dayton, O. (Tel. BAldwin 4-8355)
Purch. Agent: E. K. Griest
Asst. Purch. Agent: R. L. Reel
Sales Mgr.: Ray O. Comp PS, GS, GH

BUCKEYE TOOLS CORP.
P. O. Box 966, Dayton, Ohio (Tel. AXminster 8-5281)
V. P.-Sales: E. B. Meynard
Treas.: E. E. Reeves MF, GS

BUD RADIO, INC.
2118 E. 55th St., Cleveland 3, Ohio (Tel. HEnderson 1-7166)
V. P.-Purch.: E. J. Korey
Pres.: A. N. Haas MM

BUDD STANLEY CO. INC.
43-01 22nd St., Long Island City 1, N. Y. (Tel. STillwell 6-1706)
Purch. Agent: C. Alexander WN, GE, TS, TR

BUDELMAN ELECTRONICS CORP.
375 Fairfield Ave., Stamford, Conn. (Tel. FIreside 8-9231)
Purch. Agent: Edward Collum
Asst. Purch. Agent: M. Donnelly
Sales Mgr.: Robert L. Feistel GE

BUFFALO METAL CONTAINER CORP.
35 Roetzer St., Buffalo 11, N. Y. (Tel. BA 3944)
Dir.-Purch.: Robert J. Schieder
Sales Mgr.: A. E. Bausenbach GS, GH

BUFFALO WIRE WORKS CO., INC.
320 Terrace, Buffalo 2, N. Y. (Tel. CLeveland 4520)
Purch.: Charles F. Scheeler, Jr.
Sales Mgr.: Norman F. Grundner MM

BUHL OPTICAL CO.
1009 Beech Ave., Pittsburgh 33, Pa. (Tel. FAirfax 1-0076)
Purch.: M. Seder MF, PS, GS, GE, CO, TS, TR

BULLARD CO., THE
286 Canfield Ave., Bridgeport 9, Conn. (Tel. EDison 6-2511)
Mgr.-Purch. & Traffic: T. H. Wilber
Gen. Sales Mgr.: H. E. Neale WN, PS, GS

BULOVA WATCH CO., ELECTRONICS DIV.
40-06 62nd St., Woodside 77, N. Y. (Tel. NEwtown

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

9-5700)
Sales Mgr.: A. B. III, Jr. GS, GE, TR

BULOW ELECTRIC CO.
11000 Capital, Oak Park 37, Mich. (Tel. LI 7-1133)
Dir.-Purch.: C. J. Galea
Sales Mgr.: R. L. Bulow GS, CO, TS, TR, R&D

BURG TOOL MFG. CO., INC.
15001 S. Figueroa St., Gardena, Calif. (Tel. FA 1-3510)
Purch. Agent: M. Tavlin
V. P.-Sales: J. Burg

BURGESS BATTERY CO.
Foot of Exchange, Freeport, Ill. (Tel. ADams 2-2161)
Purch. Agent: Raymond Beldt
V. P.-Sales: C. E. Balz GS, GE, CO, TS, TR

BURGMASTER CORP.
Box 311, Gardena, Calif. (Tel. FAculty 1-3510)
Sales Mgr.: E. G. Merk
Purch. Agent: Marvin Taulin MM

BURKE & JAMES INC.
321 S. Wabash Ave., Chicago 4, Ill. (Tel. HArrisan 7-8393) R&D

BURKLYN CO.
3429 Glendale Blvd., Los Angeles 39, Calif. (Tel. NDrmandie 2-3111)
Chief Clerk: A. Reed
Pres.: Raland Stevens
Asst. Mgr.: A. L. Kissler MF, GS, GH, GE, TS, TR

BURNDY CORP., OMATON DIV.
Richards Ave., Norwalk, Conn. (Tel. TEmple 8-4711)
Dir.-Purch.: L. Menzl
Dir.-Sales: S. O. Bergman
Buyers: W. Frey, J. Hartcorn
MF, PS, GS, GH, GE, CO, TS, TR

BURNELL & CO., INC.
10 Pelham Pkwy., Pelham Manor, N. Y. (Tel. PElham 8-5000)
Purch. Agent: V. Triwedi
Sales Mgr.: L. Schwartz GS, GE, CO, TR

BURNLEY BATTERY & MFG. CO., THE
103 Clay St., North East, Pa. (Tel. 5-3595)
Pres.: N. C. Swansan

BURR-BROWN RESEARCH CORP.
Box 6444, Tucson, Ariz. (Tel. AXtel 8-0772)
Dir.-Purch. & Sales: Thomas R. Brown, Jr. R&D

BURROUGHS CORP.
6071 2nd Ave., Detroit 32, Mich. (Tel. TRinity 5-2260)
Dir.-Purch.: Russ T. Stark
Defense Sales Mgr.: Jack C. Lindley
GS, GE, CO, TS, R&D

BURROUGHS CORP., ELECTRONIC TUBE DIV.
P. O. Box 1226, Plainfield, N. J. (Tel. PL 6-0876)
Purch. Agent: Vincent Perrucci
Sales Dir.: Arthur B. Shesser GE, CO, TS

BURTON-RODGERS, INC.
Blade & Helen Sts., Cincinnati 16, Ohio (Tel. UNiversity 1-2155)
Asst.-Pres.-Sales: O. A. Linse
Purch. Agent: Allen Laftspring
GH, GS, CO, TS, R&D

BURTON-ROGERS CO., SALES DIV.-HOYT ELECTRICAL INSTRUMENTS
42 Carleton St., Cambridge 42, Mass. (Tel. Eliot 4-1643)
Dir.-Sales: William Burton
Pres.: V. S. Church TS

BUSHINGS, INC.
4358 Coolidge Hwy., Royal Oak, Mich., (Tel. LIberty 9-3320)
V. P.-Purch.: K. W. Maust
V. P.-Sales: H. G. Moore MM

BUSSMANN MFG. DIV., McGRAW-EDISON CO.
University at Jefferson, St. Louis 7, Mo. (Tel. GArfield 1-1740)
Dir.-Purch.: Lee J. Bussmann
V. P.-Sales: J. C. Ingram WN, GE, CO

BUTLER MFG. CO.
7400 E. 13th St., Kansas City, Mo. (Tel. BEntan 1-7400)
Dir.-Purch.: L. P. Melcher
V. P.-Mktg.: H. A. Edlund MF, WN, PS, GS

BYRNE DOORS INC.
1603 E. Nine Mile Rd., Ferndale, Detroit 20, Mich. (Tel. JOrdan 4-5875)
V. P.-Purch.: A. M. Latimer
Purch. Agent: F. J. Middleton GS, GH, R&D

BYRON JACKSON PUMPS, INC.
2301 E. Vernon Ave., Los Angeles, Calif. (Tel. LUdlow 7-6171)
Purch. Agent: Elmer C. Prairie
Mgr.-Sales: N. D. Jesse GS, GH, TS, R&D

CBS-HYTRON, DIV.-COLUMBIA BROADCASTING SYSTEM, INC.
100 Endicott St., Danvers, Mass. (Tel. SPring 4-2360)
Dir.-Purch.: Edward R. Carroll
Purch. Agent: John F. Ryan
Asst. Purch. Agent: William E. Dennis
Buyers: R. A. Powers, J. W. Cannery, F. W. Courage, W. W. Cook, E. F. Murphy
V. P.-Mktg.: Reed V. Bantecau

CDC CONTROL SERVICES, INC.
400 S. Warminster Rd., Hatboro, Pa. (Tel. DSbarne 5-4100)
Head, Purch. Dept.: Alfred Krieg
V. P.-Sales: J. Lawrence Tecosky
MF, WN, PS, GS, GH, GE, CO, TS, TR

CELCO (CONSTANTINE ENGRG. LABORATORIES CO.)
70 Island Ave. Mahwah, N. J. (Tel. DAvis 7-1123)
Purch. Agent: Robert Meres
Buyer: Angeline Constantine
Sales Mgr.: Stephen Stephana PS, GE

CGS LABS., INC.
Rts. 7 & 35, Ridgefield, Conn. (Tel. ID 8-2317)
Supvr.-Purch.: George W. Korper, 391 Ludlow St., Stamford, Conn. (Tel. DAvis 5-1581)
V. P.-Mktg.: Melvin L. Jackson GE, TR, R&D

C & K COMPONENTS, INC.
101 Morse St., Newton 58, Mass. (Tel. WAtertawn 3-0524)
Purch. Agent: Charles Crothers
Sales Mgr.: Robert H. Sturdy GE, TR

CABLE ELECTRIC PRODUCTS INC.
234 Oaboll St., Providence, R. I. (Tel. STuart 1-5400)
Purch. Agent: W. Balutawski
Dir.-Sales: F. W. Schwartz GS, GE

SAMUEL CABOT INC.
141 Milk St., Boston, Mass. (Tel. HAncock 6-1010)
Plant Supt.: Augustus H. Hermann
Sales Mgr.: Samuel Cabot, Jr.

CADILLAC GAGE CO.
25760 Groesbeck Hwy., Warren, Mich. (Tel. PRescott 7-7100)
Purch. Agent: George Baathrayd
Sales Mgr., Aero Div.: Robert E. Kolp GE, R&D

CAIG LABS.
46 Stanwood Rd., New Hyde Park, L. I., N. Y. (Tel. Pioneer 2-0278)
Purch.: A Pagelsan
Sales: D. Lahkemper GS, GH

CALCON MFG. CO., INC.
100 Oakland Ave., Washington, Pa. (Tel. BAldwin 2-8190)
Wks. Mgr.-Purch.: A. W. Moore
Gen. Sales Mgr.: James C. Marasco TR

CALFIBE CO., INC.
Colton & Wabash Ave., Mentone, Calif., Mailing Add.: P. O. Box 832, Redlands, Calif. (Tel. PY 4-1166)
V. P.-Purch.: William M. Jordan
Purch.: Paul Bawler
Sales: Oan F. Maier, 6214 W. Manchester Ave., Los Angeles 45, Calif. (Tel. OR 8-6890) MM

CALIDYNE CO., INC., THE
120 Cross St., Winchester, Mass (Tel. WI 6-3810)
Purch. Agent: G. Worthen
Sales Mgr.: O. L. Wrisley TS

CALIFORNIA AIRCRAFT PRODUCTS
790 Greenfield Dr., El Cajon, Calif. (Tel. HIckory 2-3451)
Purch. Agent: Gavin W. Coles
Sales Mgr.: Joseph S. Alan MF, PS

CALIFORNIA SPRING CO., INC.
8401 E. Slauson Ave., Pico-Rivera, Calif. (Tel. RAymond 3-8581)
Purch. Agent: Robert Harris
V. P. & Sales Mgr.: Ray E. Coffield

CALIFORNIA TECHNICAL INDUSTRIES, DIV.-TEXTRON INC.
1421 Old County Rd., Belmont, Calif. (Tel. LYtell 3-8466)
Purch. Agent: John Woodside
Sales Mgr.: E. J. Bradley GS, CO, TS

CALINOY-DIV.-ILLINOIS TOOL WORKS
12917 Cerise, Hawthorne, Calif. (Tel. DR 8-3437)
Dir.-Engrg. & Mfg.: T. R. Boyd
Buyer: B. Henderson
Sales Mgr.: H. O. Hansen MF, GS, GH, MM

CALLAIR, INC.
Afton, Wyoming (Tel. 166)
Pres. & Gen. Mgr.: Barlow H. Call
Purch.: Jack E. Taggart
V. P.-Sales: C. J. Petersen

CALLERY CHEMICAL CO.
9600 Perry Hwy., Pittsburgh 37, Pa. (Tel. FDrest 4-1130)
Purch. & Traffic Mgr.: L. D'Hearn
Sr. Buyer: H. W. McDanel
Mgr.-Mktg. Div.: R. A. Mulholland PS, R&D

CALTRON PRODUCTS CO.
3518 W. Pica Blvd., Los Angeles 19, Calif. (Tel. REpublic 4-2420)
Mgr.-Purch.: C. P. Swansan
Sales Mgr.: J. B. Sebrell MM

CALVERT ELECTRONICS INC.
536 Broadway, New York 12, N. Y. (Tel. CAnal 6-7400)
V. P.-Sales: Bernard Fox

CAMBRIDGE CO.-DIV.-CARRIER CORP.
2 Industrial Park, Lowell, Mass. (Tel. GLenview 4-7881)
Chief Purch. Agent: Vaughan Biggert
V. P.-Sales: Edward Elliott, Jr. GS, GH

CAMBRIDGE FILTER CORP.
728 E. Erie Blvd., Syracuse 1, N. Y. (Tel. GRanite 5-1608)
Purch. Agent: Richard C. Linehan
Sales Mgr.: Donald E. Wendel GS, GE

CAMBRIDGE INSTRUMENT CO., INC.
311 Grand Central Terminal, New York, N. Y.
Purch. Agent: R. A. Packard
Pres. & Sales Mgr.: R. H. Kruse

CAMBRIDGE THERMIONIC CORP.
445 Concord Ave., Cambridge 38, Mass. (Tel. TRowbridge 6-2800)
Purch. Agent: Frank C. Waterhouse
Asst. Purch. Agent: Jane Cheney
Sales Mgr.: Lowell Wilkes

CAMBRIDGE WIRE CLOTH CO., THE
Cambridge, Md. (Tel. CAmbridge 1033)
Purch. Agent: Fulton Moore MF, PS, GS, GH

CAMCAR SCREW & MFG. CO., DIV.-TEXTRON INDUSTRIES, INC.
600 Eighteenth Ave., Rockford, Ill. (Tel. WDadland 5-9451)
Purch. Agent: Iver Hawkinson
V. P.-Sales: James L. Holland

CAMDALE PRECISION, INC.
28300 Groesbeck Hwy., Roseville, Mich. (Tel. PRescott 1-0400)
Purch. Agent: H. L. Miller
V. P.-Sales: A. R. Schwesinger G

CAMERA MART INC., THE
1845 Broadway, New York 23, N. Y. (Tel. PLaza 7-6977)
Dir.-Purch.: E. McCarthy
Dir.-Sales: S. Hyman R&I

CAMERAFLEX CORP.
1947 Broadway, New York 23, N. Y. (Tel. TRafalgar 3-4022)
V. P. & Gen. Mgr.: George H. Kauffeld, Jr.
Chief Engr.: Joseph Henkel
Prod. Mgr.: Frank LaSala GS, TR, R&I

***CAMERON IRON WORKS, INC.**
P. O. Box 1212, Houston, Texas (Tel. UNderwood 4-4411)
Purch. Agent: I. P. Oahl
Mgr.-Special Products Div.: J. W. Braugher
WN, PS, R&I
*(See Page 34 for Advertisement)

CAMLOC FASTENER CORP.
22 Spring Valley Rd., Paramus, N. J. (Tel. HUbbard 9-4900)
Gen. Supt.: T. A. Barkauskas
Purch. Agent: U. G. Grapengeter
Purch. Dept.: T. Skelly
Eastern Sales Mgr.: Wm. E. Bracey
Western Sales Mgr.: James G. English, 5410 Wilshire Blvd., Los Angeles, Calif. (Tel. WEbster 1-1361) MF, GS, GH, G

CAMPCO, DIV.-CHICAGO MOLDED PRODUCTS CORP.
2738 N. Normandy Ave., Chicago 35, Ill. (Tel. TUxedo 9-5520)
Purch. Agent: Frank Klingenmeier
Asst. Purch. Agent: Cuyler E. Stanek
Sales Mgr.: James L. Bachner M

CANADIAN RADIUM & URANIUM CORP.
630 Fifth Ave., New York 20, N. Y. (Tel. CIrcle 6-0460)
Purch.: Carl Krieger

Sales Mgr.: Henry B. Kearney
MF, WN, PS, GE, CD, TS, TR

C. F. CANNON CO.
Springwater, N. Y. (Tel. 531)
Dir.-Sales: A. W. Shriner

CANNON ELECTRIC CO.
3208 Humboldt St., Los Angeles 31, Calif. (Tel. CApitol 5-1251)
Purch. Mgr.: Roy Whitney
Purch. Agent: Earl Bixler
Gen. Sales Mgr.: Floyd M. Cote
Purch. Agent (Salem Div.): Lauvis McCarthy (Tel. Pioneer 5-0700)
Purch. Agent (Toronto Div.): Les Colvert (Tel. PLymouth 7-2845)
(See Page 27 for Advertisement)

CANNON-MUSKEGON CORP.
2875 Lincoln St., Muskegon, Mich. (Tel. 5-1676)
Purch. Agent: George Gimakas
Sales Mgr.: F. Kenneth Iverson MM

CANOGA DIV., UNDERWOOD CORP.
15330 Oxnard St., Van Nuys, Calif. (Tel. STate 6-9010)
Dir.-Purch.: Louis E. Moore
Buyers: Warren W. Flee, J. Caminiti, H. Palmer
Dir.-Sales: G. H. Nibbe GS, GE, TR, R&D

CAPEWELL MFG. CO.
60 Governor St., Hartford 2, Conn. (Tel. JAckson 2-8191)
V. P.: Seery C. Gordon
Purch. Agent: Bernard Dunphy R&D

CAPITAL CITY MFG. CO.
857 King Ave., Columbus 12, O. (Tel. AX 9-2149)
Purch. Agent: R. F. Little
Sales Engr.: Carl Weger PS, GH, R&O

CAPITOL MACHINE CO., THE
36 Balmforth Ave., Danbury, Conn. (Tel. Pioneer 3-2758)
Purch. Agent & Sales Mgr.: Arthur E. Wilson GS, TS, TR, R&O

CAPTIVE SEAL CORP.
30 Henry, Teterboro, N. J. (Tel. AT 8-0205)
Purch. Agent: R. Dodd PS, GS, R&D

CARBOLINE CO.
32 Hanley Ind. Ct., St. Louis 17, Mo. (Tel. MI 7-5795)
Purch. Agent: R. R. Rosenthol
Pres.: S. L. Lopato MM

CARBONE CORP., THE
400 Myrtle Ave., Boonton, N. J. (Tel. DE 4-0700)
Purch. Agent: E. Wizeman
Sales Mgr.: E. Dixon MM

CARBORUNDUM CO., LATROBE PLANT, REFRACTORIES DIV.
Latrobe, Pa. (Tel. KEystone 7-3331)
Purch. Agent: J. W. Bell, Jr.
Mgr.-Electronic Sales: D. S. Bowman MM, R&D

CARBORUNDUM CO., REFRACTORIES DIV.
Perth Amboy, N. J. (Tel. Hillcrest 2-3380)
Buyer: F. Richter
Mgr.-Refractories Sales Branch: A. A. Turner
Mgr.-Mktg.: J. M. Smith MM

CARBORUNDUM METALS CO., THE
P. O. Box 32, Akron, N. Y. (Tel. 9454)
Buyer: William F. Pritchard
Mgr., Sales Branch: H. A. Andersen

CARDINAL INSTRUMENTATION CORP.
1201 Redwood Ave., Los Angeles 66, Calif. (Tel. EXmont 1-5201)
Purch. Agent: O. R. Porter
Mktg. Mgr.: J. S. Frank GS, TS, TR

CARDOX DIV., CHEMETRON CORP.
840 N. Michigan Ave., Chicago 11, Ill. (Tel. WHitehall 4-7450)
Purch. Agent: M. Hemmon
V. P.-Sales: F. C. Rodgers GS

CARLETON AVIATION CO.
3616 Buffalo Rd., East Aurora, N. Y. (Tel. CYpress 4-4838)
Merlin K. Jones

CARLING ELECTRIC, INC.
1004 New Park Ave., West Hartford 7, Conn. (Tel. ADams 2-4461)
Purch. Agent: William Fleming
Asst. Sales Mgr.: Francis Hanselman
V. P.-Sales: Wesley T. Sorenson MM

CARMAC AVIATION
2414 San Fernando Rd., Sun Valley, Calif. (Tel. STanley 7-5541)
Pres.: Carmine J. Vito MF, PS, GS, GH, MM

CARMODY CORP.
2860 Wehrle Dr., Buffalo 21, N. Y. (Tel. SPring 7-7700)
Purch. Agent: R. E. Pollock
Dir. Tng.: A. R. Molnar GS, R&D

CAROL ELECTRONICS CORP.
315 W. Stephen St., Martinsburg, W. Va. (Tel. AMherst 7-8911)
Gen. Mgr.: Eric Ruckbrod TS

CARPENTER MFG. CO., INC.
Highbridge Rd., P. O. Box 217, DeWitt 14, N. Y. (Tel. GIbson 6-0670)
Gen. Mgr.: Hubert J. Carpenter

CARPENTER STEEL CO., THE
153 W. Bern St., Reading, Pa. (Tel. Reading FRanklin 4-8211)
Purch. Agent: R. P. Freehofer
Asst. Purch. Agent: G. D. Nahn
V. P.-Sales: H. S. Potter MM

CARPENTER STEEL CO., THE, ALLOY TUBE DIV.
Springfield Rd., Union, N. J. (Tel. MUrdock 6-7230)
Purch. Agent: V. T. Nolan
Asst. Purch. Agent: R. A. Southard
Sales Mgr.: W. R. Staples MM

CARRIER CORP.
Carrier Pkwy., Syracuse, N. Y. (Tel. HOward 3-8411)
Dir.-Purch: Adolph Ruediger MF, PS

CARRUTHERS & FERNANDEZ, INC.
1501 Colorado Ave., Santa Monica, Calif. (Tel. EXbrook 4-6768)
Dir.-Purch.: Korel F. Zabloudil
V. P.-Sales: Frank C. Fernandez GS, GE, TS, R&D

J. C. CARTER CO., THE
671 W. 17th St., Costa Mesa, Calif. (Tel. LIberty 8-3421)
Purch. Agent: William C. Melo
V. P.-Mfg.: C. J. Allan
V. P.-Engrg. & Sales: M. D. Kilmer
Sales Mgr.: W. W. Soxton

CARTER CONTROLS, INC.
2800 Bernice Rd., Lansing, Ill. (Tel. GR 4-3305)
Purch. Agent: Thomas S. Britton
Sales Mgr.: J. Carter Miller GS, GH

CARTER MFG. CORP.
23 Washington St., Hudson, Mass. (Tel. HUdson 1309)
Pres.: W. Groustein

CARTRISEAL CORP.
3515 W. Touhy Ave., Lincolnwood, Ill. (Tel. BR 4-6140)
Buyer: Stanley Pyzik
Sales Mgr.: James Linskey MF, PS, GS

A. W. CASH VALVE MFG. CORP.
666 E. Wabash Ave., Decatur, Ill. (Tel. 2-8574)
Dir.-Purch.: Donald M. Perry
V. P.-Sales: G. William Modden

CASTING ENGINEERS DIV., CONSOLIDATED FOUNDRIES & MFG. CORP.
2323 N. Bosworth Ave., Chicago 14, Ill. (Tel. BUckingham 1-5940)
Purch. Agent: Arthur Matulis
Sales Mgr.: F. H. Meeder MM

CATALIN CORP. OF AMERICA
1 Park Ave., New York 16, N. Y. (Tel. MUrray Hill 3-2100)
Adv. Mgr.: R. A. Woodard MM

CATERPILLAR TRACTOR CO., ENGINE DIV.
Peoria, Ill. (Tel. 6-3311)
Purch. Agent: R. D. Norris
Asst. Sales Mgrs.: H. J. Hunkele & J. P. Morgan
Sales Mgr.: J. H. Gill GS, CO, TS

ALBERT H. CAYNE EQUIPMENT CORP.
71 Spring St., New York 12, N. Y. (Tel. CAnal 6-3317)
Purch. Agent: J. C. Lynn
Dir.-Sales: Albert H. Cayne GS, MM

CAYWOOD-SCHILLER, ASSOCIATES
203 N. Wabash Ave., Chicago 1, Ill. (Tel. ANdover 3-3340)
Purch.: T. E. Caywood
Purch. & Sales: D. H. Schiller R&O

CEDAR ENGRG. DIV.-CONTROL DATA CORP.
5806 W. 36th St., Minneapolis 16, Minn. (Tel. WEst 9-1681)
Purch. Agent: L. G. Bernier
Buyer: C. W. Engleman
Asst. Gen. Mgr.: Gordon J. Clark GE, TR, R&D

CENTRAL ELECTRONIC MFRS., DIV.-NUCLEAR CORP. OF AMERICA
2 Richwood Place, Denville, N. J. (Tel. OAkwood 7-4200)
Purch. Agent: Mike Buff
Gen. Sales Mgr.: Gene G. Perry GE, TS, TR

CENTRAL SCIENTIFIC CO.
1700 Irving Park Rd., Chicago 13, Ill. (Tel. WE 5-8600)
G. C. Gadejohn TS

CENTRAL TRANSFORMER CO.
900 W. Jackson Blvd., Chicago 7, Ill. (Tel. TAylor 9-1936)
Purch. Agent: Miss Katharine Bednor
Sales Mgr.: Frank J. Gallagher PS, GS, GE, TS, TR

CENTRALAB, DIV.-GLOBE-UNION
900 E. Keefe Ave., Milwaukee 1, Wisc. (Tel. WO 2-9200)
Dir.-Purch.: Frank A. Messar
Gen. Sales Mgr.: W. E. Peek MM

CENTRAX LTD., AMERICAN SALES OFFICE
Park Sq. Bldg., 31 St. James Ave., Boston 16, Mass. (Tel. LIberty 2-2425)
V. P.-Sales: Charles J. Trees PS

CENTRONIX INC.
4000 N. W. 28th St., Miami 42, Fla. (Tel. NE 3-2505)
Purch. Dir.: I. Saxenhaus
Sales Mgr.: H. J. Roberts MF, GS, GH, GE, CO, TS, TR, R&D

CENTURY ELECTRONICS & INSTRUMENTS, INC.
1333 N. Utica, Tulsa, Okla. (Tel. LUther 4-7111)
Purch. Agent: C. R. Campbell
V. P.-Sales: C. H. Brunell TS, TR

CENTURY FASTENERS CORP.
88 Sandford St., Brooklyn 5, N. Y. (Tel. ULster 2-6440)
Mgr., Aircraft Div.-Purch.: Pierre Tord
Sales Mgr.: George Stieglitz MF, WN, PS, GS, GH, GE, TR, MM

CERAMASEAL, INC.
P. O. Box 25, New Lebonon Ctr., N. Y. (Tel. West Lebanon 3-5851)
Purch. Agent: Everett Franszon
Mgr.-Sales Engrg.: Gene O. Sawin MF, PS, GE, MM, R&D

CHADWICK-HELMUTH CO.
472 E. Duarte Rd., Monrovia, Calif. (Tel. EL 8-4567)
Purch. Agent: Robert A. Stiver
Sales Mgr.: William F. Cox TS, R&O

CHAIN BELT CO.
4701 W. Greenfield Ave., Milwaukee, Wisc. (Tel. EVergreen 4-3000)
V. P.-Purch.: F. G. Syburg
Asst. Dir.-Purch.: F. A. Coenen
Purch. Agent: C. B. Johnson
Asst. Purch. Agent: M. D. Menzel
V. P.-Mktg.: G. H. Woodland MF, PS, GS, GH, GE

CHAIN BELT CO., SHAFER BEARING DIV.
Belmont Rd. at Curtiss St., Downers Grove, Ill. (Tel. WOodland 9-1770)
Div. Purch. Mgr.: J. J. Friedrich
Asst. Sales Mgr.: R. Schramm

CHALCO ENGRG. CORP.
15126 S. Broadway, Gardena, Calif. (Tel. FAculty 1-0121)
Dir.-Materiel: Irving Kierman
Purch. Agent: Ronald Ferdman
Dir.-Sales: William L. Rose GS, GH, GE, CO, TR, R&D

CHALLENGE MACHINERY CO., THE
First St., Grand Haven, Mich. (Tel. 2800)
Purch. Agent: James Harvey
Plant Mgr.: Arthur Nelson
Sales Mgr.: Paul Babcock TS

CHAMBERSBURG ENGRG. CO.
Chambersburg, Pa. (Tel. COlony 4-7151)
Purch. Agent: W. H. Derbyshire
Sales Mgr.: S. C. Clarke

CHAMPION AIRQUIPMENT INC.
Box 8786, Pittsburgh 21, Pa. (Tel. EXpart 360)
Purch. Agent: J. J. Konaski, Jr.
Mgr.-Sales: H. B. Middendorf MF, WN, PS, GS, GH, CO, TS, TR

CODING

Missile Frame	MF
Warhead & Nase Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

CHAMPION CO., THE
400 Harrison St., Springfield, O. (Tel. FAirfax 3-7545)
Purch. Agent: W E Cooksey
Asst. Purch. Agent: Samuel Patch
Mgr., Contracts Spec. Prod.: Thomas J. Martin
Mgr., Military Special Prod.: Norman L. Dickey GH

CHAMPION SPARK PLUG CO.
900 Upton Ave., Toledo 1, O. (Tel. JEfferson 6-3711)
Dir.-Purch.: Keith Wilson
Asst. Dir.-Purch.: C. W. Sweet
Aviation Sales Mgr.: B. R. Maus PS

CHANCE VOUGHT AIRCRAFT, INC.
P. D. Box 5907, Dallas, Tex. (Tel. AN 2-3211)
Gen. Purch. Agent: B. A. Carlson
Dir.-Sales & Service: Forbes Mann R&O

CHANDLER EVANS CORP.
Charter Oak Blvd., West Hartford 1, Conn. (Tel. ADams 6-0651)
Dir.-Purch.: F. Donald Dildine
Purch. Agent: G. Kenneth Metcalfe
V. P.: Louis G. Burns PS, GE, R&D

CHANDLER PRODUCTS CORP.
1491 Chardon Rd., Cleveland 17, O. (Tel. IVanhoe 1-4400)
Purch. Agent: R. H. Akers
Sales Mgr.: Fred C. Chandler MF, PS, GS, GH

CHASE BRASS & COPPER CO., INC.
236 Grand St., Waterbury 20, Conn. (Tel. PLaza 6-9444)
Gen. Purch. Agent: C. D. Patterson
V. P.-Sales: G. B. Moseley
Gen. Sales Mgr.: W. E. Evans
MF, WN, PS, GE, TS, TR, MM, R&D

CHASSIS-TRAK, INC.
525 S. Webster Ave., Indianapolis, Ind. (Tel. FLeetwood 9-5407)
Gen. Mgr.: Martin R. Christman
Purch. Agent: J. Maurice Harrell

JOHN CHATILLON & SONS
85-93 Cliff St., New York 38, N. Y. (Tel. BEekman 3-2552)
Dir.-Purch.: V. D. McCoy
Exec. V. P.-Sales: George C. Reiley TS

CHEMALLOY ELECTRONICS CORP.
Gillespie Airport, Santee, Calif. (Tel. San Diego—HIckory 4-7661)
Gen. Mgr.: Samuel Freedman MF, GE, CO, TS, TR

CHEMICAL PRODUCTS CORP.
King Phillip Rd., East Providence, R. I. (Tel. GE 4-1770)
V. P.-Purch.: J. Ross Mainland
V. P.-Chem-o-sol Sales: Hugh B. Allison
V. P.-Lacquer Sales: Joseph S. Hawes MM

CHEMOLD CO.
2000 Colorado Ave., Santa Monica, Calif. (Tel. TExas 0-6046)
V. P. & Gen. Mgr.: L. R. Dailey
Sales Mgr.: Ralph Anelson WN, GS, GH, MM

CHEMPLAST, INC.
3 Central Ave., East Newark, N. J. (Tel. HUmboldt 2-2622)
Dir.-Purch.: Harry M. Truska
Dir.-Sales: Stephen S. Dorn WN, MM

CHEMPUMP CORP.
1300 E. Mermaid Lane, Philadelphia 18, Pa. (Tel. CHestnut Hill 7-6300)
Mgr.-Prod. Div.: F. Coonan
Purch. Agent: R. Ashenfelter
Mgr.-Mktg. Div.: W. W Orake GS, R&D

CHESAPEAKE INSTRUMENT CORP.
Shadyside, Md. (Tel. UNiversity 7-2151)
Purch. Agent: J. D. Hogan
Sales Mgr.: Neill A. Teets TS, R&O

CHESTER CABLE CORP.
2000 Hill St., Chester, N. Y. (Tel. HOmestead 9-2141)
Gen. Purch. Agent: J A. Henderson
MF, PS, GS, GH, CO, TS, TR

CHICAGO AERIAL INDUSTRIES, INC.
1980 Howthorne Ave., Melrose Park, Ill. (Tel. FIllmore 5-1840)
Purch. Agent: Robert Rundle
Dir.-Customer Rel.: Arthur R. Fichter
GS, GE, CO, TS, R&D

CHICAGO-ALLIS MFG. CORP.
113-125 N. Green St., Chicago 7, Ill. (Tel. MOnroe 6-5050)
Dir.-Purch.: C. S. Immig
Buyer: W. J. Kelly
Gen. Sales Mgr.: D. H. Ball MF, WN, PS, GS, MM

CHICAGO BRIDGE & IRON CO.
332 S. Michigan Ave., Chicago, Ill. (Tel. HA 7-6708)
Purch. Agent: R. E. Hallenbeck
V. P.-Sales: S. C. Hamilton PS, TS, MM, R&O

CHICAGO DEVELOPMENT CORP.
5810 47th Ave., Riverdale, Md. (Tel. APpleton 7-2821)
V. P.-Purch.: William W. Gullett
Sales Mgr.: C. S. Goodloe MM, R&D

CHICAGO DIV., AMERICAN BOSCH ARMA CORP.
5857 W. 95th St., Oak Lawn, Ill. (Tel. PRescott 9-7100)
Purch. Agent: Gene Flood
Mgr.-Contracts & Sales: A. M. Bozich
GS, GE, CO, TS, TR

CHICAGO ELECTRONIC ENGRG. CO., INC.
3223 W. Armitage Ave., Chicago 47, Ill. (Tel. CApitol 7-3130)
Gen. Mgr.: B. F. Vivacque PS, GS, GE, TS, TR

CHICAGO GASKET CO.
1271 W. North Ave., Chicago 22, Ill. (Tel. HUmbolt 6-3060)
Mgr., Purch. Dept.: Paul H. Dittmer
Sales Mgr.: R. H. Martin MM

CHICAGO MINIATURE LAMP WORKS
1500 N. Dgden Ave., Chicago 10, Ill. (Tel. MOhawk 4-1741)
Secy.: T. Singer
V. P.-Sales: Ernest E Freeman, Jr. GS, CO, TS, TR

CHICAGO MOLOED PROOUCTS CORP.
1070 N. Kolmar Ave , Chicago 51, Ill. (Tel. Dickens 2-9000)
Purch. Agent: Frank E. Klingenmeier
Asst. Purch. Agent: Cuyler Stanek
V. P.-Chg. Molding Div.-Sales: James E. Johnston MF

CHICAGO PNEUMATIC TOOL CO.
6 E. 44th St., New York 17, N. Y. (Tel. MUrray Hill 7-1700)
Purch. Agent: K. T. Dolson
Sales Mgr., Pneumatic Tools: R. T. Beers
Sales Mgr., Electric Tools: L. J. Walker
WN, PS, GS, GH, GE, TS, TR

CHICAGO RAWHIDE MFG. CO.
1301 N. Elston Ave., Chicago 22, Ill. (Tel. BRunswick 8-2100)
V. P. & Dir.-Purch.: Norman R. Hanson
Asst. Dir.-Purch.: B. J. Yunker
V. P. & Oir.-Sales: Phelps Wilder

CHICAGO RIVET & MACHINE CO.
950 S. 25th Ave., Bellwood, Ill. (Tel. LInden 4-5100)
Purch. Agent: W. A. Bautz
Asst. Purch. Agent: J. A. Compbell
Sales Mgr.: Wm. O. Shineflug

CHICAGO SCREW CO., THE, OIV.-STANDARO SCREW CO.
2501 Washington Blvd., Bellwood, Ill. (Tel. LInden 4-3500)
Dir.-Purch.: W. J. McCoy
Asst. Purch. Agents: P. W. McKenna & John James
V. P.-Standard Prod. Sales: E. L. Claussen
MF, WN, PS

CHICAGO STANDARO TRANSFORMER CORP.
3501 W. Addison St., Chicago 18, Ill. (Tel. INdependence 3-7400)
Purch.: E. Donnellan
Buyer: C. Dubas
Oir.-Sales: P. N. Cook GE, CO, TS, TR

CHIKSAN CO., SUB.-FOOD MACHINERY & CHEMICAL CORP.
330 N. Pomona Ave., Brea, Calif. (Tel. JAsper 9-2121)
Mgr.-Purch.: E. H. Nelson
Sales Mgr.: L. J. Smith GS, GH

CHISHOLM-MOORE HOIST DIV., COLUMBUS McKINNON CHAIN CORP.
Fremont Ave., Tonawanda, N. Y. (Tel. JAckson 2230)
Purch. Agent: W. J. Wolf
Sales Mgr.: E. J. Byrne
Sales Pram. Mgr.: R. N. Warnke GH

C. B. CHRISTIANSEN CO.
164 Pennington St., Newark 5, N. J. (Tel. MArket 3-4979)
Purch. Agent: L. Tarzinski
Sales: B. W. Oeehan MF, WN, PS, GS, GH, TS, TR

CHRISTIE ELECTRIC CORP.
3410 W. 67th St., Los Angeles 43, Calif. (Tel. PLeasant 3-2607)
Purch. Agent: H. B. Doty
Sales Mgr.: E. E. Hughes GS, CO

CHRISTIE MACHINE WORKS
201 Harrison St., San Francisco 5, Calif. (Tel. EXbrook 2-2187)
V. P.-Purch. & Sales: Lloyd F. Christie
PS, GE, TR, R&

CHRYSLER CORP., DEFENSE OPERATIONS DIV.
7000 E. Eleven Mile Rd., Center Line, Mich. (Tel. JEfferson 9-3000) Mailing Address: P. O. Box 757, Detroit 31, Mich.
Dir.-Proc.: A. H. Hilverkus
Purch. Supvr.: A. M. Thom
Dir.-Govt. Relations: G. W. Snider
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&

CHRYSLER CORP., MISSILE DIV.
P. O. Box 2628, Detroit 31, Mich. (Tel. JEfferson 9-2000)
Purch. Agent: S. J. Roach
Purch. Admin.: J. M. Drr
Mgr.-Buying & Fallaw-up: J. P. Forbes
Mgr.-Purch. Analysis: C. R. McMacken
Mgr.-Sub-Contracts: H. L. Sinclair
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&

CIBA PROOUCTS CORP.
P. O. Box 415, Fair Lawn, N. J. (Tel. SWarthmore 1-1122)
Sales Mgr.: E. N. Dorman M

CIMASTRA OIV., THE CINCINNATI MILLING MACHINE CO.
Marburg Ave., Cincinnati 9, O. (Tel. RE 1-2121)
Purch. Agent: H. Decatur
Sales Mgr.: R. Bevis

CINCINNATI CLEANING & FINISHING MACHINERY
1100 Hageman St., Cincinnati 41, O. (Tel. PRinceton 1-5100)
Purch. Agent: C. Tyahur
Dir.-Sales: H. Nonneman

CINCINNATI MILLING MACHINE CO., THE
Marburg Ave., Cincinnati 9, Ohio (Tel. REdwood 1-2121)
Purch. Agent: Herman Decatur
Sales Mgr.: R. Bevis

CINCINNATI SHAPER CO., THE
Cincinnati, Dhio

CINCINNATI SUB ZERO PRODUCTS
3932 Reading Rd., Cincinnoti 29, O. (Tel. PLaza 1-8810)
Purch. Agent: H. Koupp
Proj. Engr.: R. E. Schroeder
Chief Engr.: T. J. Frederick T

CINEMA ENGRG.
1100 Chestnut St., Burbank, Calif.
Gen. Mgr.: James L. Fouch

CINE-VIOEO PROOUCTIONS, INC.
Boston Post Rd., Milford, Conn. (Tel. TRinity 4-6590)
Pres.: G. W. Ray

CIRCON COMPONENT CORP.
Santa Barbara Municipal Airport, Goleta, Calif. (Tel. WOodland 7-1113)
Sales Mgr.: M. J. Ainsworth
MF, WN, PS, GS, GH, GE, TS, T

CLAIREX CORP.
19 W. 26th St., New York 10, N. Y. (Tel. WAtkins 9-1668)
Dir.-Purch.: V. M. Schell
Sales: A. F. Deuth

CLARAGE FAN CO.
619 Porter St., Kalamazoo, Mich. (Tel. FIreside 9-1541)
Purch. Agent: R. F. Ware
Asst. Purch. Agent: O. F. Johnson
Dir.-Sales: C. R. McConner

C. P. CLARE & CO.
3101 Pratt Blvd., Chicago 45, Ill. (Tel. AMbassador 2-7700)
Purch. Agent: B. E. Brooks
V. P. in Chg. of Sales: O. R. Oooley
Asst. Purch. Agents: Thomas Grace & Robert Hickerson M

DAVID CLARK CO., INC.
360 Park Ave., Worcester, Mass. (Tel. PLeasant 6-6216)
Purch. Agent: Ralph Miller, Jr.
Sales Mgr.: Charles W. Kaufman

CLARK CRYSTAL CO.
2 Farm Rd., Marlboro, Mass. (Tel. MArlboro 1411)
Mgr.: F. O. Nobles GS,

CLARK ELECTRONIC LABORATORIES
Box 165, Palm Springs, Calif. (Tel. FA 8-2210)
Sales Mgr.: O. B. Clark GE, TR, R

CLARK EQUIPMENT CO.
324 E. Oewey Ave., Buchanan, Mich. (Tel. OXbow 5-3811)
V. P.-Purch.: J. G. Mack
Mgr., Oevelopment Div.: Cyril B. Rogers

CLARK-AIKEN CO., THE
Water St., Lee, Mass. (Tel. 1261)
Prod. Engr.: J. P. Stoeke — MF, PS, GS, GH

CLARKSON LABS., INC., THE
920-30 N. Darien St., Philadelphio 23, Po. (MArket 7-6764)
Treas.: Morris Coppersmith
Pres.: E. W. Heller — R&D

CLARDSTAT MFG. CO., INC.
Dover, N. H. (Tel. SHerwood 2-1120)
Purch. Dir.: E. D. Schromm
Gen. Sales Mgr.: E. W. Kingsbery

CLARY DYNAMICS
408 Junipero St., San Gabriel, Colif. (Tel. CUmberland 3-2724)
Purch. Agent: Don Werter
Gen. Sales Mgr.: Charles T. Cosser — GE, TR, R&D

CLAUSING DIV.-ATLAS PRESS CO.
1915 N. Pitcher St., Kalamozoo, Mich. (Tel. FIreside 5-7157)
Dir.-Purch.: S. L. Show
V. P.-Sales: G. C. Noncorrow — MM

CLEMCO AERO PRODUCTS, INC.
210 E. Monville St., Compton, Calif. (Tel. NEvada 6-8162)
Purch. Agent: E. J. Szkaradek
Plant Mgr.-Sales: R. E. Marsh — GE

CLEVELAND AUTOMATIC MACHINE CO., THE
4932 Beech St., Cincinnoti 12, O. (Tel. REdwood 1-5300)
Purch. Agent: A. W. Niederhelman
V. P.-Sales Mgr.: John Prohosko

CLEVELAND CONTAINER CO., THE
6201 Borberton Ave., Clevelond, O. (Tel. OLympic 1-4500)
Purch. Agent: R. F. Boll
Sales Mgr.: Jay Sebesky — MM

CLEVELAND CRANE & ENGRG. CO., THE
Wickliffe, O. (Tel. WHitney 3-3700)
Purch. Agent: G. W. Urbon — GS

CLEVELAND GRAPHITE BRONZE DIV.-CLEVITE CORP.
17000 St., Clair Ave., Clevelond 10, O. (Tel. IVonhoe 1-7221)
Dir.-Purch.: J. G. Mehring
Purch. Agent: J. C. Holl
Asst. Purch. Agent: P. W. Love
Purch. Anolyst: J. Hopkins
V. P.-Sales: L. W. Christenson
Staff Asst.-Sales: R. C. Webster — MM

CLEVELAND INSTRUMENT CO.
6220 East Schoof Rd., Clevelond 31, O. (Tel. LA 4-4821)
Purch. Agent: W. Young
Mgr.-Sales: F. W. Witzke — GE, CO, TS

CLEVELAND METAL SPECIALTIES CO., ELECTRONICS DIV.
1783 E. 21st St., Cleveland 14, O. (Tel. PRospect 1-4186)
V. P.-Purch.: Joe Jopel — WN, TR, R&D

CLEVELAND PNEUMATIC INDUSTRIES, INC.
3781 E. 77th St., Cleveland 5, Ohio (Tel. DIamond 1-1700)
Materiel Mgr.: John Chopman
V. P.-Sales: Elmer Krueger — PS, GS, GH, MM

CLEVELAND WELDING DIV.-AMERICAN MACHINE & FOUNDRY CO.
W. 117th St. & Berea Rd., Clevelond 11, Ohio (Tel. WDodbine 1-2820)
Gen. Sales Mgr.: F. L. Nemeth
Purch. Agent: A. A. Mitsch — GS, GH, MM

CLEVITE TRANSISTOR PRODUCTS, DIV.-CLEVITE CORP.
241-257 Crescent St., Walthom 54, Moss. (Tel. TWinbrook 4-9330)
Dir.-Purch. & Prod. Control: W. T. Howlond
Purch. Agent: G. Hird
Sr. Buyer: T. Kenney — GE, TS, TR

CLIFTON PRECISION PRODUCTS CO., INC.
Morple at Broodway, Clifton Heights, Po. (Tel. MAdison 6-2101)
Purch. Agent: Tyson Parker
V. P. & Sales Mgr.: Thomas W Shoop — GE, CO, TS

CLIPPARD INSTRUMENT LAB., INC.
Cincinnati 39, O. (Tel. JAckson 1-4261)
V. P.-Purch.: James W. Dillon
Sales Engineers: Oscar S. Clippard & William C. Rou

COVER INDUSTRIES, INC.
78-588 Young St., Tonawonda, N. Y. (Tel. LUdlow 1331)
V. P.-Purch.: H. Paul Henderson
V. P.-Sales: L. N. Friol — MM

COAST MFG. & SUPPLY CO.
Box 71, Livermore, Colif. (Tel. Hilltop 7-1000)
Purch. Agent: A. J. Andersen
Soles Mgr.: James A. Merritt — MM

COAXIAL CONNECTOR CO. INC.
37 N. 2nd Ave., Mt. Vernon, N. Y. (Tel. MDunt Vernon 8-6416)
Purch. Agent: William R. Cloyton
Dir.-Sales: Don Reode — GE, TS, TR

COBEHN, INC.
226 Passaic Ave., Caldwell, N. J. (Tel. CApitol 6-6675)
Purch. Agent: William E. Bellors
V. P.-Sales: David F. Cook — GS

COBRA METAL HDSE DIV., DK MFG. CO.
5059 S. Kedzie Ave., Chicago 32, Ill. (Tel. REpublic 7-3311)
Purch. Agent: T. Kwasnik
Buyers: R. A. Michudo, W. K. Davis, A. Virgo
Soles Mgr.: Clyde D. Greeno — MF, GS

COFFING HOIST DIV., DUFF-NORTON CO.
800 Walter St., Danville, Ill. (Tel. 6-3800) — GH

COHAN EPNER CO. INC.
142 W. 14th St., New York 11, N. Y. (Tel. CHelsea 3-3411)
Purch. Agent: William Epner
Dir.-Soles: Gerald Epner — MF, WN, PS, GS

CDIL CO. OF AMERICA
215 Washington St., Northvole, N. J. (Tel. CLoster 5-3434)
Purch.: H. Gay — GS, GE, TS, TR

COIL WINDING EQUIPMENT CO.
19 Moxwell Ave., Oyster Boy, N. Y. (Tel. OYster Boy 6-1285)
Purch. Agent: Mrs. Blanche A. George
Purch.: James H. George
Soles: Howard A. George — GS, GH

COILCRAFT INC.
Jondus Rd., Cory, Ill. (Tel. MErcury 9-2361)
Purch. Agent: William Desmond
V. P. & Dir.-Soles: Rolph Smith

COILS-ELECTRONICS
2939-49 N. 2nd St., Philadelphia 33, Po. (Tel. REgent 9-6465)
Purch. Agent: Ben Molkin
Dir.-Soles: Leon Ozier — R&D

COLE ELECTRIC CO.
8439 Steller Dr., Culver City, Colif. (TExas 0-4701)
Soles Mgr.: H. P. Sporkes — CO, TS, R&D

COLE-HERSEE CO.
20 Old Colony Ave., South Boston 27, Mass. (Tel. ANdrew 8-2190)
Dir.-Purch.: G. B. Jacobs
Chief Engr.-Purch: T. Unsworth
Soles Engr.: Jerry Desjordins
Gen. Soles Mgr.: L. Mayer — PS, GE, TR

COLEMAN ENGRG. CO., INC.
3500 Torrance Blvd., Torrance, Calif. (Tel. FAculty 1-3900 & FRontier 6-8921)
Purch. Agent: E. J. Hannaman
Buyers: Robert Williams & Reg Bliss
V. P.-Cust. Relations: E. M. Armstrong — GS, GH, CO, TR, R&D

COLLECTRON CORP.
304 E. 45th St., New York, N. Y. (Tel. MU 9-7120)
Purch. Agent & Soles Mgr.: R. B. Coombs — MM

G. L. COLLINS CORP.
2820 E. Hullett St., Long Beach 5, Calif. (Tel. MEtcalf 0-3121)
V. P.-Purch.: G. D. Collins
V. P.-Soles: L. A. Bondy — GE

COLLINS ENGRG. CORP.
9050 Washington Blvd., Culver City, Calif. (Tel. TExos 0-4811)
Chief Purch. Agent: Ada Kadinger
Pres.: Joe Collins — MM

COLLINS MICROFLAT CO.
3249 W. El Segundo Blvd., Hawthorne, Calif. (Tel. OREgon 8-7694)
V. P.-Purch.: E. Mike Bruhwiler
Pres.: Lee Collins — MM, R&D

COLLINS RADIO CO.
855 35th St., N. E., Cedor Rapids, Iowo (Tel. EMpire 3-0281)
Dir.-Purch: John H. Wogner, 411 First Ave., S. E., Cedar Rapids, Iowa (Tel. EMpire 3-2661)
V. P.-Soles: J. G. Flynn, Jr., Dallas, Tex. (Tel. ADoms 5-4511) — GS, GE, CO, TR, R&D

COLONIAL AIRCRAFT CORP.
Box 250 Sanford, Me. (Tel. SAnford 80)
Purch. Agent: Hervey Corpenter
Pres.: David B. Thurston — MF, GS, GH, TS

COLONIAL RUBBER CO.
706 Dakwood St., Rovenna, D. (Tel. AXminister 6-9611)
Purch. Agent: R. M. Richmond
Sales Mgr.: D. E. Moson — MM

COLORADO RESEARCH CORP.
Broomfield, Colo. (Tel. HArrison 9-3501)
Purch. Agent: A. R. Holden, Jr.
Dir.-Mktg.: David R. Miller — R&D

COLSON CORP., THE
440 Somerville Ave., Somerville 43, Moss.
Purch. Agent: C. Lockwood
Sales Mgr.: S. A. Leone — GH

COLUMBIA ELECTRIC MFG. CO.
4519 Hamilton Ave., Clevelond 14, D. (Tel. ENdicott 1-8060)
Purch. Agent: John Sygielski
Sales Mgr.: H. W. Sussmon — GS, TS, R&D

COLUMBIA NUT & BOLT CO., INC.
945 Main St., Bridgeport 3, Conn. (Tel. EDison 3-4956)
Pres.: Howard P. Cook — MM

COLUMBIA PRODUCTS CO.
R.F.D. #3, Columbio, South Carolina (Tel. SUnset 7-8710)
Purch. Agent: Frank Cox
Sales Mgr.: S. W. Trewhello — TR

COLUMBIA RESEARCH & DEVELOPMENT CORP.
4608 Indianola Ave., Columbus 15, O. (Tel. AMherst 7-1277)
Purch. Agent: D. E. Lehman
Gen. Mgr.: H. O. Kempton — GS, GH, R&D

COLUMBIA RESEARCH LABS.
MocDade Blvd. & Bullens Lone, Woodlyn, Po. (Tel. CHester 2-0381)
Buyer: Victor F. Alibert
Asst. Buyer: Thomas Carey, Jr.
Sales Mgr.: Vernon F. Alibert — MF, PS, GS, GH, GE, CO, TS, TR

COLUMBIA TECHNICAL CORP.
61-02 31st Ave., Woodside 77, N. Y. (Tel. AS 8-7401)
Purch. Agent & Treas.: V. Leibmann
Buyer: L. Tayla

COLUMBIAN CARBON CO., MAPICO IRON OXIDES UNIT
380 Madison Ave., New York 17, N. Y. (Tel. MUrray Hill 7-2300)
Sales Mgr.: C. O. Davidson — MF, PS

COLUMBIAN ROPE CO.
309 Genesee St., Auburn, N. Y. (Tel. 3-3221)
Purch. Agent: C. A. Fowler
V. P.-Soles: L. R. Hole — MM

COLUMBUS ELECTRONICS CORP.
1010 Saw Mill River Rd., Yonkers, N. Y. (Tel. YOnkers 8-1221)
Purch. Agent: Dovid Porker
Sales Mgr.: Gustov Bord

COLVIN LABS., INC.
364 Glenwood Ave., East Drange, N. J. (Tel. ORange 7-1221)
Purch. Agent: V. Tobias
Gen. Mgr.: D. P. Vogel — GE, TS, TR

COM-AIR PRODUCTS, DIV.-A-S-R PRODUCTS CORP.
1201 Rio Vista Ave., Los Angeles 23, Calif. (Tel. ANgelus 3-2171)
Purch. Agent: Frank Georgionni
Dir.-Moteriel: F. L. Loyd
Buyer: Jane Smith
Dir.-Field Engrg.: Victor Belfiore — PS, GS, GE, CO, R&D

COMAR ELECTRIC CO.
3349 Addison St., Chicago 18, Ill. (Tel. JUniper 8-2410)
Purch. Agent: Richord Boer
Asst. Purch. Agent: Chos. Kirchenbouer
Sales Mgr.: L. E. Noelck — GS, GE, TR

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsian System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materiols & Metals MM

COMCO PLASTICS INC.
97-24 Albert Rd., Ozone Park 17, N. Y. (Tel. MIchigan 1-0934)
Purch. Agent: E. Wemett
Sales Mgr.: J. C. Steele

COMMERCIAL FILTERS CORP.
2 Main St., Melrose 76, Mass. (Tel. DAvenport 4-7000)
Purch. Agent: Alan F. Riley
Sales Mgr.: J. R. Chisholm PS, GS

COMMERCIAL PLASTICS & SUPPLY CORP.
630 Broadway, New York, N. Y. (Tel. GR 7-5000)
V. P. & Dir.-Purch.: Morton R. French
Gen. Mgr.: Don I. Yarnall MM

COMMERCIAL SHEARING & STAMPING CO.
1775 Logan Ave., Youngstown 1, Ohio (Tel. RI 6-8011)
Purch. Agent: D. A. Boop
V. P.-Chg. Sales: H. B. Wollison WN, MM

COMMONWEALTH FELT CO.
76 Summer St., Boston 10, Mass. (Tel. Liberty 2-6590)
Treas.: I. Goldberg
Mgr.-Cut Parts Div.: N. M. Benson
Sales: J. S. Patterson MM

COMMUNICATIONS CO.
300 Greca Ave., Coral Gables, Fla. (Tel. HI 6-0846)
Purch. Agent: W. K. Whitmire
Asst. Gen. Mgr.-Sales: Frederick R. Mocklin GS, GH, GE, TR

COMMUNICATIONS RESEARCH CO.
P. O. Box 778, Richmond 6, Va. (Tel. MIlton 4-3255)
Pres.: Paul K. Heim
Dir.-Research & Dev.: Dr. David P. Armstrong
Purch. Agent & Bus. Mgr.: Edward I. Davies TR, R&O

COMMUNITY ENGRG. CORP.
Box 824, State College, Pa. (Tel. ADams 7-7221)
Pres.-Purch.: James R. Palmer
Sales: Floyd B. Fischer

COMPONENTS CORP.
35 N. Arroyo Pkwy., Pasadena, Calif. (RYan 1-7448)
Pres.: Evert C. Hokanson MF, WN, PS, GS, GH, GE, CO, TS, TR

COMPUTER CONTROL CO., INC.
92 Broad St., Wellesley 57, Mass. (Tel. CEdar 5-6220)
Purch. Agent: Bradford P. Daniels
V. P.-Sales: William Wolfson
Sales Mgr.-Eastern Div.: James I. Leabman GE, TR

COMPUTER ENGRG. ASSOCIATES, INC.
350 N. Halstead St., Pasadena 8, Calif., (Tel. ELgin 5-7121)
Purch. Agent: John Brunk
Customer Service Mgr.: Richard T. Campbell

COMPUTER INSTRUMENTS CORP.
92 Madison Ave., Hempstead, L. I., N. Y. (Tel. IVonhae 3-8200)
Dir.-Purch.: H. Adise
Purch. Agent: I. Clinton
Sales Mgr.: J. Herman GH, TS, MM, R&O

CONANT LABS.
Box 3997, Bethony Station, Lincoln 5, Nebr. (Tel. 4-0432)
Gen. Mgr.: G. Conant

CONAX CORP.
2300 Walden Ave., Buffalo 25, N. Y. (Tel. REgent 0600)
Purch. Agent: Edgar Kowalski
Sales Mgr.: John M. Considine MF, WN, PS, GS, GE, CO

CONCO ENGRG. WORKS
Mendota, Ill. (Tel. 2121)
Purch. Agent: P. J. Donahue
Asst. to Exec. V. P.-Sales: J. W. Burch MF, GS

CONMAR PRODUCTS CORP.
140 Thomas St., Newark 1, N. J. (Tel. BIgelow 8-2211)
Asst. Gen. Sales Mgr.: A. L. Moss

CONN-CRAFT CO.
301 Fairlawn Ave., Waterbury 5, Conn. (Tel. PLaza 4-1811)
Mgr.: Leo J. Bakinow

CONNECTICUT HARO RUBBER CO., THE
407 East St., New Haven 9, Conn. (Tel. SPruce 7-3631)
Purch. Agent: T. E. Grandshaw
Sales Mgr.: J. A. Moffitt, Jr. MF, WN, PS, GS, GH, TR

CONNECTOR CORP. OF AMERICA
12959 Sherman Way, N. Hollywood, Calif. (Tel. STanley 7-9653)
Pres.-Sales: Ralph R. Thomas MF, WN, PS, GH, GE, TR

CONOFLOW CORP.
2100 Arch St., Philadelphia 3, Pa. (Tel. LDcust 7-7560)
Purch. Agent: H. Bonekat
Sales Mgr.: J. Robert Simpson TS

CONRAD, INC.
Conrad Sq., Holland, Mich. (Tel. EXport 2-3161)
Purch. Agent: Merle Pointer, 141 Jefferson St., Holland, Mich.
V. P.-Sales: Charles Conrad, 141 Jefferson St., Holland, Mich. TS, R&O

CONSOLIDATED AIRBORNE SYSTEMS, INC.
321 Willis Ave., Mineola, N. Y. (Tel. Pioneer 6-7224)
V. P.-Gen. Mgr.: John I. Nestel
V. P.-Chief Engr.: Leo Stamler
Proj. Engr.: Hugo Daffara
Sales Mgr.: John A. Milbouer GH, GE, CO, TS, TR

CONSOLIDATED AMERICAN SERVICES, INC.
9999 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-4725)
Pres.: M. J. Ruland
Mgr.: R. A. Verna
Sales: R. Faille PS, GS, MM

CONSOLIDATED AVIONICS CORP.
800 Shames Dr., Westbury, L. I., N. Y. (Tel. EDgewood 4-8400)
Purch. Agent: Carl Cooper
Sales Mgr.: Peter J. Reuter GS, CO, TR, R&O

CONSOLIDATED CONTROLS CORP.
13 Durant Ave., Bethel, Conn. (Tel. Pioneer 3-6721)
Purch. Agent: C. S. Joyce
Sales Mgr.: C. M. Colt PS, GS

CONSOLIDATED DIESEL ELECTRIC CORP.
880 Canal St., Stamford, Conn. (Tel. DAvis 5-2261)
Purch. Agent: John Adams
Sales Mgr., Power Equipment Div.: M. J. Sullivan
Sales Mgr., Test Equipment Div.: Kenneth Gerhardt
Sales Mgr., Aircraft Equipment Div.: Robert Sellers GS, GH, CO, TS, R&O

CONSOLIDATED DIESEL ELECTRIC CORP., TEST EQUIP. DIV.
1 John St., Stamford, Conn. (Tel. DAvis 5-2261)
Purch. Agent: John Budnik
Sales Mgr.: Kenneth C. Gerhardt GS, GH, CO, TS

CONSOLIDATED DIESEL ELECTRIC CORP., WESTERN DIV.
15519 Lanark St., Von Nuys, Calif. (Tel. STate 2-4060)
Purch. Agent: T. C. McKinney GS, GH, CO, TS

CONSOLIDATED ELECTRODYNAMICS CORP.
300 N. Sierra Madre Villa, Pasadena, Calif. (Tel. RYon 1-8421)
Dir.-Purch.: Mario Gardner
V. P.-Mktg.: R. L. Smallman

CONSOLIDATED ELECTRODYNAMICS CORP., ROCHESTER DIV.
1775 Mt. Read Blvd., Rochester 3, N. Y. (Tel. GLenwood 3-7972)
Purch. Agent: W. Barton
Dir.-Mktg.: W. Dolke

CONSOLIDATED FILM INDUSTRIES
959 N. Seward St., Hollywood 38, Calif. (Tel. HOllywood 2-0881)
V. P. & Gen. Mgr.: Sidney P. Solow
Dir.-Sales: Jack M. Goetz

CONSOLIDATED INDUSTRIES, INC.
Mixville Rd., West Cheshire, Conn. (Tel. Cheshire-BRowning 2-5371)
Sales Engr.: E. A. Fentzlaff MF, PS

CONSOLIDATED PRODUCTIONS, INC.
3991 S. W. 12th Terrace, Fort Lauderdale, Fla. (Tel. JAckson 4-8361)
Purch. Agent: Gordon Jonas
V.P.-Sales: A. L. D'Connor GS

CONSOLIDATED WIRE & ASSOCIATED COMPANIES
1635 S. Clinton St., Chicago 16, Ill. (Tel. HA 1-4441)
Sales Mgr.: J. J. Mann MF, PS, GS, GH, CO, TR

CONTINENTAL AVIATION & ENGRG. CORP.
12700 Kercheval, Detroit, Mich. (Tel. VAlley 2-1500)
Dir.-Purch.: Carl L. Schiller
Purch. Agent, Toledo Div.: John Watson (Tel. GR 5-4641)
Mgr.-Sales & Service: Kenneth C. Smith PS, GS, R&O

CONTINENTAL CAN CO., INC.
530 Fifth Ave., New York 17, N. Y. (Tel. MUrray Hill 2-1300)
J. B. Jack MF, TR, MM

CONTINENTAL CARBON, DIV.-WIRT CO.
5221-27 Greene St., Philadelphia 44, Pa. (Tel. GErmantown 8-9334)
Purch. Agent: Kalman Litson
Sales Mgr.: Robert H. Hayes GE, R&

CONTINENTAL CONNECTOR CORP.
34-63 56th St., Woodside 77, N. Y. (Tel. TW 9-4422)
Purch. Agent: A. Jacob MF, G

CONTINENTAL DIAMOND FIBRE CORP.
Newark, Del. (Tel. ENdicott 8-8531)
Dir.-Purch.: W. H. Walker
Asst. Purch. Mgr.: F. A. Cain
Gen. Sales Mgr.: A. J. Briggs MM, R&

CONTINENTAL DRILL CORP.
555 W. Adams St., Chicago 6, Ill. (Tel. DEarborn 2-2776)
V. P. & Dir.-Purch.: Lawrence A. Shick

CONTINENTAL ELECTRIC CO., INC.
325 Ferry St., Newark 5, N. J. (Tel. MItchell 2-4051)
Dir.-Purch.: Fred Bamberger
Dir.-Sales: A. W. Peterson

CONTINENTAL ELECTRONICS MFG. CO.
4212 S. Buckner Blvd., Dallas 27, Tex. (Tel. EVergreen 1-1137)
Dir.-Procurement Dept.: A. W. Schmidt, Jr.
Asst.-Procurement Dept.: Robert Keith
Dir.-Sales & Contract Negotiations: Thomas B. Moseley

CONTINENTAL MFG., INC.
1612 California St., Omaha 2, Nebr. (Tel. JAckson 2753)
Plt. Mgr.: Gean D. Poole
Pres.: Roy B. McMartin

CONTINENTAL METALS, INC.
7001 Santa Monica Blvd., Los Angeles 38, Calif. (Tel. HOllywood 9-8383)
Purch. Agent & Sales: I. H. Taylor

CONTINENTAL MOTORS CORP.
Market St., Muskegon Mich. (Tel. 2-7631)
Pres. & Gen. Mgr.: C. J. Reese

CONTINENTAL RUBBER WORKS
1963 Liberty St., Erie 6, Pa. (Tel. 2-5261)
Purch. Agent: Robert A. Bailey
Sales Mgr.: Charles C. Shenk MF, WN, PS,

CONTINENTAL SCREW CO.
459 Mt. Pleasant St., New Bedford, Mass. (Tel. WYman 3-2621)
Purch. Agent: Edward Pettengill
Gen. Sales Mgr.: Victor Ladetto

CONTINENTAL TECHNICAL SERVICE, INC.
29 W. Apple St., Daytan 2, O. (Tel. BA 2-8626)
Purch. Agent: F. Nation
Sales Coordinator: George Thomas GS, GH,

CONTINENTAL WIRE SALES CORP.
322 N. Cherry St., Ext. P. O. Box 366 Wallingford, Conn. (Tel. COlony 9-1421)
Purch. Agent: C. C. Christiansen
Sales Mgr.: E. T. Harrigan

CONTROL CIRCUITS INC.
5 Barton Hill, East Hampton, Conn. (Tel. ANdrew 7-9445)
Purch. Agent: H. L. Voelker

CONTROL DATA CORP.
501 Park Ave., Minneapolis 15, Minn. (Tel. FEderal 9-0947)
Dir. Purch.: James D. Harris
Purch. Agent: L. Bernier
Dir. Sales: James G. Miles

CONTROL ENGRG. CO., DIV.-JERVIS B. WEBB
8900 Roselawn, Detroit 4, Mich. (Tel. WE 3-9311
Purch. Agent: John K. Gage
Asst. Sales Mgr.: Thomas J. Lindsay
Gen. Mgr.: Marvin S. Blemly GS, GH, CO,

CONTROL PRODUCTS, INC.
306 Sussex St., Harrison, N. J. (Tel. HUmbolt 2-0213)
Purch. Agent: H. R. Brewster
Sales Mgr.: J. R. Nile

CONTROLS CO. OF AMERICA
9555 Soreng Ave., Schiller Park, Ill. (Tel. NAtion 5-9000)
Purch. Agents: L. Manfre & H. Keller
V. P.-Sales: D. Strathearn & A. Topp MF, PS, GS, GH, GE, CO,

CONVAIR-ASTRONAUTICS DIV.-GENERAL DYNAMICS CORP.
5001 Kearny Villa Rd., San Diego 12, Calif. (Tel. BR 7-8900)
Material Mgr.: C. F. Uhden
Gen. Purch. Agent: E. Fellows, Jr.

Purch. Agents: C. C. Farnswarth, C. T. Talbott & W. S. Tucker MF, GS, CO, TS, TR, R&D

CONVAIR-INSTRUMENTS DIV.,-GENERAL DYNAMICS CORP.
3595 Frantier St., San Diego 10, Calif. (Tel. AC 3-1614)
Dr. Egan E. Muehlner CO, TS

CONVAIR-POMONA DIV.-GENERAL DYNAMICS CORP.
1675 W. Fifth St., Pamona, Calif. (Tel. NAtional 9-5111)
Mgr.-Material: R. O. Webster
Gen. Purch. Agent: O. W. Connell
Purch. Agent-Standard Parts, Raw Materials, Facilities & Commercial: R. J. Hartmayer
Purch. Agent-Subcontracts, Special Components, Castings & Forgings: J. O. Currier
MF, GS, CO, TS, TR, R&D

C. LEE COOK CO., AIRTOMIC PRODUCTS DIV.
916 S. Eighth St., Louisville 3, Ky. (Tel. JUniper 7-6783)
Purch. Agent: S. J. Wahlhueter
Sales Engr.: W. E. Gossage PS, MM

FRANK R. COOK CO.
3850 Olive St., Denver 7, Colo. (Tel. FL 5-3531)
Purch.: M. L. Mawbray
Sales Mgr.: W. B. Winder

COOK ELECTRIC CO.
2700 N. Southport Ave., Chicago 14, Ill.

HERBERT COOPER CO., INC.
Box 1, Genesee, Pa. (Tel. 2761)
Secy. & Treas.: Joseph C. Herbert, Jr.

COOPER ALLOY CORP.
Hillside, N. J. (Tel. MU 8-4120)
Mgr.-Adv. & Sales Prom.: Stuart F. Cooper MF, GS

COOPER DEVELOPMENT CORP., SUB.-MARQUARDT AIRCRAFT CO.
2626 South Peck Rd. Monrovia, Calif. (Tel. HIllcrest 6-3138)
Purch. Agent: Eugene Binford
Mgr.-Contracts Planning: Malcalm C. Tucker
MF, PS, GS, CO, TS, TR, MM, R&D

COOPER INDUSTRIES, INC.
2149 E. Pratt Blvd., Elkgrove, Ill. (Tel. HEmpstead 9-2050)
Pres.: Harry Cooper
Sales Mgr.: Herbert Cooper MM

CO-OPERATIVE INDUSTRIES, INC.
100 Oakdale Rd., Chester, N. J. (Tel. 255)
Purch. Agent: E. F. Youngquist
Asst. Purch. Agent: Barnes Barker
V. P.-Sales: V. C. Banardel
MF, WN, PS, GS, GH, GE, CO, TR

COPER-BESSEMER CORP., THE
Mt. Vernon, O. (Tel. EX 3-0121)
Dir.-Purch.: H. C. Jones
Purch Agent: H. L. Winger
Dir.-Adv.: R. S. Warren
V. P.-Sales: S. E. Johnson GS

COPPERWELD STEEL CO., WIRE & CABLE DIV.
Glassport, Pa. (Tel. NOrth 4-7131)
Purch. Agent: M. M. Siegel
Sales Mgr.: F. E. Leib
MF, PS, GS, GH, TS, TR, MM

COPPUS ENGRG. CORP.
344 Park Ave., Worcester 10, Mass. (Tel. PLeasant 2-5638)
Purch. Agent: H. C. Hult
Sales Mgr.: E. Kundig PS, GS, GH

CORBIN PRODUCTS DIV.
Crescent Plaza Bldg. 306-B, Long Island City 1, N. Y. (Tel. ST 6-0700)
Exec. Secy.: D. R. Locke GS, GH, MM

CORDO CHEMICAL CORP.
11 Smith St., Norwalk, Conn. (Tel. VOlunteer 6-4438)
Purch. Agent: Robert F. Walsh
Exec. V. P. & Gen. Mgr.: George H. Sherrard
Sales Mgr.: F. W. Hall GS, MM

CORNELIUS CO., THE, AERO DIV.
20 39th Ave., N. E., Minneapolis 21, Minn. (Tel. SUnset 8-8613)
Purch. Agent: Fred A. Andersan
Mgr.-Sales: J. W. Mahanay GS, GH, CO, R&D

CORNELL AERONAUTICAL LAB.
Buffalo, N. Y.

CORNELL DEEP DRAWING CO., DIV.-LANES INDUSTRIES CORP.
2-620 Colorada Ave., Santa Monica, Calif. (Tel. EXbrook 3-1810)
V. P.-Purch. & Personnel: Peter F. Lanes MM

CORNELL-DUBILIER ELECTRIC CORP.
Hamilton Blvd., South Plainfield, N. J. (Tel. PLainfield 6-9000)
Dir.-Purch.: Paul H. Burbage
Sales Mgr., Mfg. Div.: Arthur Williams TR

CORNING GLASS WORKS
Corning, N. Y. (Tel. 2-5011)
Dir.-Purch.: T. S. Wood
Purch. Agent: Ralph Baker
Dir.-Mktg.: T. A. Kirkland
Sales Mgr.-Elec.: C. C. Harwood WN, MM

CORNISH WIRE CO. INC.
50 Church St., New York 7, N. Y. (Tel. BArclay 7-5140)
Purch. Agent: N. A. Brennan, 101 Water St., Williamstown, Mass. (Tel. GLenview 8-4111) MM

CORRUGATED PAPER PRODUCTS, INC.
2233 Utica Ave., Brooklyn, N. Y. (Tel. ESplamade 7-6112)
Pres.: J. Kapor

CORSON ELECTRIC MFG. CORP.
540 39th St., Union City, N. J. (Tel. UNion 6-4227)
Purch. Agent: Frank E. Oame
Sales: D. Corson

COSA CORP.
Chrysler Bldg., 405 Lexington Ave., New York 17, N. Y. (Tel. YUkan 6-9696)
Sales Mgr.: P. M. Aubry GS, TS, TR

COTO-COIL CO., INC.
65 Pavilion Ave., Providence 5, R. I. (Tel. WIlliams 1-3355)
Pres.: L. S. Bellem, Jr.
Treas. & Dir.-Sales: M. S. Musler

COUCH ORDNANCE, INC.
3 Arlington St., North Quincy, Mass. (Tel. BL 8-4147)
Purch. Agent: S. O. Bellis
Mgr.-Relay Div.-Sales: B. W. Gray GE, TR

COURTNEY & CO., INC.
1711 Walnut St., Philadelphia 3, Pa. (Tel. LOcust 7-1313)
Admin. Officer: Charles Wheeler R&O

COVEL MFG. CO.
P. O. Box 116, Graham Ave. at North Shore Dr., Bentan Harbor, Mich. (Tel. WAlnut 6-6157)
Purch. Agent: J. E. Schadler
Sales Mgr.: Elmer A. Hapf

COX & CO., INC.
115 E. 23rd St., New York 10, N. Y. (Tel. ORegon 4-4727)
Purch. & Prod. Mgr.: Edward Kraft
Dir.-Sales: Herbert M. Brusman

COX INSTRUMENTS DIV., GEORGE L. NANKERVIS CO.
15300 Fullertan, Oetrait 27, Mich. (Tel. VErmont 8-5780)
Purch. Agent: R. I. Pieti
Sales Mgr.: Robert Yung CO, TS

CRAIG SYSTEMS, INC.
360 Merrimack St., Lawrence, Mass. (Tel. MUrdock 8-6961)
Dir.-Purch.: Joseph L. Frost
Buyers: Miss Mildred Kazar & Barry Barker
Dir.-Sales Engrg.: Perry L. Nies GS

CRAMER CONTROLS CORP.
Centerbrook, Conn. (Tel. SOuth 7-8255)
Purch. Agent: R. W. Williams
V. P. & Dir.-Sales: W. H. Armstrong GS

CRANE CO.
836 S. Michigan Ave., Chicago 5, Ill. (Tel. WA 2-3123)
Mgr.-Chem. Mdsg.: J. E. Bradbury GS, GH

CRANE CARRIER CORP.
1150 N. Pearia, Tulsa, Okla. (Tel. LUther 3-5133)
V. P.-Purch.: W. T. Barber
Gen. Sales Mgr.: William Shames GS, GH

CRANE PACKING CO.
6400 Oakton St., Morton Grove, Ill. (Tel. ORchard 4-0100)
Purch.: Victar Gargleth
Buyers: William Parlette & Harry Schnur
V. P.-Sales: V. E. Varhees

CRATEX MFG. CO.
1600 Rollins Rd., Burlingame, Calif. (Tel. OXford 7-1600) MM

CRESCENT ENGRG. & RESEARCH CO.
5440 N. Peck Rd., El Monte, Calif. (Tel. GIlbert 4-0528)
Purch. Agent: J. Wackerman
Sales Mgr.: Scott B. Linn
PS, GS, GE, CO, TS, TR

CROLL-REYNOLDS CO. INC.
759 Central Ave., Westfield, N. J. (Tel. AD 2-4200)
Purch. Agent: C. D. Van Duzer R&D

CROMER MFG. & ENGRG., INC.
2138 E. 88th St., Las Angeles 2, Calif. (Tel. LUdlow 2-5383)
Purch. Agent: Mildred Hilgardner
Plt. Supt.: Darrel L. Sewart
V. P.-Chg. Sales: Harry S. Green MF, PS, GS, GH

CROMPTON & KNOWLES CORP.
93 Grand, Worcester, Mass. (Tel. PL 3-5431)
Purch. Agent: Joseph J. Benait
Mgr.-Special Mfg. Dept.: R. J. McGivney MF

CRONAME INC.
6281 Howard, Chicago 48 (Niles), Ill. (Tel. SPring 4-2100)
Dir.-Purch.: Arthur J. Dahlgren
V. P.-Sales: Anthany F. Nosek MM

CROSBY LABORATORIES, INC.
299 Robbins Lane, Syosset, N. Y. (Tel. WElls 1-3191)
Purch. Agent: Samuel George
Liaison Engr.: Franklin J. White R&D

CROUSE-HINDS CO.
Walf & 7th North Sts., Syracuse, N. Y. (Tel. GR 4-8411)
Purch. Agent: John Link
Asst. Purch. Agents: Paul Billy, Frank Eagan, Robert Gardner, Floyd Spaulding
Mgr.-Procurement: M. D. Law
V. P.-Sales: E. R. Manesmith GS

CROWN CONTROLS CO., INC.
40-44 S. Washington, New Bremen, O. (Tel. 2311)
Dir.-Purch.: Harry Gilbert
Contract Sales Mgr.: Ernest Jamesan GS, GH

CROWN MFG. CORP.
33 Pequat Ave., New Landan, Conn. (GI 2-4325)
Office Mgr.: Harry Ali
Treas.: T. Kelly Parker MM

CRUCIBLE STEEL CO. OF AMERICA
P. O. Box 2518, Oliver Bldg., Pittsburgh 30, Pa. (Tel. ATlantic 1-3800)
Dir. Purch.: R. O. Bridge
V. P.-Sales: G. W. Stamm MF, WN, MM

CRYSTAL-X CORP.
112 W. Lenni Rd., Lenni Mills, Pa. (Tel. GLabe 9-1000)
Sales Mgr.: W. H. Seiler WN, MM

CUBIC CORP.
5575 Kearny Villa Rd., San Diego 11, Calif. (Tel. BRowning 7-6780)
Dir.-Purch.: John C. Buchan
Buyers: George Oatsan & Gussie Seeley
Sales Mgr.: Oanald E. Raat TR

CUMMINS ENGINE CO., INC.
1000 Fifth St., Columbus, Ind. (Tel. ORexel 2-7211)
Gen. Purch. Agent: R. W. McNealy
Asst. Gen. Purch. Agent: J. A. Beaman
V. P.-Sales: C. R. Ball GS

JAMES CUNNINGHAM SON & CO., INC.
33 Litchfield, Rochester 8, N. Y. (Tel. BAker 5-7240)
Purch. Agent: James Elliott
Sales: Peter F. Cunningham
Chief Engr.: A. W. Vincent GS, CO, TS, TR

CUNO ENGRG. CORP., THE
S. Vine St., Meriden, Conn. (Tel. BEverly 7-5541)
Purch. Agent: Fred Gagnier
V. P.-Sales: Walter Holder
MF, WN, PS, GS, GH, GE, CO, TR

CURTIS AUTOMOTIVE DEVICES, INC.
P. O. Box 297, Westfield, Ind. (Tel. 3-2415)
Purch.: Dale Stevens
V. P.-Sales: E. H. Hostettler PS, GS, GH

CURTIS UNIVERSAL JOINT CO., INC.
5A Birnie Ave., Springfield 7, Mass, (Tel. RE 7-0281)
Sales: T. B. Cavanaugh
Purch.: R. E. Curtis MM

CURTISS-WRIGHT CORP.
Valley Blvd., Wood-Ridge, N. J. (Tel. WEbster 3-0800)
Chrm. & Pres.: Roy T. Hurley

CURTISS-WRIGHT CORP., ELECTRONICS DIV.
631 Central Ave., Carlstadt, N. J. (Tel. GEneva 8-4000)

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

Purch. Mgr.: F. L. Nicholls
Buyer-Sheet Metal: John Kroll
Buyer-Subcontract: C. D. Post
Buyer-Resistors, Relays, Rheostats: C. Guerriere
Buyer-Tubes, Rectifiers, Knobs, Switches: R. Cucci
Buyer-Machined Parts, Gears, Raw Materials, Plating & Finishing: A. Protono
Dir.-Sales: Charles O. Cary
PS, GS, GE, CO, TS, TR

CURTISS-WRIGHT CORP., INDUSTRIAL & SCIENTIFIC PROOUCTS DIV.
P. O. Box 110, Princeton, N. J. (Tel. SWinburne 9-0500)
Supvr.-Purch.: V. L. Croal
Gen. Mgr.-Sales: H. S. Bamford
GS, GH, GE, CO, TS, TR

CURTISS-WRIGHT CORP., MARQUETTE OIV.
1145 Galewood Dr., Cleveland 10, O. (Tel. GLenville 1-4800)
GS, GH, MM

CURTISS-WRIGHT CORP., PRINCETON OIV.
P. D. Box 110, Princeton, N. J. (Tel. SWinburne 9-0500)
Purch. Agent: Victor Croal
Mgr.-Radiographic Sales: James Commins
Mgr.-Ultrasonic Sales: William F. Smith TS

CURTISS-WRIGHT CORP., PROPELLER OIV.
Caldwell, N. J. (Tel. CApital 6-2540)
Mgr.-Purch.: W. B. Thompson
Purch. Agent: C. V. Cross
Sales Mgr.: H. S. Robbins PS

CURTISS-WRIGHT CORP., RESEARCH OIV.
Quehanna, Pa. (Tel. AMherst (Frenchville) 3-4711)
Purch. Agent: D. Bottenus
Asst. Purch. Agent: F. B. McBride
Buyers: J. Auman & D. Sicktich
Sales Mgr.: A. M. Weis PS, GH, R&O

CURTISS-WRIGHT CORP., SANTA BARBARA DIV.
P. O. Box 689, Santa Barbara, Calif. (Tel. WOodland 7-3411)
Oir.-Purch.: P. J. Canavan MF, GS, TS, R&O

CURTISS-WRIGHT CORP., SOUTH BENO DIV.
701 W. Chippewa Ave., South Bend, Ind. (Tel. ATlantic 9-7192)
Mgr.-Purch.: G. R. Quilhot
Chief Buyer: J. L. LaVine
Gen. Sales Mgr.: Robert Campello
MF, WN, GS, GH, MM, R&D

CURTISS-WRIGHT CORP., UTICA OIV.
50500 Mound Rd., Utica, Mich. (Tel. REpublic 2-2111)
Purch. Mgr.: A. T. Holland
Asst. Sales Oir.: G. S. Moule

CURTISS-WRIGHT CORP., WRIGHT AERONAUTICAL OIV.
Wood-Ridge, N. J. (Tel. PRescott 7-2900)
Dir.-Purch.: James R. Donahue
Oir.-Sales: J. V. Miccio PS, R&O

CURTISS-WRIGHT ELECTRONICS OIV., IMI BRANCH
P. O. Box 8324, 4401 Lunada S. E., Albuquerque, N. M. (Tel. AMherst 8-8791)
Purch. Agent: Hoyt S. Westcott
Branch Mgr.: John F. Quirk
Branch Sales Mgr.: Victor V. Myens
GS, CO, TS, TR, R&O

CUSHMAN PRECISION INOUSTRIES
262 Alexander St., Princeton, N. J. (Tel. WAlnut 1-7008)
Dir.-Purch.: Irving Gemmell
Pres.: Robert H. Cushman TS, TR, R&D

CUSTOM COMPONENTS, INC.
P. D. Box 248, Caldwell, N. J. (Tel. CAldwell 6-3403)
Sales: Harold I. Danziger TR

CUTLER METAL PROOUCTS CO.
1025 Line St., Camden, N. J. (Tel. WOodlawn 3-1060)
V. P.-Purch.: Irving Shipkin
Pres.: Harry H. Cutler

CUTLER-HAMMER INC.
212 N. 12th St., Milwaukee 1, Wisc. (Tel. BRoadway 1-7800)
Oir.-Purch.: B. M. Horter
Purch. Analyst: C. N. Harwood
Buyers: J. A. Twet, J. R. Leedom, W. L. Gaulke
V. P.-Mktg.: J. M. Cook WN, GS, GH, CO, TS

CYCLE TRANSFORMER CORP.
356 Glenwood Ave., East Orange, N. J. (Tel. ORange 4-0731)
Purch. Agent: J. U. Dion
Chief Engr.: H. Edgar Snow
Sales Engr.: Paul M. Brubaker
GS, GE, CO, TS, TR

OBM RESEARCH CORP.
Stoddard Bldg., Atlantic Ave., Cocoa Beach, Fla. (Tel. SUnset 3-2438)
Mgr.-Purch. Oept.: Cliff E. Mattox TS, TR, MM, R&D

O K MFG. CO.
5059 S. Kedzie, Chicago 32, Ill. (Tel. RE 7-3311)
Purch. Agent: Ted Kwasnik
Sales Mgr.: John Ferdinandsen MF, PS, GS, GH

O & R, LTD.
402 E. Gutierrez St., P. O. Box 1500, Santa Barbara, Calif. (Tel. WDodland 5-4511)
Purch. Agent: C. E. Schaefer
V. P.-Purch.: E. D. Sperry
Sales Mgr.: J. A. Moseley
PS, GS, GE, CO, TS, TR

O & R PILOT PLANTS INC.
Water St., Hazardville, Conn. (Tel. Riverview 9-8303)
Oir.-Sales: M. Mead
Group Leaders: H. S. Schnitzer & S. B. King MM

O. S. D. MFG. CO., THE
2964 Whitney Ave., Hamden, Conn. (Tel. ATwater 8-1678)
Wks. Mgr. & Secy.: William J. Devin MF, PS, GS

DAGE ELECTRIC CO., INC.
67 N. 2nd St., Beach Grove, Ind. (Tel. STate 6-0458)
Purch. Agent: Roger Mays
Gen. Mgr.: Calvin J. Zehr GE, TR

DAGE TELEVISION OIV., THOMPSON RAMO WOOLORIDGE, INC.
West 10th St., Michigan City, Ind. (Tel. TR 4-3251)
Purch. Agent: W. E. Dillon GS, TR, R&O

OAHLSTROM METALLIC DOOR CO.
443 Buffalo St., Jamestown, N. Y. (Tel. 7991)
Dir.-Purch.: Henry N. Ericson
V. P.-Sales: Carl T. Bergstrom

DAKOTA ENGRG., INC.
4315-4317 Sepulveda Blvd., Culver City, Calif. (Tel. TExas 0-7983)
Sales Mgr.: Betty Boundy MF, PS, GS, GH, GE, TR

DALE PROOUCTS, INC.
P. O. Box 136, Columbus, Nebr. (Tel. LOcust 4-3131)
Purch. Agent: Wallace Brunken
V. P.-Sales: Don Geeding
MF, WN, PS, GS, GH, GE, CO, TS, TR

OALMO VICTOR CO., DIV.-TEXTRON INC.
1515 Industrial Way, Belmont, Calif. (Tel. LYtell 1-1414)
Purch. Agent: Ralph Brown
Supt.-Outside Procurement: Bill Wurfer
Buyer-Electronic Components: Mike Lichtenstein
Buyer-Electrical Supp., Bearings: Hal Amberg
Buyer-Maintenance, Machine Tools, Equip.: Al Viano
Buyer-Stationary, AN Hardware & Fittings, Raw Materials: Ken Irwin
Oir.-Sales: George C. Stewart
MF, WN, PS, GS, GE, CO, TS, TR

OALMORE CORP.
47 Prospect St., Woburn, Mass. (Tel. WElls 3-5390)
Purch. Agent: R. A. Joyce
MF, WN, PS, GS, GE, TR

DALMOTOR OIV., YUBA CONSOLIOATED INDUSTRIES, INC.
1375 Clay St., Santa Clara, Calif. (Tel. CHerry 3-9414)
Purch. Agent: H. Walraven
Sales Mgr.: J. Booth
GS, GH, GE, CO, TS, TR, R&O

DALWELD CO. INC.
15 Bertel Ave., Mt. Vernon, N. Y. (Tel. MDunt Vernon 4-8698)
Pres.: Jerry Robinson MM

DAMASCUS TUBE CO.
P. O. Box 71, Greenville, Pa. (Tel. Transfer, Pa., Mitchell 6-1500)
Purch. Agent: J. M. Thompson
Sales Mgr.: Walter J. Erdell MM

DAMPP-CHASER, INC.
1440 Ridgewood Blvd., Hendersonville, N. C. (Tel. OXford 3-8271)
Purch.: B. Oalton
Sales Mgr.: O. Jack Buckley MM

OANBURY CENTERLESS GRINOING CO.
Rt. 7, Sugar Hollow Rd., Oanbury, Conn. (Tel. PI 3-5525)
Gen. Mgr.: George P. Valluzzo
Office Mgr.: Anthony F. Asmar MM

C. R. DANIELS, INC.
Oaniels, Md. (Tel. ELlicott City 1200)
Purch. Agent: D. H. Kelley
Buyers: W. L. Young, F. J. Trumpbour & J. Russell
V. P.-Sales: W. E. Carson
GS, GH, TR

DANLY MACHINE SPECIALTIES, INC.
2100 S. Laramie Ave., Chicago 50, Ill. (Tel. BIshop 2-1800)
Purch. Agent: Paul R. Fields
Asst. Purch. Agent: Donald McGibbon
Buyer: William Gardner
V. P.-Press Sales: D. R. Oanly
V. P.-Sales, Die Makers Supp.: R. E. Danly
MF, WN, PS, GS, GH, TS

DANTE ELECTRIC MFG. CO.
Marne Park, Bantam, Conn. (Tel. Litchfield, JOrdan 7-5307)
Gen. Mgr.: Joseph J. Dante

OARCOIO CO, INC., THE
145 6th Ave., New York 13, N. Y. (Tel. ALgonquin 5-1393)
Gen. Mgr.: Peter J. Digilio MF, PS

DARLING VALVE & MFG. CO.
Foot of Walnut, Williamsport, Pa. (Tel. 3-6121)
Oir.-Sales: D. F. Sable
Sales Admin. Mgr.: H. B. Foster

DARNELL CORP. LTD.
37-28 61 st St., Woodside 77, N. Y. (Tel. HAvemeyer 4-3717)
Sales Mgr.: A. L. Foster
Div. Sales Mgr.: R. J. Geberth GH

DATA INSTRUMENTS DIV.-TELECOMPUTING CORP.
12838 Saticoy St., North Hollywood, Calif. (Tel. STanley 7-8181)
Purch. Agent: Jim Newton
Dir.-Sales: Robert E. Poole CO, TS, TR, R&D

DATA-CONTROL SYSTEMS INC.
39 Rose St., Danbury, Conn. (Tel. Pioneer 3-0241)
V. P.-Operations: W. E. Estelle
Sr. Buyer: Joseph Rowlins
Acting Sales Mgr.: Robert J. Jeffries
GS, GH, GE, CO, TS, TR, R&D

DATASCAN INC.
48 Notch Rd., Little Falls, N. J. (Tel. CL 6-0077)
Dir.-Purch.: Mrs. W. Morris GS, CO, TS

DATEX CORP.
1307 S. Myrtle Ave., Monrovia, Calif. (Tel. ELliot 9-5381)
Chief Buyer: Richard V. Ireland
Buyer: J. P. Ainsworth
V. P. & Sales Mgr.: John W. Bodnar
GS, GE, CO, TS, TR, R&D

OATRAN ELECTRONICS, OIV.-MID-CONTINENT MFG., INC.
1836 Rosecrans Ave., Manhattan Beach, Calif. (Tel. OSborne 5-7131)
Purch. Agent: Robert D. Errington
Gen. Mgr.: Allen J. Edwards
Chief Engr.: Richard E. George GS, CO, TS, TR

DAVEN CO., THE
Rt. 10, Livingston, N. J. (Tel. WYman 2-4300)
Dir.-Purch.: G. H. Newman
Buyers: A. M. Watkins, M. H. Scherr & I. Valentine
Sales Mgr.: E. L. Grayson
GS, GE, CO, TS, TR, R&D

DAVENPORT MFG. CO.
1713 N. Ashland Ave., Chicago 22, Ill. (Tel. DIckens 2-5620)
Treas.: A. W. Davenport TS, R&D

DAVIOSON MFG. CO., INC.
2223 Ramona Blvd., West Covina, Calif. (Tel. EDgewood 7-7281)
Purch. Agent.: O. A. Kidwell
Sales Mgr.: L. Van Valkenburg GS, GE, TS, R&D

DAVIS INSTRUMENTS
47 Halleck St., Newark, N. J. (Tel. HUmboldt 2-3660)
Purch. Agent: C. Freeman

OAVISON CHEMICAL CO.
Erwin, Tenn. (Tel. ERwin 2-1721)
Purch. Agent: A. Price
Dir.-Sales: T. C. Runion MM

J. H. DAY CO., THE, OIV.-THE CLEVELAND AUTOMATIC MACHINE CO.
4932 Beech St., Cincinnati 12, Ohio (Tel. RE 1-5300)
Purch. Agent: A. W. Niederhelman
Sales Mgr.: Jack Oiltz
V. P.-Sales: Martin Miller

OAY-RAY PROOUCTS, INC.
1133 Mission St., South Pasadena, Calif. (Tel. MUrray 2-1189)
Secy.-Treas.: Mrs. W. O. Adams

OAYSTROM INSTRUMENT, OIV.-DAYSTRDM, INC.
Archbald, Pa. (Tel. JErmyn 1100)

Dir.-Purch.: A. I. Manuel
V. P.-Sales & Contracts: Howard J. Wornken
MF, WN, PS, GS, GE, TR

DAYSTRDM PACIFIC DIV.-DAYSTRDM, INC.
9320 Lincoln Blvd, Los Angeles 45, Calif. (Tel. DRchard 4-7100)
Purch. Agent: Bernard A. Thompson
Sr. Buyers: Richard E. Sexton & Rex Ayares GE
Dir.-Sales: J. T. Cairns

DAYSTROM TRANSICDIL DIV., DAYSTRDM, INC.
Worcester, Montgomery County, Pa. (Tel. JUno 4-2421)
Dir.-Sales: G. Barnes Stevenson

DAYTDN AIRCRAFT PRDDUCTS, INC.
P. D. Box 8007, 812 N. W. First St., Ft. Lauderdale, Fla. (Tel. JAckson 3-5451)
Dir.-Purch.: H. A. Cline
Dir.-Engrg.: A. J. Benkoczy
Dir.-Sales: J. H. Sampson GE, TS, TR, R&D

DAYTON AVIATIDN RADID & EQUIPMENT CDRP.
Box 258, Troy, Ohio (Tel. FEderal 2-5513)
Purch. Agent: Earl Bolger
Military Mgr.: Ralph D'Connor
Sales Mgr.: E. Polonsicy GE, TS, R&D

DAYTON RUBBER CO., THE
2345 Riverview Ave., Dayton 1, Ohio (Tel. CRestview 8-2666)
Dir.-Purch.: L. J. Keyes
Buyers: R. P. Heist, R. A. Greenwold, J. B. Cochenour & B. Rhines WN, GS, MM, R&D

DAYTRONIC CORP.
216 S. Main St., Dayton 2, D. (Tel. BAldwin 3-7618)
Prod. Mgr.: W. R. Winger
Chief Engr.-Purch.: R. M. Kinkead
Dir.-Sales: M. M. Moorhead, Jr. PS, CO, TS

DEAN & BENSON RESEARCH, INC.
16 Richmond St., Clifton, N. J. (Tel. GRegory 1-1600)
Purch. Agent: Robert Bridge
Sales Mgr.: Richard Portafee
Plant Mgr.: Joseph Micko GS, GH, GE, TS, R&D

DEAN PRDDUCTS, INC.
616 Franklin Ave., Brooklyn 38, N. Y. (Tel. ST 9-5400)
V. P.-Sales: Rubin Roskin

DEARBDRN ELECTRONIC LABS.
1421 N. Wells St., Chicago, Ill. (Tel. WH 3-2412)
Purch. Agent: Gus Stamos
Gen. Mgr.: Roy Simpson
Sales Mgr.: Bill Cox GE, TR, R&D

DeBELL & RICHARDSDN INC.
Water St., Hazardville, Conn. (Tel. RIverview 9-8301)
Pres.: John M. DeBell
Sr. Group Leader: Arthur J. Worner TS, MM, R&D

DECISION INC.
4602 Red Bank Rd., Cincinnati 27, D. (Tel. BRamble 1-3200)
Pres.: Dliver P. Bardes R&D

DECKER CORP., THE
45 Monument Rd., Bala-Cynwyd, Pa. (Tel. GArfield 5-2300)
Dir.-Purch.: A. Richard Newhouse, Jr.
Dir.-Sales: Neil B. Harding
V. P.-Sales: Thomas W. Spirito
WN, PS, GE, TS, TR, R&D

DE ELECTRIC CO.
101 N. Paulina St., Chicago 22, Ill. (Tel. BElmont 5-5151)
Pres.: W. DeVerter
Purch. Agent: G. Porrish

DEJUR-AMSCO CDRP., ELECTRDNIC SALES DIV.
45-01 Northern Blvd., Long Island City 1, N. Y. (Tel. RAvenswood 1-4009)
Purch. Dir.: Peter Heaney
Indust. Sales Mgr.: N. J. Geldman GS, GE, CD, TR

DEL ELECTRDNICS CDRP.
121 Homestead Ave., Mt. Vernon, N. Y. (Tel. DWens 9-3232)
V. P.-Engrg.: H. J. DiGiovanni
V. P.-Research: R. Koufman MM, R&D

DELAVAN MFG. CD.
811 4th St., West Des Moines, Iowa (Tel. CR 4-1561)
Purch. Agent: W. E. Stroeber
Buyers: Robert Heles & Charles D'Brien
Gen. Sales Mgr.: J. D. Hopkins PS

DELCD RADID DIV.-GENERAL MDTDRS CDRP.
600 E. Firmin, Kokomo, Ind. (Tel. GLadstone 2-8211)
Purch. Agent: R. Hill, Jr.
Dir.-Sales & Engrg.: H. M. Stelzl
Gen. Sales Mgr.: D. A. Sandberg GS, GE

DELCO-REMY DIV., GENERAL MDTDRS CDRP.
1001 Columbus Ave., Andersan, Ind. (Tel. 5581)
Dir.-Purch.: F. E. Boze
Dir.-Sales & Engrg.: J. H. Bolles
GS, GE, CO, R&D

DELL OPTICS CO., LTD.
327 55th St., West New York, N. J. (Tel. UN 7-1599)
Dir.-Purch. & Sales: Peter F. Tralongo MM, R&D

DEL'S TUMBLING SERVICE
232 N. Rosemary St., Deerborn 6, Mich. (Tel. LDgan 2-5537)
Pres.: D. W. Dyer

DELSEN CORP.
719 W. Broadway, Glendale 4, Calif. (Tel. CHapman 5-6126)
Purch. Agent: H. A. Schnaeckel
Sales Mgr.: Nils G. Strid TS, R&D

DELTA CHEMICAL WDRKS, INC.
23 W. 60th St., New York 23, N. Y. (Tel. PLaza 7-6317)
Asst. Dir.-Purch.: P. K. Mossey
Comptroller: Max Lendner
MF, WN, PS, GS, GH, GE

DELTA DESIGN ENGINEERS, INC.
3163 Adams Ave., San Diego 16, Calif. (Tel. AT 3-3193)
Pres.: Trigg Stewart
V. P.: David P. Comey
Sales Mgr.: D. H. Evans, Jr. TS

DELTA PRDDUCTS DIV.-AIR ACCESSORIES, INC.
1400 Henderson St., P. D. Box 1440, Ft. Worth, Texas (Tel. EDison 5-3214)
Chief-Materials: Donald M. Miles
Purch. Agent: Thomas Swann
Asst. Purch. Agents: Marvin Thompson & Richard Long
Sales Mgr.: Ray Goudeau GS, GH, MM

DELUXE METAL PRODUCTS CD.
Warren, Pa. (Tel. 1791)
Purch. Agent: V. E. Finzer
Gen. Sales Mgr.: R. H. Hauser GH

DEMING CO., THE
South Broadway, Salem, Ohio
V. P.-Sales: R. F. Webber
Sales Prom. Mgr.: G. E. Trisler GS

DEMDRNAY-BONARDI
780 S. Arroyo Pkwy., Pasadena, Calif. (Tel. SYcamore 2-4142)
Dir.-Purch: Herbert J. McCann
Sales: M. G. Ekstrom GS, GH, CO, TS, TR, R&D

DENISON ENGRG. DIV., AMERICAN BRAKE SHOE CD.
1160 Dublin Rd., Columbus 16, D. (Tel. HUdson 8-1191)
Dir.-Purch.: G. T. Hoys
Gen. Sales Mgr.: R. H. Krepps
Dir.-Sales: Denison Neale GS, GH, TS

DENNIS CHEMICAL CD.
2701 Papin St., St. Louis 3, Mo. (Tel. PRospect 6-1868)
Purch. Agent: L. R. Pope
Sales Mgr.: Milton Carlie MM, R&D

DERINGER METALLURGICAL CDRP.
8131 Monticello Ave., Skokie, Ill. (Tel. DRchard 5-1030)
Pres.: Edwin F. Allison
Exec. V. P.: J. Porter Duell, Jr.
Purch. Agent: Quintin E. Wiersum
Sales Mgr.: Paul H. Loeffler MM

A.L. DERY & SDNS TDDL & DIE CO.
Main St., Pine Meadow, Conn. (Tel. FRontier 9-4951)
Sr. Partner: Aldege L. Dery
Jr. Partner: Edmund E. Dery
WN, GS, GH, GE, CO, TS, TR

DESIGNERS FDR INDUSTRY, INC.
4241 Fulton Pkwy., Cleveland, Ohio

DESMOND-STEPHAN MFG. CO., THE
Urbana, Ohio

DESOMATIC PRDDUCTS, INC.
1109 W. Broad St., Falls Church, Va. (Tel. JEfferson 3-9600)
Purch. Agent: M. W. Reed
Exec. V. P.-Sales: Gunnar C. F. Asker
GS, TS, R&D

DESTRDN CD.
1321 Flarwood Ave., Torrance, Calif. (Tel. FA 8-0579)
Gen. Mgr.: D. E. St. John GS, GE, CD, TS, TR

DETREX CHEMICAL INDUSTRIES, INC.
Box 501, Detroit 32, Mich. (Tel. TDwnsend 8-8600)
V. P.-Sales: W. F. Newbery GS, GH, MM

DETRDIT DIESEL ENGINE DIV.-GENERAL MOTDRS CDRP.
13400 W. Outer Dr., Detroit 28, Mich. (Tel. KE 1-7100)
Mgr.-Purch. & Prod.: John E. McKenna
Gen. Sales Mgr.: Robert E. Hunter PS

DETROIT HDIST & MACHINE CD.
8201 Morrow St., Detroit 11, Mich. (Tel. TR 5-8344)
Purch. Agent: J. S. Koloso
Sales Engr.: V. A. Fulton GH

DETRDNIC INDUSTRIES
33840 Plymouth Rd., Livonia, Mich. (Tel. GA 4-4700)
Dir.-Purch.: C. Miller
Dir.-Sales: J. M. Wheeler GE, TS, R&D

DEUTSCH FASTENER CDRP.
14504 S. Figueroa St., P. D. Box 61072, Los Angeles 61, Calif. (Tel. DAvis 3-6640)
Purch. Agent: A. Hicks
V. P. & Sales Mgr.: B. S. Souter MF, GS

DEVCO ENGRG. INC.
Pier Lane West, Caldwell, N. J. (Tel. CA 6-0610)
Purch. Agent: G. Schmidt
Sales: C. Allen
MF, WN, PS, GH, GE, CD, TS, TR

DEVCDN CDRP.
Endicott St., Danvers, Mass. (Tel. SP 4-1990)
Dir.-Sales: E. L. Hall MM

DEVELDPMENT ENGRG. CD., INC.
9 Cross St., Norwalk, Conn. (Tel. VDlunteer 6-7720)
Chief Engr.: Richard L. Seidman

DEVICE DEVELDPMENT CDRP.
428 Boston Post Rd., Weston 93, Mass. (Tel. TW 3-0300)
Dir.-Purch.: H. Stacey
Dir.-Sales: R. B. Holt GE, TR, R&D

DeVILBISS CO., THE
300 Phillips Ave., Toledo, D. (Tel. GReenwood 4-5411)
Mgr.-Adv. & Sales Prom.: H. A. Longe
MF, PS, GS, GH

DeWALT DIV., AMERICAN MACHINE & FDUNDRY CD.
Fountain Ave., Lancoster, Pa. (Tel. EXpress 3-5831)
V. P. & Gen. Sales Mgr.: Truman Janes
Purch. Agent: Frank Zecher MM

DeWITT DEVELDPMENT CD.
3008 W. 127th St., Blue Island, Ill. (Tel. FUlton 8-2480)
Pres.: B. G. DeWitt MM

DIAL PRODUCTS CD.
9 Ave. "E", Bayonne, N. J. (Tel. HEmlock 7-0720)
V. P.-Purch.: Paul Schechter
Sales Mgr.: E. Koy PS, GS, GH, GE

DIALIGHT CORP.
60 Stewart Ave., Brooklyn 37, N. Y. (Tel. HYacinth 7-7600)
Purch. Agent: E. S. Formon
Sales: R. E. Greene GS, GH, GE, CD, TS, TR

DIAMOND ANTENNA & MICRDWAVE CDRP.
7 North Ave., Wakefield, Mass. (Tel. CRystal 9-4650)
Purch. Agent: William L. Page
Asst. Purch. Agent: William Rond
Gen. Mgr.-Sales: Albert S. Hovannesian
WN, PS, GE, CD, TS, TR

DIAMDND DRILL CARBDN CD., THE
244 Madison Ave., New York 16, N. Y. (Tel. LExington 2-3006)
Sales: Bernard Rhodes MM

DIAMONITE PRDDUCTS MFG. CD.
Shreve, Ohio (Tel. JD 7-4211)
Dir.-Purch.: R. J. Uhl
Sales Engr.: R. C. Mulligan MM

DI/AN CDNTRDLS, INC.
40 Lean St., Boston 15, Mass. (Tel. HIghlands 5-5640)

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

Purch. Agent: Walter A. Kaminski
Tech. Sales Mgr.: Nathan O. Sokal GS, CO, TS

J. W. DICE CO.
16 Highwood Ave., Englewood, N. J. (Tel. LOwell 9-0471)
Chief Engr.: M. Strain
Purch. Agent: E. Franz
Sales: E. Van Ressel TS

DIEHL MFG. CO.
1224 Finderne Ave., Somerville, N. J. (Tel. RAndolph 5-2200)
Purch. Agent: F. Boyne
V. P.-Sales: A. R. Booth GE

DIELECTRIC MATERIALS CO.
5315-17 N. Ravenswood Ave., Chicago 40, Ill. (Tel. LOngbeach 1-5833)
Purch. Agent: O. C. Muenzer
Asst. Purch. Agent: Charles Kling MM

HENRY G. DIETZ CO., INC.
12-16 Astoria Blvd., Long Island City 2, N. Y. (Tel. RAvenswood 6-3347)
Pres.: Henry G. Dietz
Secy.: M. Pheasey GS

DIETZ DESIGN & MFG. CO.
Grandview, Mo. (Tel. SOuth 1-7216)
Purch. Agent: L. M. Dietz
Sales Mgr.: E. C. Dietz GE, TR

DIGITRONICS CORP.
Albertson Ave., Albertson, N. Y. (Tel. PI 7-5090)
Purch. Agent: Angelo Targia
V. P.-Sales: Eugene Leonard GS, CO

DILECTRIX CORP.
Allen Blvd., Farmingdale, L. I., N. Y. (Tel. CHapel 9-7999)
Purch. Agent: M. Petriello
Sales Mgr.: M. Zangrillo MF, PS, GE, TR

W. C. DILLON & CO., INC.
14620 Keswick St., Van Nuys, Calif. (Tel. STate 5-3168)
Purch. Agent: Earl O. Roberts
Sales Mgr.: George A. Dillon TS, MM

DIMCO-GRAY CO.
207 E. 6th St., Dayton 2, O. (Tel. BAldwin 2-6703)
Purch.: J. O. Gray
Sales Mgr.: C. F. Dearth MF, PS, GS, GE, CO

DINION COIL CO., INC.
North St., Caledonia, N. Y. (Tel. KEystone 8-4412)
Purch. Agent: R. S. Eldridge
V. P. & Sales Mgr.: E. J. Holland GE

DIRILYTE CO. OF AMERICA, INC.
P. O. Box 747, 1142 S. Main St., Kokomo, Ind. (Tel. GLadstone 2-5688)
V. P. & Secy.: Robert R. Arnett MF, MM

DIT-MCO, INC., ELECTRONICS DIV.
911 Broadway, Kansas City 5, Mo. (Tel. HArrison 1-8484)
Purch. Agent: William O. Britt
V. P.-Mktg.: W. W. Hannon GS, GH, CO, TS

DIVCO-WAYNE ELECTRONICS DIV., DIVCO-WAYNE CORP.
9701 Reading Rd., Cincinnati 15, Ohio (Tel. POplar 1-0010)
Purch. Agent: T. C. Grote
Dir.-Sales: Gene Rove GE, TS, TR, R&D

DIVERSEY ENGRG. CO.
10550 W. Anderson Place, Franklin Park, Ill. (Tel. GLadstone 1-0200)
Purch. Agent: Walter Kloske
Asst. to Pres.: John Switack
MF, WN, PS, GS, GH, GE, MM, R&D

DIVISION LEAD CO.
7742 W. 61st Place, Summit, Ill. (Tel. Chicago—REliance 5-8600)
Purch. Agent: Mary J. Spocek MM

DIXON CORP.
19-21 Burnside St., Bristol, R. I. (Tel. CLifford 3-7500)
Purch. Agent: Gerald Almeida
V. P.-Sales: John M. Feeley MM

DOCKENDORFF & CO. INC.
606 Lindley St., Bridgeport 6, Conn. (Tel. ED 4-7329)
Purch. Agent: J. M. Dockendorff
Sales Mgr.: W. M. Bacon MM

DODGE MFG. CORP.
S. Union St., Mishawoka, Ind. (Tel. BLackburn 9-2421)
V. P.-Prod. & Purch.: Earl Wedlake
Dir.-Prod. & Purch.: Donald Saunter
Purch. Agent: Edwin Rhodes
Asst. Purch. Agent: Clifford Miller
Steel Buyer: Clifford Mechling
V. P.-Sales: Harry A. Torson GS, GH, GE

DODGE STEEL CO.
6501 State Rd., Philadelphia 36, Pa. (Tel. OEvonshire 2-2200)
Purch. Agent: R. Miller
Sales Mgr.: Morris Neeley

DOEHLER-JARVIS DIV., NATIONAL LEAD CO.
1945 Smead Ave., Toledo 1, Ohio (Tel. CHerry 4-9521)
Purch. Agent: Miss N. DiPersia
Mgr.-Sales: F. W. Burgie MM

DOLGORUKOV MFG. CO.
407 Fisher Bldg., Detroit 2, Mich. (Tel. TR 1-6383)
Dir.-Sales: Gregory S. Dolgorukov R&O

DOLINKO & WILKENS, INC.
1907 Summit Ave., Union City, N. J. (Tel. UNion 7-6630)
V. P.: Louis Dolinko GE, TR

DOLLIN CORP.
600 S. 21st St., Irvington, N. J. (Tel. ESsex 4-3000)
V. P.-Sales: Gordon C. Curry

DONNER SCIENTIFIC CO.
888 Galindo St., Concord, Calif. (Tel. MUlberry 2-6161)
Purch. Agent: W. H. Burr, Jr.
Dir.-Mktg.: Gene Hopkins GS, GE

DORNE & MARGOLIN, INC.
29 New York Ave., Westbury, L. I., N. Y. (Tel. EDgewood 4-3200)
Purch. Agent: J. Escalette
Buyer: O. M. Portocarrero
Sales Supvr.: David L. Ward GS, GE, TR

DORSETT LABS., INC.
P. O. Box 862, 401 E. Boyd St., Norman, Okla. (Tel. JEfferson 4-3750)
Secy.: H. L. Munde
Purch. Agent: O. K. Simpson
V. P.-Sales: O. G. Wantland TR, R&D

DORSEY TRAILER
401 Hickman, Elba, Ala.

DOTY ACOUSTICA ELECTRONIC LABS.
Tobyhanna, Pa. (Tel. TW 4-8117)
Engr.-Purch.: Jose Masri GE, TS

DOUBLE "E" PRODUCTS CO.
208 Standard St., El Segundo, Calif. (Tel. EAstgate 2-2501)
Purch. Agent: Stanley S. Trier
Sales Mgr.: J. S. Trier PS, GS, GH, GE, CO, TS

DOUGLAS AIRCRAFT CO., INC.
3000 Ocean Park Blvd., Santa Monica, Calif. (Tel. EXbrook 9-9311)
Dir.-Materiel: W. E. Doran
V. P.-Sales: N. Paschall
MF, GS, GH, CO, TS, TR, MM, R&D

DOUGLAS MICROWAVE CO., INC.
252 E. Third St., Mt. Vernon, N. Y. (Tel. MOunt Vernon 8-6900)
Purch. Agent: Leonard G. Geier
Sales Mgr.: Herbert M. Hendlin R&D

TURNER F. DOW
261 Oakridge Dr., Rochester 17, N. Y.
Turner F. Dow

DOW CHEMICAL CO., THE
Midland, Mich. (Tel. MElrose 6-1000)
Dir.-Purch.: M. E. Lefevre
Dir.-Sales: D. K. Ballman

*DOW CORNING CORP.
Midland, Mich. (Tel. TEmple 2-2371)
Mgr.-Purch. & Stores: O. R. Coultrip
V. P. & Sales Mgr.: O. D. Blessing MM
*(See Page 10 for Advertisement)

DOW-ELCO, INC.
1313 W. Olympic Blvd., Montebello, Calif. (Tel. RAymond 3-1288)
Pres.: J. W. Eldridge GS, GH

DOWELL DIV.-THE DOW CHEMICAL CO.
P. O. Box 536, Tulsa, Okla. (Tel. RI 2-5501)
Chief Purch. Agent: V. M. Lewis
Dir.-Sales: R. H. Smith

DOYLE & ROTH MFG. CO., INC.
136 S. Twenty Fourth St., Brooklyn 32, N. Y. (Tel. SOuth 8-3800)
Purch. Agent: Richard Zino
Sales Mgr.: Richard S. Holl

B. F. DRAKENFELD & CO., INC.
Box 519, Washington, Pa. (Tel. BAldwin 5-5600)
Purch. Agent: F. K. Eakin
V. P.-Sales: Irwin F. Zeiller MM, R&D

DRAYER-HANSON DIV., NATIONAL-U. S. RADIATOR CORP.
P. O. Box 2215, Terminal Annex, Los Angeles 54, Calif. (Tel. ANgelus 9-0321)
Purch. Agent: E. E. Petro
Sales Mgr.: I. B. Secord GS

DREMEL MFG. CO.
2420 18th St., Racine, Wisc. (Tel. MElrose 3-8267)
E. A. Erdman GS

DRESSEN-BARNES CORP.
250 Vinedo Ave., Pasadena, Calif. (Tel. RYan 1-0643)
Sales Mgr.: George A. Hall GS

DRESSER ELECTRIC CO.
2705 Wight St., Detroit 7, Mich. (Tel. LOrain 8-1855)
Purch. Agent: A. J. Hluylaert
Sales Dir.: O. P. Friedt GS

DRESSER INDUSTRIES, INC.
Republic Natl. Bank Bldg., Dallas, Tex. (Tel. RIverside 8-6411)
Dir.-Purch.: Robert C. Kelley
Asst. Dir.-Purch.: Robert D. Crane
GS, GH, CO, TS, MM, R&D

DRESSER MFG. DIV., DRESSER INDUSTRIES, INC.
41 Fisher Ave., Bradford, Pa. (Tel. BRadford 3131)
Acting Purch. Mgr.: G. G. Thomas
Supvr.-Purch.: W. L. Dawson
Sales Mgr.: George R. Leonard MF, WN, PS, MM

DRESSER-IDECO CO., DIV.-DRESSER INDUSTRIES, INC.
875 Michigan Ave., Columbus 8, Ohio (Tel. AXminster 9-2123)
Dir.-Purch.: Leo Wildermuth
Asst. Purch. Agent: E. L. Frey GS, GH, TR

DRIAIRE, INC.
132 S. Main St., South Norwalk, Conn. (Tel. TEmple 8-0686)
Mgr.-Purch.: M. S. Miller
Mgr.-Prod.: R. W. Haines
Mgr.-Maintenance: J. Hollis
Mgr.-Sales: J. H. Donovan MM

WILBUR B. DRIVER CO.
1875 McCarter Hwy., Newark 4, N. J. (Tel. HUmboldt 2-5550)
Purch. Agent: Edwin J. Looges
Asst. Purch. Agent: Arthur Knittel
V. P.-Sales: Norman P. Narlie MM

DRYOMATIC CORP.
806 N. Fairfax St., Alexandria, Va. (Tel. KIng 9-3060)
Purch. Agent: C. E. Wells
Sales Mgr.: Anthony Hass GS, GH

DU-CO CERAMICS CO.
Box 278, Saxonburg, Pa. (Tel. FL 2-1511)
Pres.: John J. Duke MM, R&D

M. DUCOMMUN CO.
580 Fifth Ave., New York 36, N. Y. (Tel. PLaza 7-2540)
Mgr.: A. G. Stepchuk GE, CO, TS

R. C. DUDEK & CO.
407 N. Maple Dr., Beverly Hills, Calif. (Tel. BRadshaw 2-8097)
Richard C. Dudek GS, GE

DU KANE CORP.
St. Charles, Ill. (Tel. 2300)
Purch. Mgr.: E. E. Swick
Purch. Agent: R. H. Magden
Mgr.-Govt. & Contract Div.: R. W. Robbins
GS, GE, CO, TS, TR

DUKES CO., INC
3999 N. 25th Ave., Schiller Park, Ill. (Tel. GLadstone 5-5795)
Purch. Agent: G. Tidd
Sales Mgr.: J. C. Wetter GS, GH

DUMONT AIRCRAFT FITTING CO.
1401 Freeman Ave., Long Beach 4, Calif. (Tel. GE 3-4931)
Gen. Mgr.: Harry Pahner
Buyers: Helen Heffman & Shirley Wedekind
Sales Mgr.: Fritzie Williams
MF, WN, PS, GS, GH, GE, MM

DUMONT AVIATION ASSOCIATES
1401 Freeman Ave., Long Beach 4, Calif. (Tel. 3-4931)
Purch. Agent: George MacRae
Buyer: Pat Welsh
Sales Mgr.: E. J. Easterbrook
MF, WN, PS, GS, GH, TS, TR

DUNBAR-KAPPLE INC.-AIRCRAFT COMPONENTS DIV.

Island Ave., Batavia, Ill. (Tel. BAtavia 5400)
Mgr.-Procurement: E. Ricker
Buyer: J. Vanliersburg
Sales Mgr., Aircraft Div.: H. M. Lockhart
MF, GS, R&D

DUNHAM-BUSH INC.
West Hartford, Conn. (Tel. CHapel 9-8671)
V. P.-Purch.: Frank Carney
Purch. Agent: T. Logan
V. P.-Sales: J. A. Mulcahey GS, GE

DUNLAP & ASSOCIATES, INC.
429 Atlantic St., Stamford, Conn. (Tel. FIreside 8-9271)
Treas.: A. M. Miller
V. P.: H. E. Blank, Jr. R&D

M. W. DUNTON CO. INC., THE
No. 7 Goff St., Providence, R. I. (Tel. DExter 1-3600)
V. P. & Gen. Mgr.: Raymond T. Wilber MM

DUOTONE CO., INC.
Locust St., Keypart, N. J. (Tel. CDlfax 4-2200)
Pres.: Stephen Nester
V. P.-Purch.: B. Rosenberg

E. I. DU PONT DE NEMOURS & CO. INC.
2537 Nemours Bldg., Wilmington 98, Del. (Tel. PRospect 4-3373)
Purch. Agent: E. N. Burlinson
Asst. Purch. Agent: W. Biongt
Sales: M. N. Nickowitz MM

E. I. DU PONT DE NEMOURS & CO. INC., PHOTO PRODUCTS DEPT.
Wilmington 98, Oel.
Dir.-Sales: H. L. Graham TS

DURACOTE CORP.
350 N. Diamond St., Ravenna, O. (Tel. AXminster 6-3487)
V. P.-Purch.: W. Randle Truog
Pres.: John B. Schneller MM, R&D

DURAKOOL, INC.
1010 N. Main St., Elkhart, Ind. (Tel. 3-3160)
Purch. Agent: J. B. Witcher
Sales & Product Mgr.: V. H. Hoehn GS, GH

DURALITH CORP.
1025 Race St., Philadelphia 7, Pa. (Tel. WAlnut 3-1900)
Gen. Sales Mgr.: Jack M. Smith MM

DURALOY CO., THE
Bridge St., Scottdale, Pa. (Tel. TUrner 7-5100)
Purch. Agent: B. W. Lydic
Gen. Sales Mgr.: Jack B. Dear

DURAMARK, INC.
2 Secatoag Ave., Port Washington, N. Y. (Tel. Port Washington 7-3232)
Purch. Agent: Mrs. Ada P. Schweder
V. P.-Sales: Andrew T. Callan

DURAMETALLIC CORP.
Factory St., Kalamazoo, Mich. (Tel. FI 3-2688)
Purch. Agent: Miss Fern Thrall
V. P. & Sales Mgr.: Roscoe R. Smith

DURAMIC PRODUCTS INC.
262-72 Mott St., New York 12, N. Y. (Tel. WAlker 5-1644)
Purch. Agent: C. Saso
Sales Mgr.: H. Schwartz MM

DURANT MFG. CO.
955 N. Buffum, Milwaukee 1, Wisc. (Tel. LOcust 2-5035)
Purch. Agent: A. M. Jones
Sales Mgr.: Robert B. Winkler CO, TS, TR

DUREZ PLASTICS DIV., HOOKER CHEMICAL CORP.
980 Walck Rd., North Tonawanda, N. Y. (Tel. LU 1860)
Purch. Mgr.: C. W. Selover
Gen. Sales Mgr.: A. W. Hanmer, Jr. R&D

DURO SPECIALTY CO., INC.
11 Boston St., Lynn, Mass. (Tel. LYnn 3-3585)
Purch. Agent: William I. Frankel
Sales Dir.: S. Joseph Hoffman MM

DYCHRO CORP.
2 Centre Ave., Newton 58, Mass. (Tel. OEcatur 2-7307)
Purch. Agent: Arthur A. Goldberg TR

DYMEC INC.
395 Page Mill Rd., Palo Alto, Calif. (Tel. DAvenport 6-1755)
Purch. Agent: Dale D. DeWitt
Mgr., Instrument Sales: E. C. Morgan GS, GE, CO, TS, TR

DYNACOR, INC.
10431 Metropolitan Ave., Kensington, Md. (Tel. LOckwood 4-8120)
Chief Purch. Agent: P. W. Waymoth
Buyer: Henry Veazey MM

DYNAMETRICS CORP.
N. W. Industrial Park, Burlington, Mass. (Tel. BRowning 2-1600)
Mfg. Mgr.: Fred Hugel
Buyer & Sub-Contract: Malcolm Winsor
Sales Mgr.: John F. Clough GS, CO, TS, R&D

DYNAMIC CONTROLS CO.
1955 Massachusetts Ave., Cambridge, Mass. (Tel. ELiot 4-3633)
Dir.-Purch.: L. J. Dougall
Dir.-Sales: J. J. Gano GS

DYNAMIC CONTROLS CORP.
30 Thomas St., E. Hartford, Conn. (Tel. BU 9-5906)
Purch. Mgr.: F. Roth
Gen. Mgr.: T. P. Farkas MF, WN, PS, GS, GH, R&D

DYNAMIC DEVICES, INC.
P. O. Box 843, Denville, N. J. (Tel. MI 2-7083)
V. P.-Purch.: John C. Stienberg
Pres.: C. E. Kastner, Jr. PS, GS, TS, R&D

DYNAMIC FILTERS INC.
2100 Howard St., Detroit 16, Mich. (Tel. TAshmoo 6-4107)
Purch. Agent: A. L. Pomaville
Dir.-Sales: Roy Okonski PS, TS, R&D

DYNAMIC GEAR CO., INC.
20 Merrick Rd., Amityville, L. I., N. Y. (Tel. AM 4-4788)
Purch. Agent: Jaques Edeline
Asst. Buyer: Adam Kuby
Sales Mgr.: Thomas J. Smith GE, TR, R&D

DYNAMIC INSTRUMENT CO., INC.
42 Carleton St., Cambridge 42, Mass. (Tel. UN 4-7260)
Of. Mgr.-Purch.: Dan Shea
Chief Engrg.: Harvey Paston PS, GE, CO, TS, TR

DYNAMIC INSTRUMENT CORP.
59 New York Ave., Westbury, L. I., N. Y. (Tel. EDgewood 3-1600)
Buyer: Robert J. Messina
Gen. Mgr.-Sales: Harold E. Sulger

DYNAMICS INSTRUMENTATION CO., DIV.-ALBERHILL CORP.
1118 Mission St., South Pasadena, Calif. (Tel. RY 1-3318)
Div. Mgr. & Purch. Agent: Nathan Brownstone
Sales Mgr.: O. E. Strickland
Mgr.-Mktg.: Geoffrey H. Grey R&D

DYNA-THERM CHEMICAL CORP.
3813 Hoke Ave., Culver City, Calif. (Tel. TExas 0-4751)
Purch. Agent: J. M. Maddock
V. P.-Sales: Larry Vernon
V. P.-Research: Jerry Gabriel MM, R&D

DYTRONICS CO.
P. D. Box 3676, Columbus 14, Ohio (Tel. AM 3-0890)
Dir.-Purch. P. Ryan
Sales Mgr.: K. Gregersen TS, R&D

EFCON (ELECTRONIC FABRICATORS, INC.)
682 Broadway, New York 12, N. Y. (Tel SPring 7-4900)
V. P.-Sales: Mitchel Samuels MM

ESC CORP.
534 Bergen Blvd., Palisades Park, N. J. (Tel. WIndsor 7-0400)
Purch. Agent: J. Curtin
V. P.-Sales: Stanley S. Pocker GE, CO, TS, TR

E-Z-HOOK TEST PRODUCTS
1536 Woodburn Ave., Covington, Ky. (Tel. COlonial 1-1495)
Sales Mgr.: Robert N Younger TS

E-Z WAY TEMPLATES
P. O. Box 535, Resedo, Calif.
Gen. Mgr.: W. Juran

EAGLE ELECTRIC MFG. CO. INC.
23-10 Bridge Plaza S., Long Island City 1, N. Y. (Tel. ST 4-9200)
Purch. Agent: I. Sobol
Asst. Purch. Agent: A. Feiner
Sales Mgr.: S. Jay Atkin

EAGLE OTTAWA LEATHER CO.
P. D. Box 308, Beachtree St., Grand Haven, Michigan (Tel. 8)
Purch. Agent: E. D. Harbeck
Sales Mgr.: Milto E. Burr

EAGLE-PICHER CO., THE
American Bldg., Cincinnati 1, O. (Tel. PArkway 1 7010)
Dir.-Sales: D R. Carter WN, GE, TR, MM, R&D

EAST COAST AERONAUTICS, INC.
10 Pelham Pkwy. Pelham, N. Y.

EAST DAYTON TOOL & DIE CO., THE
1425 Keowee St., Dayton 4, O.

EASTERN INDUSTRIES INC.
100 Skiff St, Hamden 14, Conn (Tel. CHestnut 8-3841)
Purch. Agent: C. Phillips
Asst. Purch. Agent: R. Jerzyk
Sales Mgr.: H. W. Whitaker MF, WN, GS, GH, GE, R&D

EASTERN JEWEL CORP.
Rego Park 74, N. Y. (Tel. BOulevard 1-8072)
Purch. Dept.: Melvin Marcus

EASTERN SMELTING & REFINING CORP.
109 W. Brookline St., Boston 18, Mass. (Tel CDmmonwealth 6-7504)
Treas.: Maurice G. Alperin
Comptroller: Frank E. Wondrey MM

EASTERN SPECIALTY CO., THE
3617 N. Eight, Philadelphia 40, Pa. (Tel. BAldwin 8-0500)
Dir.-Purch.: H. F. McGinley
Dir.-Sales: Edward P Cornely TS, MM

EASTERN STAINLESS STEEL CORP.
P. D. Box 1975, Baltimare 3, Md. (Tel. ATwater 8-2000)
Buyer: E. J. Thon
V. P.-Sales: R. C. Cunningham MF, PS

EASTMAN KODAK CO.
343 State St., Rochester, N Y. (Tel. LOcust 2-6000)
Stacey F. Oakes GS, GE, CO, TS, TR

EATON ELECTRONICS CORP.
Eaton Ave., Moodus, Conn. (Tel. TRiangle 3-8628)
Sales Mgr.: Joseph O. Eaton, Jr. GS, GE, TR

EATON MFG. CO.
739 E. 140th St., Cleveland 10, O. (Tel GLenville 1-5600)
Dir.-Purch.: H. A. Williams
Dir.-Sales: R. E. Fisher

EATON MFG. CO., AIRCRAFT DIV.
Avenue "C", Battle Creek, Mich. (Tel. WOodward 2-8751)
Purch. Agent: Robert Stevens
Sales Mgr.: Hol Reigner PS

EATON MFG. CO., RELIANCE DIV.
25 Charles Ave., S. E., Massillon, Ohio (Tel. TE 2-1511)
Div. Purch. Agent: J. W. Morton
Buyer: W. Matthey
Gen. Sales Mgr.: R. B. Little MM

EBERT ELECTRONICS CORP.
212-26 Jamaica Ave., Queens Village 28, N. Y. (Tel. SPruce 6-1800)
Purch. Agent: L. Mitchell
Sales Mgr.: V. Horowitz GS, GH, CO

ECKEL VALVE CO.
1425 First St., San Fernando, Calif. (Tel. EMpire 1-6251)
Purch. Agent: Edward Beinfest
Gen. Mgr.: J. R. Bly

ECKOL PACKAGING CO.
3001 W. Columbia Ave., Philadelphia 21, Pa. (Tel. STevenson 7-6172)
Purch. Agent: Rodger Weltman
Sales Mgr.: Herbert R. Locke MF, PS, GS, GH

ECO ENGRG. CO.
12 New York Ave., Newark 1, N. J. (Tel. MArket 4-6565)
Purch. Agent: Vernon Oavis
Sales Mgr.: Jomes Eisenberg GS, GH, MM, R&D

ECONOWELD CORP.
519 Hunter Ave., Dayton, O. (Tel. BAldwin 3-7295)
V. P.-Purch.: Bart Wilgus
Engr. Sales: C. A. Thomas GS, GH

ED-BERL PRODUCTS, INC.
96 S. Grand Ave., Baldwin, L. I., N. Y. (Tel. BAldwin 3-1636)
Dir.-Purch.: Fred W. Will
V. P.-Sales: Howard Kaufman R&D

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

EDCLIFF INSTRUMENTS
1711 S. Mountoin Ave., Monrovia, Calif. (Tel. ELliott 8-4S71)
Purch. Agent: John Smith
Mgr., Engrg. & Tech. Services: John R. Thompson
GS, GH, GE, CD, TS, R&D

EDDINGTON METAL SPECIALTY CO.
3088 Bristol Pike, Eddington, Pa. (Tel. MErcury 9-3600; ORchard 3-8383)
Purch. Agents: Walter V. Czarnecki, Jr., Casimer M. Czarnecki, Wesley Czarnecki, Stanley Czarnecki
Engr.-Sales: Richard Connell PS, R&D

EDER ENGRG. CO., INC.
1S68 S. First St., Milwaukee 4, Wisc. (Tel. EVergreen 3-3900)
Purch. Agent: Anthony J. Mis
Pres.: Harvey P. Eder TS, R&D

EDER INSTRUMENT CO. INC.
2293 N. Clybourn Ave., Chicago 14, Ill. (Tel. EAstgate 7-2131)
Sales: L. Streifeneder

EDGERTON, GERMESHAUSEN & GRIER, INC.
160 Brookline Ave., Boston 1S, Mass. (Tel. COpley 7-9700)
Dir.-Product Sales: R. L. Purrington, (Tel. COpley 7-9S40) GS, GH, TR, R&D

EDGEWATER STEEL CO.
Box 478, Pittsburgh 30, Pa. (Tel. OAkmont 280)
Purch. Agent: L. W. Engel
Asst. Purch. Agent: W. Schano
Gen. Mgr.-Sales: W. M. Cree
Mgr., Indsl. Sales: W. O. Fleming MM

EDIN, DIV.-EPSCD, INC.
207 Main St., Worcester 8, Mass. (Tel. PLeasant 7-8394)
Gen. Sales Mgr.: Daniel R. Berne TS, TR

THOMAS A. EDISON IND. INSTRUMENT DIV.-McGRAW-EDISON CO.
8S Lakeside Ave., W. Orange, N. J. (Tel. ORange 3-6800)
Purch. Agent: Alex N. Teilschak
Purch.: Horry Keirnan, Richord A. Brennan & Thomas M. Callahan
Gen. Sales Mgr.: George J. Bindewald GE, R&D

EDMUND SCIENTIFIC CO.
101 E. Gloucester Pike, Barrington, N. J. (Tel. LIncoln 7-3488)
Pres.: Norman W. Edmund

EDWARDS ENGRG. CO.
21 Yennicock Ave., Port Washington, N. Y. (Tel. PO 7-6700)
Gen. Mgr.: John E. Kane TS, TR

EICOR DIV.-SCRANTON
40S9 W. North Ave., Chicago, Ill. (Tel. HUmbolt 6-2060)
Purch. Agent: R. Farneti, 517 W. Walnut St., Oglesby, Ill. (Tel. 3-8453)

EIOAL MFG. CO., INC.
2S0 Woodward Rd., S. E., Albuquerque, N. M. (Tel. CHapel 2-S223)
Purch. Agent: W. A. Muff
V. P.-Sales: S. J. Woodin GH

EISLER ENGRG. CO., INC.
769 S. 13th St., Newark 3, N. J. (Tel. Bigelow 3-S310)
Pres.: Charles Eisler, Jr.

EITEL-McCULLDUGH, INC.
301 Industrial Way, San Carlos, Calif. (Tel. LYtell 1-14S1)
Purch. Agent: Donald Rogers
Mgr.-Prac.: John Stenson
Dir.-Mktg.: O. H. Brown GE, TR

ELASTIC STOP NUT CORP. OF AMERICA
2330 Vauxhall Rd., Union, N. J. (Tel. MUrdock 6-6000)
Purch. Agent: Everett F. Howell
Gen. Sales Mgr.: D. E. Lally MF, PS, GS, MM, R&D

ELCO CDRP.
"M" St. Below Erie Ave., Philadelphia 24, Pa. (Tel. CUmberland 9-S500)
Purch. Agent: Henry Marks
V. P.-Sales: Leo Kagan GS, GH, GE, CD, TS, TR, R&D

ELCDR, INC.
122S W. Broad St., Falls Church, Va. (Tel. JEfferson 2-7718)
Bus. Mgr.: Edmund Smollwood
Pres.: John H. Reaves R&D

ELDEMA CDRP.
180S Belcroft Ave., El Monte, Calif. (Tel. GIlbert 4-7077)
Purch. Agent: Russel Jones
V. P.-Sales: J. A. Moore GH, GE, CD, TS, TR, R&D

ELDORADO ELECTRONICS
2821 10th St., Berkeley, Calif. (Tel. THornwall 1-4613)
Purch. Agent: A. E. Cummins
Sales Mgr.: J. H. Werlin TR, R&D

ELECTRA MFG. CD.
4051 Broadway, Kansas City, Mo. (Tel. WEstport 1-6864)
Purch. Agent: D. E. Aitken
V. P.-Electranic Sales: R. R. Burton
Sales Mgr., Resistar Dept.: R. T. Means GE, TS, TR, R&D

ELECTRALAB INC.
Industrial Ctr., Needhom Hts., Mass. (Tel. HIllcrest 4-5000)
Purch. Agent: H. Vaughn
Materials Cantrol: K. B. Lorey
Sales Mgr.: W. G. Abbott GE, TR

ELECTRIC AUTO-LITE CO., THE
1201 Champlain St., Toledo 1, O. (Tel. CHerry 3-3131)
V. P.-Purch.: J. H. Lambrix R&D

ELECTRIC AUTO-LITE CO., THE, WIRE & CABLE DIV.
3529 24th St., Port Huron, Mich. (Tel. YUkon S-6131)
Purch. Agent: A. L. Bailey
Gen. Sales Mgr.: O. M. Skirving PS, GS, GH, GE, CO, TR

ELECTRIC CORDS & SUPPLY CDRP.
413 E. Third St., Los Angeles 13, Calif. (Tel. MA 8-2278)
Purch. Agent: Alfreda Chandler
Sales Engr.: J. W. Hemphill GH, CO

ELECTRIC DESIGN & MFG. CO.
722 Jefferson St., Burlington, Iowa (Tel. PLaza 2-768S)
Pres.: Fred Bulmahn TS

ELECTRIC HEATER CO., THE
4S Seymour St., Stratford, Conn. (Tel. DRexel 8-2659)
Dir.-Purch.: W. E. Newbauer MF, WN, GS, GH, MM

ELECTRIC HOSE & RUBBER CO.
Wilmington, Del. (Tel. OLympia S-6261)
Purch. Agent: S. M. Howard
Sales Mgr.: V. W. Wells PS, GS

ELECTRIC MACHINERY MFG. CO.
800 Central Ave., Minneapolis 13, Minn. (Tel. FEderal 9-67S1)
Dir.-Purch.: J. Murnane
Purch. Agent: W. Fisher
Asst. Purch. Agents: Duane Larson, H. Roeger
V. P.-Sales: A. P. Burris GS

ELECTRIC MOTORS & SPECIALTIES, INC.
King & Hamsher Sts., Garrett, Ind. (Tel. 613)
Purch.: M. Bryant
Sales: J. A. Fuhrman TS

ELECTRIC PRODUCTS CO., THE
172S Clarkstone Rd., Cleveland 12, Ohio (Tel. IVanhoe 1-1S00)
Secy-Treas.: Robert J. Berry
Mgr., Power Equip. Div.: John H. Kellogg GS, TR, R&D

ELECTRIC REGULATOR CORP.
Pearl St., Norwalk, Conn. (Tel. VI 7-2401)
Purch. Agent: E. Aaronson
Sales Mgr.: W. H. Walter GS, R&D

ELECTRIC STEEL FOUNDRY CD.
2141 N. W. 2Sth St., Portland 10, Ore. (Tel. CApital 8-2141)
Purch. Agent: Marvin E. Price
Gen. Sales Mgr.: Joe McQuaid MF, PS, GS, GH, MM

ELECTRIC TERMINAL CORP.
Warwick Industrial Park, Providence, R. I. (Tel. STuart 1-2189)
V. P.-Prod.: William Massie, Jr.
V. P.-Sales: N. MacNeil MM

***ELECTRICAL ENGRG. & MFG. CORP.**
4612 W. Jefferson Blvd., Los Angeles 16, Calif. (Tel. REpublic 3-01S1)
Pres.: Fronk Gindroz
Chief Engr.: Gerhard Mauric
*(See Page 110 for Advertisement)

ELECTRICAL INDUSTRIES, DIV.-PHILIPS ELECTRDNICS, INC.
691 Central Ave., Murray Hill, N. J. (Tel. CRestview 7-4300)
Purch.: Clarence Graham, Nicholas Perna, & Risley Marsh
V. P.-Sales: Peter Muto MF, PS, GS, GE, TR

ELECTRICAL INSULATIDN CD., INC.
1245 Marconi Blvd., Copiague, L. I., N. Y. (Tel. AM 4-6190)
V. P.-Purch.: Robert S. Goldstein
Sales Mgr.: Gilbert Arm TS, TR

ELECTRICAL & MECHANICAL OESIGN CO.
P. O. Box 706, Clark, N. J. (Tel. FUlton 8-3381)
Purch. & Sales: Raymond E. Hall

ELECTRICAL REFRACTORIES CO., THE
East End, East Clark St., East Palestine, O. (Tel. GArden 6-9433)
Plant Supt.: Hector B. Moore
Gen. Mgr.: L. J. Turner MM

ELECTRICAL WINDINGS, INC.
2015 N. Kolmar Ave., Chicago, Ill. (Tel. BElmont 5-3360)
Purch. Agent: Arnold M. Topper
Sales Mgr.: L. C. Kammerer GS, GE, TS, TR

ELECTRO OEVELOPMENT CO.
14701 Keswick St., Van Nuys, Calif. (Tel. STate 6-3660)
Purch. Agent: Rick Geiger (Tel. ST 3-1850)
Sales Mgr.: R. Vaccarello GE

ELECTRO DEVELOPMENT CORP.
3939 University Way, Seattle 5, Wash. (Tel. MElrose 3-3094)
Pres.: G. Weinstein
Factory Mgr.: D. D'Angelo GS, GE, R&D

ELECTRO DEVICES INC.
S80 Main St., Wilmington, Mass. (Tel. PArkview 9-28S1)
Chief Engr.: A. A. Ryalls (Tel. TWinbrook 4-S988)
Sales Mgr.: Paul J. Past MM

ELECTRO ENGRG. WORKS
401 Preda St., San Leandro, Calif. (Tel. LO 9-3326)
Purch. Agent: Marvin C. Phillips
Sr. Buyer: Miss Lois C. Crigler
Sales Mgr.: Rex E. Brooks

ELECTRO INSTRUMENTS, INC.
3S40 Aero Ct., San Diego 11, Calif. (Tel BRowning 7-6590)
Purch. Agent: Wade C. Gilliland, Jr.
Sales Mgr.: R. H. Applin
V. P.-Sales: Walter H. East GS, CO, TS, R&D

ELECTRO PRECISION CORP.
P. O. Box 669, Arkadelphia, Ark. (Tel. CHapel 6-2272)
Purch. Agent: Lanona Allen
Sales Mgr.: A. James Edwards GS, CO, TS, R&D

ELECTRO PRODUCTS LABS., INC.
4S01 N. Ravenswood Ave., Chicago 40, Ill. (Tel. LOngbeach 1-1707)
Purch. Agent: E. V. Tetzner
Sales Mgr.: Lloyd A. Thatcher M

ELECTRO TEC CORP.
10 Romanelli Ave., South Hackensack, N. J. (Tel. HUbbard 7-4940)
Dir.-Purch.: George Porigoris
Sales Mgr.: Eugene Parks GS, GE, CO, TS, TR, R&

ELECTRD TEC CORP., VIRGINIA DIV.
P. O. Box 219, Blacksburg, Va. (Tel. PRescott 2-8208)
Purch. Agent: Thomas F. Mantz
Sales Coordinator: Fred Sylvester, South Hackensack, N. J. (Tel. HUbbord 7-4940) MF, PS, GE, T

ELECTRO TECHNICAL PRODUCTS DIV., SUN CHEMICAL CORP.
113 E. Centre St., Nutley 10, N. J. (Tel. NUtley 2-7070)
Gen. Sales Mgr.: W. F. Hugger M

ELECTRO-CAPACITORS CO.
10132 Edes Ave., Oakland 3, Calif. (Tel. LOckhaven 8-7910)
Sales Mgr.: H. Marquess GE, T

ELECTROCRAFT, INC.
4432 N. Kedzie Ave., Chicago 2S, Ill. (Tel. CArnelia 7-4011)
Sales: Stephen G. Richards
Buyer: Otto F. Leske MF, GS, GH, GE, T

ELECTRODATA DIV.-BURROUGHS CORP.
460 Sierra Madre Villa, Pasadena, Calif. (Tel. SYcamore 3-6121)
Mgr.-Material Oept.: W. B. Wight
Mgr.-Sales Dept.: R. G. Dee GE, T

ELECTRDFILM, INC.
7116 Laurel Canyon Blvd., P. O. Box 106, N. Hollywood, Calif. (Tel. POplar S-4420)
Purch. Agent: R. R. Schweger, Jr.
Gen. & Sales Mgr.: J. A. Droege MF, WN, PS,

ELECTRO-FLEX HEAT, INC.
83 Woodbine St., Hartford 6, Conn. (Tel. CHapel

6-5413)
Sales: Ronold J. Borrup PS

ELECTROL INC.
85 Grond St., Kingston, N. Y. (Tel. FEderol 1-1980)
Purch. Agent: J. Tyrrell
Sales Mgr.: D. C. Pierson PS, GS, GH

ELECTROMATH CORP.
42-14 Greenpoint Ave., Long Island City 4, N. Y. (Tel. STillwell 4-3483)
Purch. Agent: Frank G. Taylor
V. P.-Sales: Thomas A. D. Canovo
Sales Promotion Dept.: Frank R. Porisi GE

ELECTRO-MEASUREMENTS, INC.
7524 S. W. Macadam, Portland 1, Ore. (Tel. CHerry 6-3332)
Purch. Agent: Lloyd Smith
Sales Mgr.: L. A. Morin GS, TS, R&D

ELECTRO-MEC LAB. INC.
47-51 33rd St., Long Island City 1, N. Y. (Tel. STillwell 6-3402)
Purch. Agent: Leo F. Ostar
Sales Mgr.: Forbes Morse GE, TS, TR

ELECTRO-MECHANICAL PRODUCTS CO.
32700 Ford Rd., Garden City, Mich. (Tel. LOgon 2-8900)
Chief Purch. Agent: Charles Hefner
Purch. Agent: Parke Chase WN, GS, GH, GE, TS, TR

ELECTRO-MECHANICAL RESEARCH, INC.
Box 3041, Sarasota, Fla. (Tel. RIngling 6-1148)
Purch. Agent: John Moore
V. P.-Sales: T. E. Stewart TR, R&O

ELECTRO-MECHANICAL SPECIALTIES CO., INC.
743 W. 39th St., Banning, Calif. (Tel. VIctor 9-4795)
Purch. Agent: R. L. Kritser
Gen. Mgr.: James Goodmon GE

ELECTRO-MEDICAL LAB., INC.
South Woodstock 25, Vt. (Tel. WOodstock 144M4)
Pres.: Lovett Gorceou
Treas.: D. S. Garceau GE, TS, TR

ELECTRO-MINIATURES CORP.
1060 Elm Ave., Ridgefield, N. J. (Tel WHitney 3-7300)
Purch. Agent: Louis A. Lopez
Sales Engr.: L. Sonders GE, TR

ELECTRON PRODUCTS CO.
430 N. Holstead, Pasadena, Calif. (Tel. RYon 1-0666)
Purch. Agent: F. S. Pirrie
Sales Mgr.: R. F. Hastings MF, PS, GS, GE

ELECTRONIC APPLICATIONS, INC.
194 Richmond Hill Ave., Stamford, Conn. (Tel. DAvis 5-1574)
Purch. Agent: Vincent J. Skee
Dir.-Sales: Truus M. Skee TS, R&O

ELECTRONIC ASSEMBLY CO., INC.
5 Prescott St., Roxbury 19, Moss. (Tel. HIghlonds 2-1600)
Purch. Agent: Soul Buchbinder
Asst. Purch. Agent: Joyce J. Horby
Sales Engr.: Jacob B. Giller GE, TR

ELECTRONIC ASSOCIATES, INC.
Long Beach, N. J. (Tel. CApitol 9-1100)
Purch. Agent: E. F. Von Pelt
Sr. Buyers: L. W. Cavolier, J. H. Schochter & J. W. Thompson
Buyers: R. A. Grammer and E. Volente GE, CO, TS, TR

ELECTRONIC BRAZING CO.
140 Glenridge Ave., Montclair, N. J. (Tel. PIlgrim 4-2160)
Dir.-Purch.: Walter J. Lombert TS

ELECTRONIC COILS, INC.
33 Lymon St., Springfield, Moss. (Tel. REpublic 6-6339)
Purch. Agent: Miss F. Jaworek
Chief Engr.: E. Bossett
Sales Mgr.: G. Lindstrom

ELECTRONIC COMMUNICATIONS, INC.
1501 72nd St., N., St. Petersburg, Flo. (Tel. DIckens 5-9301)
Purch. Mgr.: R. B. Wolworth
V. P.-Mktg.: E. F. Coy GS, GE, CO, TS, TR, R&O

ELECTRONIC CONTROL CORP.
573 E. Forest Ave., Detroit 7, Mich. (Tel. TEmple 2-6625)
V. P.-Sales: Stephen V. Hart
Dir.-Purch.: S. C. Lowrence GS

ELECTRONIC ENGRG. CO. OF CALIFORNIA
601 E. Chestnut Ave., Santo Ana, Calif. (Tel. KImberly 7-5501)
Purch. Agent: A. R. Hormon
Buyers: Gene Froke & Steve Gondolfo
Sales, R&D: M. H. Sonder
Sales Mgr.: W. R. McQuiston TR, R&O

ELECTRONIC FABRICATORS, INC.
682 Broodwoy, New York 12, N. Y. (Tel. SPring 7-4900)
Pres.: M. Somuels

ELECTRONIC INDUSTRIES
Stote Rd., Potterson, N. Y.

ELECTRONIC INSTRUMENT CO., INC. (EICO)
33-00 Northern Blvd., Long Island City 1, N. Y. (Tel. STillwell 6-8700)
V. P.: Philip A. Portnoy TS

ELECTRONIC MEASUREMENTS CO., INC.
Lewis St. & Maple Ave., Eotontown, N. J. (Tel. 3-0300)
Purch. Agent: B. DeBlosio
Buyer: Mrs. Doris Shultz
Expediter: Mrs. Edith Walsh
Sales Mgr.: Douglas Stevens GS, GE, TR

ELECTRONIC MEASUREMENTS CORP.
625 Broodwoy, New York 12, N. Y. (Tel. GRomercy 5-0610)
Purch. Agent: L. Stons
Sales Mgr.: M. Lieblich PS, GS, GH, GE, CO, TS, TR

ELECTRONIC MECHANICS, INC.
101 Clifton Blvd., Clifton, N. J. (Tel. GRegory 3-4108)
Comptroller: N. E. Brown
Gen. Sales Mgr.: J. E. Nester MM

ELECTRONIC PARTS MFG. CO., INC.
508 25th St., Union City, N. J. (Tel. UNion 5-4028) MM, R&O

ELECTRONIC PROCESSES CORP. OF CALIFORNIA
436 Bryont, San Francisco 7, Calif. (Tel. EXbrook 7-3882)
Purch. Agent: Charles Meode PS, GE, CO, TS, TR

ELECTRONIC RESEARCH ASSOCIATES, INC.
67 Factory Pl., Cedor Grove, N. J. (Tel. CEnter 9-3000)
Purch. Agent: N. D. Burgess
Sales Mgr.: D. D. Grieg GE, TS, TR, MM, R&O

ELECTRONIC SPECIALTY CO.
5121 San Fernando Rd., Los Angeles 39, Calif. (Tel. CHopmon 5-3771)
Purch. Agent: H. A. Venturino
Buyers: Doug Taylor, Joe Canfield, Horvey Korosov, Robert Dobe
Sales Mgr.: Ted M. Duoy GS, GE, CO, TS, R&O

ELECTRONIC TRANSFORMER CO., INC.
70 Washington St., Brooklyn 1, N. Y. (Tel. MAin 5-6123)
Purch. Mgr.: Irv Fields
Sales Mgr.: Hal Borgen GS, GE, TR, R&O

ELECTRONIC TUBE CORP.
1200 E. Mermoid Lone, Philodelphio 18, Po. (Tel. CHestnut Hill 7-6800)
Pres.: Kenneth C. Meinken GS, GE, TS, TR, R&D

ELECTRONICS OF CLEARFIELD, INC.
P. O. Box 792, Clearfield, Po. (Tel. POplar 5-3801)
Purch. Agent: Katherine Potterson
Exec. V. P.: James C. Boyd TS

ELECTRONICS CORP. OF AMERICA
One Memorial Dr., Cambridge, Moss. (Tel. UN 4-8000)
Mgr., Military Contracts-Military Div.: B. Howord Deon MF, WN, PS, GS, GE, CO, TS, TR

ELECTRONICS DEPT., HAMILTON STANDARD DIV., UNITED AIRCRAFT CORP.
Brood Brook, Conn. (Tel. NAtionol 3-1621)
Purch. Agent: K. Williams
Sales Mgr.: Boone T. Guyton MF, WN, PS, GS, GH, GE, CO, TS, TR

ELECTRONICS DEVELOPMENT CO., INC.
3743 Cahuengo Blvd., N. Hollywood, Calif. (Tel. STonley 7-3223)
Gen. Mgr.: D. W. Boisch
Sales: F. P. Leoming TR

ELECTRONICS DIV., VAN NORMAN INDUSTRIES INC.
186 Gronite St., Manchester, N. H. (Tel. NAtionol 5-9701)
Dir.-Purch.: S. Copewell
Buyer: T. Galont
Tech. Sales Mgr.: Poul Borr R&O

ELECTRONICS INTERNATIONAL CO.
145 W. Magnolio Blvd., Burbank, Calif. (Tel. Victorio 9-2481)
Purch. Agent: Philip Solomon
Sales Mgr.: John R. Foster PS, GE, TS

ELECTRON-RADAR PRODUCTS
4806 W. Chicago Ave., Chicago 51, Ill. (Tel. ESterbrook 9-1232)
Laboratory: Rt. 30, P. O. Box 50, North Aurora, Ill.
Purch. Agent: W. A. Bailey
Proprietor: J. J. Bailey GE, R&O

ELECTRONS, INC.
127 Sussex Ave., Newark, N. J. (Tel. HUmboldt 2-5977)
V. P.-Sales: J. H. Burnett TR

ELECTRO-SEAL CORP.
946 North Ave., DesPloines, Ill. (Tel. VA 4-6173)
Dir.-Purch.: E. J. Boch GS, GH, CO

***ELECTROSNAP CORP., ASTROMATIC DIV., SWITCH DIV., OPTICAL & SCIENTIFIC DIV.**
4218 W. Loke St., Chicago 24, Ill. (Tel. VAn Buren 6-3100)
Purch. Agent: E. W. Holl
V. P.-Sales: G. M. Bollee GS, CO, TS
*(See Pages 67 & 68 for Advertisement)

ELECTRO-SWITCH & CONTROLS, INC.
5755 Comille Ave., Culver City, Calif. (Tel. TExos 0-4643)
Gen. & Sales Mgr.: J. K. Brose
Buyer: R. E. Preston GS, GE, TR

ELECTRO-TECH EQUIPMENT CO.
308 Canal St., New York 13, N. Y. (Tel. WO 6-2350)
Purch. Agent: Martin J. Jockins
Expediting & Delivery: Miss Barbara Holler
Gen. Mgr.-Sales: Arthur Prince GS, GE, CO, TS, TR

ELECTRO-WINDERS CO. INC.
854 W. Front St., Covina, Calif. (Tel. EDgewood 2-6207)
Plt. Mgr.-Purch. Agent: George Poyne
Asst. Purch. Agent: Agnes Munson
Sales Mgr.: Jock Rotner

ELGEET OPTICAL CO., INC.
838 Smith St., Rochester 6, N. Y. (Tel. BEverly 5-8080)
Purch. Agent: S. J. Royburn
V. P.-Materials: M. A. London
V. P.-Equip.: Peter Terbuska TR

ELGENCO, INC.
P. O. Box 90344, Airport Sta., Los Angeles 45, Calif. (Tel. FRontier 5-4685)
Chief Engr.: Henry Low CO, TS, R&D

ELGIN MICRONICS DIV.-ELGIN NATIONAL WATCH CO.
366 Bluff City Blvd., Elgin, Ill. (Tel. SHerwood 2-5700)
Purch. Mgr.: E. F. Antonson WN, TS, R&O

ELGIN MICRONICS, WEST COAST DIV.-ELGIN NATIONAL WATCH CO.
21001 Nordhoff St., Chatsworth, Calif. (Tel. DIomond 0-7220)
Purch. Agent: Harold E. Houn
Customer Rel. Mgr.: James W. Browder MF, WN, PS, GS, GH, GE, CO, TS, TR

ELGIN NATIONAL WATCH CO.
107 Notional St., Elgin, Ill. (Tel. SHerwood 2-3300)
Dir.-Purch., Watch Div.: W. H. Miller
Gen. Sales Mgr., Watch Div.: Horold Rich WN, PS, GS, GH, GE, CO, TR

ELJAY CORP.
2908 Herbert St., Baltimore 16, Md. (Tel. WIlkens 5-2902)
Purch. Mgr.: Stonley A. Sladek MF, WN, PS, GE, TS, TR

B. W. ELLIOTT MFG. CO., INC.
221 Prospect Ave., Binghomton, N. Y. (Tel. 4-2512)
Purch.: E. M. Twining PS

ELLIS & WATTS PRODUCTS, INC.
8407 Monroe Ave., Cincinnati 36, Ohio (Tel. TWeed 1-8000)
Admin. Supvr.: Robert J. Lommert

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

Purch. Agent: James Macke
V. P.-Sales: William O. Ross GS, R&D

ELMET DIV.-NORTH AMERICAN PHILIPS CO., INC.
Lisbon Rd., Lewiston, Me. (Tel. 4-5478)
V. P.-Purch., Elmet Div.: R. Lowit
Sales, Elmet Div.: O. R. Donovan MM

EL RAY MOTOR CO., INC.
11747 Vose St., North Hollywood, Calif. (Tel. STanley 7-3351)
Purch.: Joseph Ferrante
V. P.-Sales: Lee Valianos

ELSIN ELECTRONICS CORP.
Eileen Way, Syosset, L. I., N. Y. (Tel. WA 1-5200)
Purch. Agent: Robert Reinstein
Gen. Sales Mgr.: Maurice L. Goodman
GE, CO, TS, TR

ELWELL-PARKER ELECTRIC CO., THE
4205 St. Clair Ave., Cleveland 3, Ohio (Tel. UT 1-6200)
Purch. Agent: P. F. Mitchell
Sales Mgr.: J. A. Ackermann GH

ELZEE METAL PRODUCTS CO., INC.
775 39th St., Brooklyn 32, N. Y. (Tel. GEdney 5-5000)
Gen. Mgr.: Milton M. Lynn
Dir.-Sales: Mel Leipzig MM

EMELDID CO. INC., THE
1239 Central Ave., Hillside 5, N. J. (Tel. ELizabeth 2-1944)
Purch. Agent: Mrs. Florence Headley
Sales Mgr.: George W. Emerson MF, GE, CO, TR

EMERSDN & CUMING, INC.
869 Washington St., Canton, Mass. (Tel. CAnton 6-1066)
Purch. Agent: C. B. McSorley
Sales: E. W. Anderson MM, R&D

EMERSDN ELECTRIC MFG. CO., THE, ELECTRONICS & AVIONICS DIV.
8100 Florissant Ave., St. Louis 21, Mo. (Tel. COlfax 1-800)
Dir.-Purch.: John A. Alles, 59th & Industrial Aves., Washington Park, Ill. (Tel. Bridge 1-6060, Sta. 850)
Purch. Agent: M. Randall, Washington Park (Tel. Bridge 1-6060, Sta. 852)
Mgr., Sales Dept.-E & A Div.: C. F. Pizac
MF, WN, GS, GH, GE, CO, TS, TR, MM, R&D

EMERSON PLASTICS CORP.
1383 Seabury Ave., Bronx 61, N. Y. (Tel. SYcamore 2-4400)
Purch. Agent: D. Singer
Asst. Purch. Agent: I. Boxer
Dir.-Sales: W. Elsfelder WN, GE

EMERSON RADIO & PHONOGRAPH CORP.
14th & Coles Sts., Jersey City 2, N. J. (Tel. SWarthmore 5-3500)
Dir.-Purch.: William Hayward, Silver Spring, Md. Office (Tel. JUniper 8-7273)
Purch., Emersan Research Labs.: T. Pritchard
V. P.-Mktg.: George Rappaport
WN, GS, GH, GE, CO, TS, TR, R&D

EMHART MFG. CO., MAXIM DIV.
85 Homestead Ave., Hartford, Conn. (Tel. JA 7-9285)
Prod. Mgr.: S. E. Phelps
Purch. Agent: F. N. Dull
Dir.-Sales: T. S. Willets GS

EMHART MFG. CO., SKYWORKER DIV.
760 Windsor St., Hartford 1, Conn. (Tel. CHapel 9-0671)
Gen. Sales Mgr.: Stephen B. Ooss GS

EMMCO PLASTIC FABRICATORS-DIV.-E. M. McCARTHY MACHINE CO.
68 Vine St., Everett, Mass. (Tel. OUnkirk 9-1660)
Purch. Agent: John Olley
Gen. Mgr.: Roger M. Allen
Dir.-Sales: Oonold West (Warwick, Conn., Tel. REgent 7-5721) MM

EMMERT MFG. CO.
1051 E. Main St., Waynesboro, Pa. (Tel. 848)
Pres.: A. B. Sollenberger GS

EMPIRE ELECTRONICS CO., INC.
166 River St., Paterson 1, N. J. (Tel. ARmory 4-8282)
V. P.: George Surosky PS, GS, GH, GE, TS, TR

EMPIRE PRODUCTS SALES CDRP.
37 Prospect St., Amsterdam, N. Y. (Tel. Victor 2-8400)
Purch. Agent: Allen Cohen
Buyer: Arthur E. Lubo
V. P.-Sales: Michael T. Harges
GE, CO, TS, TR, R&D

EMPIRE STATE ALUMINUM CORP.
15 Baston St., Newark 3, N. J. (Tel. MArket 2-3150)
Secy.: Edward Fielding MF, PS, GH

ENDEVCD CORP.
161 E. California Blvd., Pasadena, Calif. (Tel. RYan 1-5231)
Purch. Agent: Alex Zielinski
Prod. Mgr.: John Daly
Sales Mgr.: Warren O. Hancock TS, R&D

ENDICOTT FORGING & MFG. CD., INC.
1901 North St., Endicott, N. Y. (Tel. 5-3331)
Gen. Sales Mgr.: A. L. Coleman MF, PS

ENFAB INC.
312 E. Brokaw Rd., San Jose, Calif. (Tel. CY 5-1801)
V. P.-Purch.: Mac C. Cutler
Plant Mgr.: R. B. Taylor
Dir.-Sales: L. W. Taylor MM, R&D

ENGLEHARD INDUSTRIES, INC.
133 Astor St., Newark, N. J. (Tel. Bigelow 3-0030)
Purch. Agent: W. Marks
Sr. V. P. & Sales Mgr.: O. L. Alexander MM

ENGELHARD INDUSTRIES INC., D. E. MAKEPEACE DIV.
Pine & Dunham Sts., Attleboro, Mass. (Tel. 2-0089)
Purch. Agent-Main Div. & Slip Ring Assn. Div.: George Aucoin
V. P.-Sales: W. F. Mittendorf
MF, WN, PS, GE, TS, TR

ENGINEERED MAGNETICS, DIV.-GULTON INDUSTRIES, INC.
13030 Cerise Ave., Hawthorne, Calif. (Tel. DRegon 8-7608)
Purch. Agent: Don Wills
Buyers: Art Corralos & Paul Foresman
GE, CD, TR, R&D

ENGINEERED PLASTICS, INC.
Chase St., Gibsonville, N. C. (Tel. 2411)
Purch. Agent: C. V. Long, Jr.
Sales Mgr.: C. H. Phillips MF, PS, GE, TR

ENGINEERED PRECISION CASTING CO.
Box 68, Hwy. 29, Matawan, N. J. (Tel. LOwell 6-2204) GE, TR

ENGINEEREO PRODUCTS CO., THE
129 N. Grand Traverse St., P. O. Box 118, Flint, Mich. (Tel. CEdar 9-8689)
Purch. Agent: S. G. Both
Sales Mgr.: H. Scott PS, R&D

ENGINEERING ASSOCIATES
434 Patterson Rd., Dayton 19, Ohio (Tel. AXminster 3-1662)
Pres.: Charles C. Littell, Jr. TS

ENGRG. CORP. OF AMERICA
5111 Santa Monica Blvd., Hollywood 29, Calif. (Tel. NDrmandy 4-1961)
Purch. Agent & Head-Sales: Vernon W. Haas

ENGRG. DEVELOPMENTS, INC.
P. O. Box 149, Newport, R. I. (Tel. VIking 6-9100)
Pres.: J. H. Millar
V. P.: L. F. Gill

*ENGIS EQUIPMENT CO.
431 S. Dearborn St., Chicago 5, Ill. (Tel. HArrison 7-3223)
Treas.: Mrs. C. L. Morton
V. P.: E. J. Schneider GS, GE
*(See Page 4 for Advertisement)

ENSCD, INC.
3100 Eldredge St., Salt Lake, Utah (Tel. HUnter 5-9162)
Gen. Mgr.: Frank W. Longson TS

ENSIGN-BICKFORD CO., THE
P. O. Box 308, Simsbury, Conn. (Tel DLdfield 8-4411)
Dir.-Mktg.: William S. Sherman MF, R&D

ENTERPRISE TOOL & GEAR CORP.
8320 E. McNichols Rd., Detroit 36, Mich. (Tel. TW 1-5780)
Purch. Agent: Bruce F. Rogers
Sales Mgr.: George R. Alschbach GS

ENTRON, INC.
P. O. Box 287, Bladensburg, Md. (Tel. APpleton 7-9585)
Purch. Agent: Carl D. Jones
V. P.-Sales: Robert J. McGeehan

ENVIRONMENTAL EQUIPMENT CO.
369 Linden St., Brooklyn 27, N. Y. (Tel. HEgeman 3-9872)
Purch. Agent: V. Batalin
Chief Engr.-Purch.: A. Hershey
Head-Sales: L. W. McDaniel GS, TS

EPIC, INC.
154 Nassau St., New York 38, N. Y. (Tel. OIgby 9-2470)
Head-Purch. Dept.: O. Nicolitch
Head-Sales: Peter Letica GS, GE, TS, TR

EPPLEY LABORATORY, INC., THE
12 Sheffield Ave., Newport, R. I. (Tel. VIking 7-1020)
Mgr.-Purch. & Sales: Roy Anderson GE, TR

EPOXY PRODUCTS, INC., DIV.-JOSEPH WALDMAN & SONS
133 Coit St., Irvington, N. J. (Tel. ESsex 5-6000)
Purch. Agent: Edward Sagerman MF, WN, PS, GE

EPSCO INC.
588 Commonwealth Ave., Boston 15, Mass. (Tel. COpley 7-8100)
Purch. Dir.: George R. Herring
Buyer: Robert R. Doucette
Expediter: Richard A. Nichols GS, GE, CO, TS, TR

ERA ELECTRIC CORP.
67 E. Centre St., Nutley, N. J. (Tel. NUtley 2-5811)

ERA ENGRG. INC.
1009 Montana Ave., Santa Monica, Calif. (Tel. EX 5-9995)
Pres.: H. Hutchinson
Dir.-Sales & Contracts: M. Cramer
WN, CO, TS, R&D

ERDCO ENGRG. CORP.
Addison, Ill. (Tel. KIngswood 3-6733)
Purch. Agent: William E. Huntsha
Sales Mgr.: Milton H. Goemann PS

ERICSDN MFG. CO., THE
1660 Hayden Ave., Cleveland 12, Ohio (Tel. GLenville 1-2030)
V. P.-Purch.: J. E. Ericson
Asst. Purch. Agent: M. L. Parker
Dir.-Sales: E. O. Ericson

ERIE INSTRUMATIDN, DIV.-ERIE RESISTOR CDRP.
12932 S. Weber Way, Hawthorne, Calif. (Tel. ORegon 8-5418)
Mgr.-Purch.: Joseph Simmons
Gen. Mgr.: George H. Osborn CO, TS, TR

ERIE RESISTOR CORP.
640 W. 12th St., Erie, Pa. (Tel. 2-1481 — after July 1, GLendale 6-8592)
Dir.-Purch.: George T. Griswold
Buyer-Electro-Mechanical Div.: M. Mikoda
Mgr.-Govt. Contracts & Spec.: J. C. Van Arsdell
GE, CO, TS, TR

ERIEZ MFG. CO.
1945 Grove Or., Erie, Pa. (Tel. 4-0133)
Purch. Agent: G. A. Amidon
Asst. to Pres.: D. E. Dunne MM

ERWIN-NEWMAN CO., THE
P. O. Box 1308, Houston 1, Tex. (Tel. JAckson 4-8186)
Partners: R. J. Newman, C. P. Erwin
Chief Engr.: J. F. Irvine GS

ESCAMBIA CHEMICAL CORP.
261 Madison Ave., New York 16, N. Y. (Tel. OX 7-4315)
Purch. Agent: G. F. Jones, P. O. Box 467, Pensacola, Fla. (Tel. Milton, Fla.—2293)
Pres.: R. U. Haslanger PS

ESSEX MFG. CO., INC.
8213 Gravois, St. Louis 23, Mo. (Tel. VErnon 2-4500)
Purch. Agent & Dir.-Sales: Harold Guller
PS, GS, GH, R&D

ESSEX WIRE CORP.
1601 Wall St., Fort Wayne, Ind. (Tel. E-0311)
Purch.: G. Brown
V. P.-Sales: J. W. Stewart MF, PS, GS, TR

ESSEX WIRE CORP., MAGNET WIRE DIV.
1601 Wall St., Ft. Wayne, Ind. (Tel. EAstbrook 0311)
Dir.-Purch.: G. Kohlmeier
V. P.-Sales: J. W. Stewart MF, TR

ESSO STANDARD OIL CO.
15 W. 51st St., New York 19, N. Y. (Tel. PL 7-1200)
Mgr.-Purch.: A. J. Kelly
Gen. Mgr.-Mktg.: R. O. Goodykoontz MM

ESTERLINE-ANGUS CO., INC., THE
P. O. Box 596, Indianapolis, Ind. (Tel. CHapel 4-3318)
Purch. Agent: J. T. Casebourne
Sales Operation Mgr.: James Gall
Sales Promotion: Lewis Meier, Jr.

ETCHED PRODUCTS CORP.
39-01 Queens Blvd., Long Island City 4, N. Y. (Tel. STilwell 4-5900)
Purch. Agent: Michael Lome

V. P.-Purch.: Leonard D. Kiechel
MF, PS, GE, CO, TS, TR, MM

***ETS-HOKIN & GALVIN**
551 Mission St., San Francisco, Calif. (Tel. EXbrook 2-0432); 218 N. Avalon Blvd., Wilmington, Calif. (Tel. TErminal 5-5601); 2295 E. Belt St., San Diego, Calif. (Tel. BElmont 4-6301)
Chief Purch. Agent: Fred Oakey
V. P.-Sales: Jerry Ets-Hokin GS, TS, TR, R&D
*(See Page 54 for Advertisement)

EVERLUBE CORP.
6940 Farmdale Ave., North Hollywood, Calif. (Tel. ST 7-7101)
Sales Dir.: Roy Smith MF, PS, GS, GH

EWALD INSTRUMENTS
Rt. 7-G, Kent, Conn. (Tel. WAlker 7-3278)
Gen. Mgr.: L. H. Ewald TS

EXACT ENGRG. & MFG. INC.
2375 Canyon Dr., P. O. Box 668, Oceanside, Calif. (Tel. SAratoga 2-2144)
Purch. Agent: Frank Pendleton
Dir.-Sales: George A. Brusch MF, GS, GE, TR

EX-CELL-O CORP.
1200 Dakman Blvd., Detroit 32, Mich. (Tel. TOwnsend 8-3900)
Dir.-Purch.: F. D. Sicklesteel
Purch. Agent: F. Grimm
V. P.-Indsl. Sales: D. H. McIver MF, PS, GS, GE

EXCELSIOR LEATHER WASHER MFG. CO. INC.
720-730 Chestnut St., Rockford, Ill. (Tel. WOodland 8-2203)
Pres.: C. E. Duclon
Treas.: W. E. Duclon MF, PS

EXECUTONE, INC.
415 Lexington Ave., New York 17, N. Y. (Tel. MUrray Hill 7-7440)
Purch. Agent: Bernard Loew, 47-37 Austell Place, Long Island City 1, N. Y. (Tel. RAvenswood 9-7031)
Natl. Sales Mgr.: Ed Brody GS, GE, TR

EXIDE INDUSTRIAL DIV.-THE ELECTRIC STORAGE BATTERY CO.
Rising Sun & Adams Ave., Philadelphia 20, Pa. (Tel. FIdelity 2-8000)
Purch. Agent: H. S. Stevenson
Sales: C. J. Moore GS, GH, GE, TS

EYELET TOOL CO. INC.
236a Broadway, Cambridge 39, Mass. (Tel. UN 4-8170) MF, GS, TS

FWD CORP.
Clintonville, Wisc. (Tel. 2241)
Dir.-Purch.: Lloyd Pinkowsky
Asst. Dir.-Purch.: Leroy Hughes
Buyers: C. Pederson, M. N. Nordwig, N. Hansen, A. Hill, C. Chandler & C. Weck GS, GH

FXR, INC.
2612 Baraugh Pl., Woodside 77, N. Y. (AS 8-2800)
Purch. Agent: Lou Eskanazy
Prod.-Co-ordinator: John H. Wendt
V. P.-Sales: William D. Marshall TS, R&D

FABER PENCIL CO., EBERHARD
Crestwood–Wilkes-Barre, Pa. (Tel. GRanite 4-6711)
Dir.-Purch.: A. H. Dietze
Sales Mgr.: C. P. Mailloux

FABRI-FORM CO., THE
258 W. Main Ave., Byesville, O. (Tel. 5416)
Purch. Agent: E. E. Wray
V. P.-Sales Mgr.: R. L. Baker

FAE INSTRUMENT CORP.
42-61 Hunter St., L. I., N. Y. (Tel. STillwell 6-4959)
Purch. Agent: Joseph Voros GE, TR, R&D

FAFNIR BEARING CO., THE
37 Booth St., New Britain, Conn. (Tel. BAldwin 5-5151)
Purch. Agent: H. P. Knowles
V. P.-Sales: R. W. Powell
PS, GS, GH, GE, CO, TS, TR, R&D

FAIRBANKS CO., THE
393 Lafayette St., New York 3, N. Y. (Tel. SPring 7-8800)
V. P.-Sales: E. T. Flanagan GS

FAIRBANKS MORSE
600 S. Michigan Ave., Chicago 5, Ill.

FAIRCHILD ASTRIONICS DIV., FAIRCHILD ENGINE & AIRPLANE CORP.
Straight Path Rd., Wyandanch, L. I., N. Y. (Tel. Midland 3-7171)
Materials Mgr.: B. B. Kimball GS, GE, R&D

FAIRCHILD CAMERA & INSTRUMENT CORP., INDUSTRIAL CAMERA DIV.
Aerial Way, Syosset, N. Y. (Tel. WEIls 1-4500)
Purch. Agent: Wm. Crocker
Mktg. Mgr.: C. Cherry CO, TS, TR

FAIRCHILD CONTROLS CORP., COMPONENTS DIV.
255 Park Ave., Hicksville, L. I., N. Y. (Tel. Wells 8-5600)
Purch. Agent: Robert Crockett
Natl. Contracts Admin.: T. F. D'Andrade
WN, GS, GE, CO, TS, TR

FAIRCHILD DATA DEVICES CORP.
580 Midland Ave., Yonkers, N. Y. (Tel. GReenleaf 6-0201)
Prod. Mgr.: Kenneth LiDonnici
Sales Mgr.: Charles E. Cherry, Jr. TR

FAIRFIELD ENGINEERING CORP.
934 Hope St., Springdale, Conn. (Tel. DAvis 5-1561)
Purch. Agent: Katherine Kiniry
Dir.-Sales: Arthur Gutterman R&D

FALSTROM CO.
75 Falstrom Ct., Passaic, N. J. (Tel. PRescott 7-0013)
Purch. Agent: P. W. Kievit
Asst. Purch. Agent: R. L. Chapman
Sales & Adv. Mgr.: R. E. Hill MF, GS, GH, R&D

FANSTEEL METALLURGICAL CORP.
North Chicago, Ill. (Tel. DExter 6-4900)
Dir.-Purch.: J. A. Teece
Purch. Agent: G. E. Powell
Buyers: L. W. Carter, W. Laser & E. A. Weidman
Asst. Purch. Agent: G. Conner
MF, WN, PS, GS, GH, GE, CO, TS, TR

FARLEY & LOETSCHER MFG. CO., PLASTICS DIV.
7th & White St., Dubuque, Iowa (Tel. 2-5451)
Purch. Agent: L. J. Streinz
Div. Mgr.-Purch.: F. R. Loetscher
Asst. Div. Mgr.-Purch.: C. E. Walz MM

FARMER ELECTRIC PRODUCTS CO., INC
2300 Wash. St., Newton Lower Falls, Mass. (Tel. DEcatur 2-8383)
Purch. Agent: T. L. Parker
Pres.-Sales: E. B. Farmer TS

FARMINGDALE MFG. CORP.
40 Potter St., Farmingdale, L. I., N. Y. (Tel. CHapel 9-7200)
Exec. V. P.: R. W. Craig
Buyer: F. S. Davis PS, GS, TS

FARREL BIRMINGHAM CO., INC.
25 Main St., Ansonia, Conn. (Tel. REgent 4-3331)
Purch. Agent: H. F. Williams
Sales Mgr.: P. H. Dreissigacker
Mgr.-Spec. Prod.: R. J. Swett, Jr. GH

FARWELL METAL FABRICATING
75 W. Fairfield Ave., St. Paul 7, Minn. (Tel. CApitol 4-5318)
Purch. Agent: Arnold Portugal
Asst. Purch. Agent: Mike Daddario
Sales Mgr.: W. J. Marzolf MF, WN, GH, MM

FASTENERS, INC.
198 Columbus Ave., Pittsfield, Mass. (Tel. HIllcrest 3-9105)
Purch. Agent: Robert G. Schneider
Pres.-Sales: C. M. Cambern
V. P. & Dir.-Sales: Ben Sprague
V. P.-Sales: Louis A. Cummaro
MF, WN, PS, GS, GH, GE, R&D

FAULTLESS CASTER CORP.
1427 N. Gervin St., Evansville 7, Ind. (Tel. HArrison 5-9041)
V. P.-Purch.: Elmer H. Noelting
Purch. Agent, Parts: Roy C. Lackyear
Purch. Agent, Raw Materials: George L. Wood
Gen. Sales Mgr.: C. Bernard Noelting GS

J. W. FECKER, INC.
6592 Hamilton Ave., Pittsburgh 6, Pa. (Tel. EMerson 1-7617)
Purch. Agent: Bert DeMarco
Pres.-Sales: Joseph Kalla GS, GH, CO, TS, TR

FEDERAL BEARINGS CO. INC., THE
Fairview Ave., Poughkeepsie, N. Y. (Tel. GL 2-6000)
Dir.-Purch.: E. Wallin
Dir.-Sales: E. Sweeney GS, GH

FEDERAL MACHINE CO. INC.
841 Garfield Ave., Jersey City, N. J. (Tel. HEnderson 5-1500)
Purch. Agent: H. Shapiro
Pres.: Harold H. Butler MM

FEDERAL MACHINE TOOL CO.
626 Dorchester Ave., South Boston 27, Mass. (Tel. ANdrew 8-8380)
Purch. Agent: George W. Kenty
Sales Mgr.: Walter J. Murphy WN, PS, MM

FEDERAL MFG. & ENGRG. CORP.
1055 Stewart Ave., Garden City, N. Y. (Tel. Pioneer 2-7400)
Purch. Agent: Harry Levin
V. P.-Sales: Robert S. Schlanger
GS, GE, CO, TS, R&D

FEDERAL METAL HOSE CORP.
277 Military Rd., Buffalo 7, N. Y. (Tel. DE 4893)
Pres.: Harry C. Neff
Purch.: K. E. Lehr MF, PS, GS

FEDERAL PRODUCTS CORP.
1144 Eddy St., Providence 1, R. I. (Tel. STuart 1-9300)
Asst. Adv. Mgr.: G. H. Wilson

FEDERAL SCIENTIFIC CORP.
615 W. 131st St., N. Y., N. Y. (Tel. AU 6-4400)
Purch. Agent: Murray Wiener R&D

FEDERAL SCREW PRODUCTS INC.
3917 N. Kedzie Ave., Chicago 18, Ill. (Tel. IRving 8-5744)
Purch. Agent: Ted Eisman
Sales Mgr.: L. L. Harris MF, WN, PS, GS, GH, GE

FEDERAL SHOCK MOUNT CORP., DIV.-THE KORFUND CO., INC.
1060 Washington Ave., New York 56, N. Y. (Tel. WYandotte 3-0400)
Purch. Agent: J. Silverman
Sales Mgr.: J. I. Hammond
Sales Prom. Mgr.: S. L. Perlow GS, TR, MM, R&D

FEDERAL TELECOMMUNICATIONS LABS.
500 Washington Ave., Nutley, N. J.

FEDERAL TELEPHONE & RADIO CO.
100 Kingsland Rd., Clifton, N. J. (Tel. NUtley 2-3600)
Purch. Mgr.: H. P. Sommerer
V. P.-Sales: T. M. Douglas

FEDERAL TOOL ENGRG. CO.
1384 Pompton Ave., Cedar Grove, N. J. (Tel. CLifford 6-5300)
Purch. Agent: Mrs. E. Lindenfield
Sales Mgr.: Robert H. Pityo

FEEDBACK CONTROLS, INC.
899 Main St., Waltham 54, Mass. (Tel. TWinbrook 4-1020)
Purch. Agent: Stanley W. Block
Sales Mgr.: John J. Fernsler
GE, CO, TS, TR, R&D

FEILER ENGRG. & MFG. CO.
8026 N. Monticello Ave., Skokie, Ill. (Tel. CDrnelia 7-8280)
Purch. Agent: G. Wolf
Sales Mgr.: Elwood Talan GE, TS

FELKER MFG. CO.
1128 Border Ave., Torrance, Calif. (Tel. Fairfax 8-4704)
Purch. Agent: George Mittl
Purch. Dept.: Helen Sutor
Sales Mgr.: Fred K. Ryan MM, R&D

FELTERS CO., THE
210 South St., Boston 11, Mass. (Tel. LIberty 2-7021)
V. P.-Purch.: J. G. Bowden, 22 W. St., Millbury, Mass. (Tel. UNion 5-4404)
V. P.-Sales: G. C. Howe
Asst. Sales Mgr.: G. J. Harrington MM

FENWAL ELECTRONICS, INC.
Mellen St., Framingham, Mass. (Tel. TRinity 3-7455)
Pres.-Purch.: R. S. Goodyear
Sales Mgr.: H. J. Andrews

FENWAL INC.
Pleasant St., Ashland, Mass. (Tel. TRinity 5-6111)
Purch. Agent: F. Stockwell
Buyers: J. Mahoney & R. Thorne
Gen. Sales Mgr.: S. Edgerly
MF, WN, PS, GS, GE, CO, TS, TR

FERRANTI ELECTRIC INC.
30 Rockefeller Plaza, New York 20, N. Y. (Tel. CIrcle 7-0911)
Purch. Agent: P. C. Pope
Dir.-Sales: D. G. Pacy GS, GE, TS, TR

FERRIS-MFG. CO., THE
45 Seymour St., Stratford, Conn. (Tel. DRexl 8-0120)
Purch. Agent: S. McDonough
Pres.-Sales: Stanley Dulski MF

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

FERROTHERM CO., THE
1861 E. 65th St., Cleveland 3, Ohio (Tel. EN 1-0745)
Asst. Secy.-Purch.: Clem Gross
Sales Mgr.: Max Korb

FERROTRAN ELECTRONICS CO., INC.
693 Broadway, New York 12, N. Y. (Tel. ALgonquin 4-5810)
Sales Mgr.: H. King
Gen. Mgr.: Edward A. Abbot TR, R&D

FERROXCUBE CORP. OF AMERICA
129 E. Bridge St., Saugerties, N. Y. (Tel. CHerry 6-2811)
Purch. Agent: J. P. O'Reilly
Sales Adm.: W. J. Crosby MF, PS, GS

FIDELITY AMPLIFIER CO.
1633 N. Halsted St., Chicago 14, Ill. (Tel MOhawk 4-3515)
Purch. Agent: W. Stanton Martin GE

FIDELITY CHEMICAL PRODUCTS CORP.
470 Frelinghuysen Ave., Newark 12, N. J. (Tel. BI 2-4110)
Gen. Mgr.-Purch.: Maurice Bick
Head-Sales: S. B. Lonyai MF, WN, PS, GS, GH, TR

FIDELITY INSTRUMENT CORP.
1000 E. Boundry Ave., York, Pa. (Tel. 7675)
Purch. Agent: George Dietz
Pres.-Sales: A. A. Wolf GS, GE, TR

FILMOHM CORP.
48 W. 25th St., New York 10, N. Y. (Tel. WAtkins 4-3244)
Purch. Agent: Bob Latin
Buyer: M. Rosten
V. P.-Sales: J. N. Papper TS, TR

***FILTORS, INC.**
30 Sagamore Hill Dr., Port Washington, N. Y. (Tel. 7-8220)
Purch. Agent: D. Bochicchio
V. P. Sales: C. G. Barker GE, TR
*(See Page 6 for Advertisement)

FILTRON CO., INC.
131-15 Fowler Ave., Flushing 55, N. Y. (Tel. HIckory 5-7000)
Dir.-Purch.: Lou Kerestury
Gen. Sales Mgr.: Samuel I. Perry TS

FINE ORGANICS, INC.
211 E. 19th St., New York 3, N. Y. (Tel. GRamercy 5-1030)
Purch. Agent: Miss Agnes Guidice
Asst. to the Pres.: Emanuel Rosenblat

FINN AERONAUTICAL DIV., T. R. FINN & CO., INC.
275 Goffle Rd., Hawthorne, N. J. (Tel. HA 7-7123)
Purch. Engr.: T. B. Malloy
Sales: William Grimm PS

FINNELL SYSTEM, INC.
500 East St., Elkhart, Ind. (Tel. 2-0586)
V. P.-Purch.: W. S. Finnell, Jr.
V. P.-Sales: James E. Bates

FINNEY CO., THE
34 W. Interstate St., Bedford, Ohio (Tel. Bedford 2-6161)
Pres.-Purch.: L. H. Finneburgh
V. P.-Purch.: M. L. Finneburgh, Sr.
Sales Mgr.: M. L. Finney, Jr.
Gen. Sales Mgr.: M. L. Finney, Sr. GE, TR, MM

FIRESTONE TIRE & RUBBER CO., THE, GUIDED MISSILE DIV.
2525 Firestone Blvd., Los Angeles 54, Calif. (Tel. LUdlow 3-4411)
Purch. Agent-Coast Div.: J. D. Esterly
Mgr., Purch. Dept.-Guided Missile Div.: N. H. Peterson
Buyers: Fred Jewett, W. F. Koehne, Leo L. Lawrence, M. I. Doles, R. B. Harper, T. W. Dunford, C. W. Smith, & C. A. Giboney
Sales Engr.: F. W. Thompson MF, WN, PS, GS, GH, CO, TS, TR, R&D

FIREWEL CO., INC., THE
3685 Broadway, Buffalo 25, N. Y. (Tel. REgent 0440)
Purch. Agent: A. DiMiceli
V. P.-Aviation Products: John C. Goodell GS, R&D

FIRST ELECTRONICS CORP., THE
117 Blue Hill Ave., Boston 19, Mass. (Tel. HI 5-5900)
Purch. Agent: A. Miller MF, PS, GS, GH, GE, CO, TS, TR

FIRTH STERLING INC.
3113 Forbes, Pittsburgh, Pa. (Tel. MUseum 2-4600)
Purch. Agent: Harry K. Stern, McKeesport, Pa. (Tel. HOmestead 1-4776)
Asst. Purch. Agent: George L. Miller, McKeesport, Pa.
V. P.-Sales: Thomas G. Barnes MF, WN, PS, GS

FISCHER & PORTER CO.
6 Warminster Rd., Hatboro, Pa. (Tel. OSborne 5-6000)
Purch. Agent: Daniel Steelman
V. P.-Sales: Robert L. Rice PS, GS, GH, GE, CO, TS, TR

FISHER & CROME
109 N. Camac St., Philadelphia, Pa. (Tel. LOcust 4-5054)
Buyer: John C. Bucher GS, GH

FISHER GOVERNOR CO.
Box 307, Marshalltown, Iowa (Tel. 5561)
Purch. Agent: A. M. Chard
Sales Mgr.: Bruce Price GH

FISHER RESEARCH LAB., INC.
1975 University Ave., Palo Alto, Calif. (Tel. DAvenport 2-4646)
Purch. Agent: James G. Rafferty
V. P.-Sales: Irwin Feichtmeier TR, R&D

FISHER SCIENTIFIC CO.
711 Forbes Ave., Pittsburgh 19, Pa. (Tel. EXpress 1-1330)
Purch. Agent: E. A. Eyerman
Sales Mgr.: J. Cramer TS, R&D

FISH-SCHURMAN CORP.
70 Portman Rd., New Rochelle, N. Y. (Tel. New Rochelle 6-1300)
Purch. Agent: N. Raptoulis
Pres.-Sales: Murray Yawitz

FLEETWOOD LABS., INC.
300 Victory Blvd., New Rochelle, N. Y. (Tel. BEverly 5-0831)
Sales Mgr.: W. A. Scism CO, TS

FLETCHER MFG. CO., INC., THE
10th & Missouri Sts., Oklahoma City 17, Okla. (Tel. FOrest 5-9232)
V. P.-Purch. & Sales: C. F. Fletcher
Plant Supt.: Kenneth P. Kerr MF, WN, PS, GS, GE, TS, TR

FLEXAUST CO., THE
100 Park Ave., New York, N. Y. (Tel. ORegon 9-1300)
Supt.-Purch.: T. Burbank, Chestnut St., Amesbury, Mass. (Tel. 1396)
Adv. Mgr.: T. G. May PS, GS, GH

FLEXIBLE METAL HOSE MFG. CO.
777 W. 16th St., Costa Mesa, Calif. (Tel. LIberty 8-6252)
Pres.: Elton Hallett MF, PS, GS, GH, GE

FLEXIBLE TUBING CORP.
New Whitfield St., Guilford, Conn. (Tel. GLendale 3-2777)
Purch. Agent: Robert F. Moran
Asst. Mgr.-Aircraft & Missile Sales: John D. Kohler MF, GS, GE, CO

***FLEXONICS CORP., AERONAUTICAL DIV.**
1414 S. Third Ave., Maywood, Ill. (Tel. FIllmore 3-8000)
Purch. Agent: R. Ferguson
Gen. Mgr.-Aeronautical Div.: R. R. Muller
Systems Mgr.: William C. Gage
Mktg. Mgr.: Dale Ankeney TS, MM, R&D
*(See Page 41 for Advertisement)

FLEXROCK CO.
3609 Filbert St., Philadelphia, Pa. (Tel. BAring 2-5500)
Mech. Engr.-Purch.: H. Schmidt
Sales Mgr.: H. Himbert MF, PS, MM

FLIGHT REFUELING, INC.
P. O. Box 1701, Baltimore 3, Md. (Tel. SOuthfield 6-5000)
Treas.-Purch.: Albert Roeper
Buyers: Rudolph Borke, Lloyd Lilly, Jr. & John Kucher
Asst. to Pres.: Richard C. Dickinson GS, TS, R&D

FLIGHT RESEARCH, INC.
P. O. Box 1-F, Richmond 1, Va. (Tel. REpublic 7-4163)
Purch. Agent: William J. Waymack, Jr.
Sales Mgr.: John C. Pennock R&D

FLIGHT SCIENCES LAB.
1963 Sheridan Dr., Buffalo, N. Y. (Tel. VI 7166)
Purch. Agent: Mrs. Mary Bacon R&D

FLOCK PROCESS CO. INC.
375 Main Ave., Norwalk, Conn. (Tel. VIctor 7-4586)
Head-Purch. Dept.: R. J. Leff
Head-Sales: H. A. Leff MF, PS, GS, TS, TR

FLORI PIPE CO., THE
601 E. Red Bud Ave., St. Louis 15, Mo. (Tel. EVergreen 1-3800)
Purch. Agent: Dwight Ketring
Sales Mgr.: Robert D. Flori

FLOW CORP.
85 Mystic St., Arlington 74, Mass. (Tel. MIssion 8-3185)
Admin. Asst.-Purch.: R. J. McIlveen
Mgr.-Sales: H. P. Grant T

FLOW MEASUREMENTS CORP.
10506 Wheatley St., Kensington, Md. (Tel. LOckwood 4-0122)
Purch. Agent: Joseph H. West
Sales Mgr.: Don Pardue T

FLUID REGULATORS CORP.
313 Gillette St., Painesville, Ohio (Tel. ELmwood 2-3319)
Purch. Agent: Ray W. Honeywell
Sales Mgr.: Ralph W. Barnes PS, GS, GH, GE, R&

JOHN FLUKE MFG. CO., INC.
1111 W. Nickerson St., Seattle 99, Wash. (Tel. AT 2-5700)
Plant Mgr.: R. M. Nicholas
Sales Mgr.: Robert E. Florence GS, GE, CO, TS, T

FLUOROCARBON CO. INC., THE
1206 E. Ash Ave., Fullerton, Calif. (Tel. MA 6-9369)
Purch. Agent: Frank Willey
Sales Mgr.: Sandy Poteet MM, R&

FLUORULON LABS., INC.
Box 305, Caldwell, N. J. (Tel. CA 6-8228)
Pres.-Purch.: F. B. DuVall
Sales Mgr.: W. P. Hemmel PS, M

FLUSH WALL RADIO CO.
1012 Cleveland St., Clearwater, Fla. (Tel. 34-6061)
Pres.: L. R. Schenck

FONDA GAGE CO., INC.
Box 1050, 200 Henry St., Stamford, Conn. (Tel. DA 4-5787)
Office Mgr.: O. A. Romaniello
Gen. Mgr.-Purch.: H. Wunselt
Sales Mgr.: A. J. Erickson TS, R&

FOOD MACHINERY & CHEMICAL CORP., CHEMICAL DIVISIONS
161 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-7400)
Purch. Dir.-Chemical Divs.: J. A. Mooney WN, PS, GH, R&

FOOD MACHINERY & CHEMICAL CORP., ORDNANCE DIV.
1105 Coleman Ave., San Jose, Calif. (Tel. CYpress 4-8124)
Procurement Mgr.: H. L. Hall
Purch. Agent: H. V. Rogers
Asst. Purch. Agent: F. P. Gorentz
Sales: H. R. Hammond MF, PS, GS, GH, CO,

FOOTE BROS. GEAR & MACHINE CORP.
4545 So. Western Blvd., Chicago 9, Ill. (Tel. VIrginia 7-4200)
V. P.-Mrktg.: R. W. Johnson MF,

FOOTE MINERAL CO.
18 W. Chelten Ave., Philadelphia 44, Pa. (Tel. VIctor 8-4000)
Dir.-Purch.: W. M. Raynor
Asst. Dir.-Purch.: W. J. Brooking
Purch. Agent: H. H. Apgar
Gen. Sales Mgr.: James Fentress

FORBES, GEORGE F., INDUSTRIAL MATHEMATICIAN
13745 Eldridge Ave., Sylmar (San Fernando), Calif (Tel. EMpire 7-1219) R

FORBES & WAGNER, INC.
345 Central Ave., Silver Creek, N. Y. (Tel. 650)
Purch. Agent: R. L. Hollowood
V. P.-Sales & Engrg.: John C. Pontius GE,

M. A. FORD MFG. CO., INC.
1545 Rockingham St., Davenport, Iowa (Tel. 7-3251)
Secy.: Stanley Hill
Sales Mgr.: L. E. Schumann

FORD INSTRUMENT CO., DIV.-SPERRY RAND CORP.
31-10 Thomson Ave., Long Island City 1, N. Y. (Tel. STillwell 4-9000)
V. P.-Sales: A. L. Coulson
Purch. Agent: S. J. Nastri WN, GS, GE, CO, TS, TR, F

FORD RADIO & MICA CORP.
536 63rd St., Brooklyn 20, N. Y. (Tel. GEdney 9-8300)
Purch. Agent: Alan J. Long
Sales Mgr.: Delos Maynard GS, TS,

FOREDOM ELECTRIC CO., INC.
Bethel, Conn. (Tel. Pioneer 8-3S21)
Purch. Agent: Henry Holmes
Sales Mgr.: Douglas E. Kellogg MM

FOREST ELECTRIC CO., THE
7216 Circle Ave., Forest Park, Ill. (Tel. FP 6-4100)
Dir.-Purch.: Louis Picchietti
Dir.-Sales: Charles F. King

FORMED STEEL TUBE INSTITUTE
850-52 Hanna Bldg., Cleveland 15, Ohio (Tel. MAin 1-4012)
Exec. Secy.-Treas.: Jehu R. Derricksan
MF, WN, PS, TS, TR, MM, R&D

FORMICA CORP.
4614 Spring Grove Ave., Cincinnati 32, Ohia (Tel. Kirby 1-3670)
Purch. Agent: H. Heitbruik
Prod. Mgr.: F. H. Hamilton MM

FORM-IT PRODUCTS, INC.
1619 W. Walnut St., Chicago 12, Ill. (Tel. HAymarket 1-7337)
V. P.-Purch.: E. S. Jamison MM

FORMSPRAG CO.
23601 Hoover Rd., Warren, Mich. (Tel. JEffersan 6-9000)
Purch. Agent: E. D. Mackie
Buyer: R. F. Agnelly
V. P.-Sales: Charles F. Trapp, Jr.

FORSBERG MFG. CO., THE
125 Seaview Ave., Bridgepart 1, Conn. (Tel. EDisan 4-9469)
Plant Mgr.: Jahn W. Nystram
Sales Mgr.: H. S. Farsberg

FORT HILL PLASTIC LETTERS CORP.
40 Hanaver St., Bastan 8, Mass. (Tel. RIchmand 2-2S70)
V. P.: Dswald W. Gregson

FORT WAYNE METALS, INC.
3211 MacArthur Dr., Ft. Wayne 6, Ind. (Tel. SHerwaad 3181)
V. P.-Purch.: Frank B. Didier
Pres.: Ardelle Glaze MM, R&D

FOSTER TRANSFORMER CO.
3820 Calerain Ave., Cincinnati, D. (Tel. MUlberry 1-2420)
Purch. Agent: A. L. Janas
Sales Mgr.: S. D. Haffey MM

FOTO-VIDEO LABS., INC.
46 Commerce Rd., Cedar Grave, N. J. (Tel. CEnter 9-6100)
Purch. Agent: James Palmere
Sales Mgr.: Jahn Mahler GS, GE, TR, R&D

FOUR WHEEL DRIVE AUTO CO., THE
12th & Auto Sts., Clintanville, Wisc.

FRAM CORP.
105 Pawtucket Ave., Providence 16, R. I. (Tel. GEneva 4-7000)
Dir.-Purch.: H. Keaugh
V. P.-Sales: H. R. Robinson
Mgr., Aviation Div.: Jahn J. McKee
PS, GH, TS, MM, R&D

FRANKLIN FIBRE-LAMITEX CORP.
E. 18th St.-on P.R.R. Siding, Wilmington, Del. (Tel. DL 8-S269)
Purch.: A. R. Campbell
MF, WN, PS, GS, GE, TS, TR

FREBANK CO.
11 W. Braadway, Glendale 4, Calif. (Tel. CHapman S-6SS8)
Purch. Agent: R. L. Harris
Sales Mgr.: J. G. Tillery GS, GE, R&D

FREED TRANSFORMER CO., INC.
1718 Weirfield St., Braaklyn 27, N. Y. (Tel. EVergreen 6-1300)
Purch. Agent: G. Lesser
Sales Mgr.: M. Salzberg GE, TR

FREEMAN CO., THE
4th & Walnut Sts., Yanktan, S. Dak. (Tel. North S-2829)
Purch.: E. W. Freeman
Dir.-Sales: S. H. Byquist
MF, WN, PS, GS, GH, GE, TR, MM

FRENCHTOWN PORCELAIN CO.
Morrisan & 8th Sts., Frenchtawn, N. J. (Tel. 480)
Prod. Development Engr.: C. L. Seversike
Mgr.-Mktg. & Engrg.: J. E. Camefaro MM

FRICK GALLAGHER MFG. CO., THE
20 S. Michigan Ave., Wellston, Ohia (Tel. WEllstan 4-2121)
Purch. Agent: D. A. Dabbins

FRIEDMSON DRBAN CO., INC.
33 Madisan Ave., New York 16, N. Y. (Tel. MUrray Hill 7-0920) MM

FRUEHAUF TRAILER CO., MILITARY EQUIPMENT DIV.
10940 Harper Ave., Detrait 32, Mich. (Tel. WA 1-2410)
Dir.-Purch.: Bruce M. Kirsten
Purch. Agent: H. E. Vermillian
Purch.: Robert Liggett, Delphas, D. (Tel. 2-6015)
Dir.-Military Equip.: E. R. Neumann GS, GH, R&D

FUGLE-MILLER LABS. INC.
301 Central Ave., Clark, N. J. (Tel. FUltan 1-2727)
Purch. Agent: F. L. Fugle, Jr.
Sales Mgr.: Conrad Miller TR

FULLER CO.
124 Bridge St., Catasauqua, Pa. (Tel. CDngress 4-2841)
Purch. Agent: J. A. Nark
Sales Mgr.: C. C. Kaesemeyer GH

FULTON-IRGON CORP., THE
P. D. Box S91, Dover, N. J. (Tel. FDxcraft 6-7474)
Purch. Agent: John D. Black
Sales Mgr.: David Fultan PS, GS, GH, MM

FURANE PLASTICS, INC.
4S16 Brazil St., Las Angeles 39, Calif. (Tel. CHapman S-S763)
Purch. Agent: B. Halbraak
Sales Mgr., Tooling: B. J. Bryan TS, MM, R&D

FURNAS ELECTRIC CO.
1000 McKee St., Batavia, Ill. (Tel. 3410)
Purch. Agent: C. R. Mead
V. P.-Sales & Engrg.: W. F. Lisman

FUSITE CORP.
6000 Fernview Ave., Cincinnati 13, D. (Tel. REdwaad 1-2020)
Purch. Agent: J. Fax
V. P.-Sales: J. H. Marsh, Jr. MF, PS, GS, GE

FUTURECRAFT CORP.
1717 N. Chico Ave., El Monte, Calif. (Tel. CUmberland 3-2113)
Purch. Agent: Wesley Janes
Buyer: Claude Knight
Prod. Contral: Ray Curtis
Supt.: Aage Hansen
Chief Test Engr.: Richard Fewell
Sales Mgr.: Robert Burke MF, PS, GS, GE

GAR MFG. CORP.
73 Park St., Beverly, Mass. (Tel. WA 2-1626)
Purch. Agent: Arthur D. Stane
Asst. Purch. Agent: Francis F. Perry
Dir.-Sales: Jerame B. Bates MM

GAR PRECISION PARTS, INC.
190 Henry St., Stamford, Conn. (Tel. FI 8-2671)
Purch. Agent: Albert D. Palmer GE

G-L ELECTRONICS CO., INC.
2921 Admiral Wilsan Blvd., Camden S, N. J. (Tel. WDadlawn 6-2780)
Purch. Agent: Bayd F. Beatty
Dir.-Sales: Stephen G. Lax PS, TR

G-M LABS. INC.
4300 N. Knox Ave., Chicago 34, Ill. (Tel. PEnsacala 6-1800)
Purch. Agent: Irving M. Temen
Sales Mgr., Components Div.: A. G. Bradt GE

GPS INSTRUMENT CO., INC.
180 Needham St., Newtan 64, Mass. (Tel. DEcatur 2-8110)
Purch. Agent: Samuel Giser
Sales Mgr.: Strain Suttan GE, TR

G-V CONTRDLS INC.
Dkner Pkwy., Livingstan, N. J. (Tel. WYman 2-6200)
Gen. Sales Mgr.: Robert F. Stockton, III
Buyer: Richard Maloney
Production Mgr.: Ray Weckstein GS, GH, GE, CO

GABRIEL CO., THE, GABRIEL ELECTRONICS DIV.
135 Crescent Rd., Needham Heights 94, Mass. (Tel. HIllcrest 4-0005)
Purch. Agent: Charles Nalan
Dir.-Sales: Steven Galagan
V. P.-Electronics: Stanton L. Yarbraugh
GS, GE, TR

GABRIEL CO., THE, TALCO ENGRG. CO. DIV.
Falcan Field, Mesa, Ariz. (Tel. WD 4-1711)
Purch. Agent: Edward Lah
Dir.-Sales: A. E. Ehlenberger PS, GS, GH, GE

GAERTNER SCIENTIFIC CDRP., THE
1262 Wrightwaad Ave., Chicaga 14, Ill. (Tel. BUckingham 1-S33S)
Purch. Agent: L. V. Masbarger
Sales Mgr.: Lyman W. Higgins
CD, TS

GAHAGAN INC.
Waterman Ave., Esmand 17, R. I. (Tel. CEnterdale 1-4000)
Purch. Agent: E. Jahnsan
Sales: E. S. Holland

GALLAND-HENNING NOPAK DIV.
2753 S. 31st St., Milwaukee 46, Wisc. (Tel. MItchell S-6000)
Sales Mgr.: R. W. Peterman
Dir.-Purch.: R. J. White

G. W. GALLDWAY CO.
220 S. 1st Ave., Arcadia, Calif. (Tel. RYan 1-4961)
Purch. Agent: M. J. Carlaw
V. P.-Sales: M. E. Tait

GAMEWELL CO., THE
1238 Chestnut St., Newtan Upper Falls, Mass. (Tel. BIgelaw 4-1240)
Purch. Agent: E. D'Hallaran
Sales Mgr., Patentiameter Div.: J. Manning
GE, CC, TS, TR, R&D

GARDEN CITY FAN CO.
801 N. Eighth St., Niles, Mich. (MUtual 3-11S0)
Asst. Treas.-Purch. Agent: J. Gertz
Sales Engr.: E. E. Falkers
Pres.: G. E. Bauer

GARDNER-DENVER CD.
Front St., Quincy, Ill. (Tel. BAldwin 2-S400)
Dir.-Purch.: E. E. Graves
Gen. Sales Mgr.: G. W. Gutekunst MF, GH

GARDE MFG. CD.
S3 Jahn St., Cumberland, R. I. (Tel. PAwtucket 6-4200)
Purch. Agent: Charles H. D'Kaomian
Pres.: A. C. Demurjian

GARDNER LABORATORY, INC.
P. D. Box 5728, Bethesda 14, Md. (Tel. DL 6-3600)
Head-Purch. Dept.: W. J. Furmage
Head-Sales: Henry A. Gardner, Jr. TS

GEORGE K. GARRETT CO., INC.
Torresdale Ave. at Talbut St., Philadelphia 36, Pa. (Tel. DEvanshire 2-6000)
Purch. Agent: Joseph Armstrang
Sales Mgr.: Walter G. Jahnsan MM

GARRETT CORP., THE, AIR CRUISERS DIV.
Rt. 34, Wall Township, N. J.; P. O. Box 180, Belmar, N. J. (Tel. MUtual 1-3S27)
Purch. Agent: W. Haward Trawbridge
Div. Mgr.: Walter L. Clark
Mgr., Contract Admin.: Earl E. Dix MF, PS

GAS APPLIANCE STORES, INC.
Box S0S7, Columbia, S. C. (Tel. ALpine 2-7248)
Pres.: J. C. Beatty

GASKET MFG. CO. INC.
319 W. 17th St., Las Angeles 15, Calif. (Tel. RIchmand 9-4063)
Purch.: C. Lane
Sales: D. W. Goodin MF, WN, PS

GATKE CDRP.
248 N. LaSalle St., Chicago 1, Ill. (Tel. STate 2-0081)
Purch. Agent: W. R. Berngen
Buyer: J. Call
V. P.-Sales: F. T. Gatke MF, WN, PS, MM

GENALEX DIV.-BRITISH INDUSTRIES CORP.
80 Share Rd., Part Washingtan, N. Y. (Te. PO 7-7700)
Dir.-Sales: Ed Carnfield

GENERAL ALLDYS CD.
367-40S W. First St., Baston, Mass. (Tel. ANdrew 8-1710)
Purch. Agent: John Barnes
Asst. Sales Mgr.: Allyn S. Crawfard
V. P.-Sales Mgr.: Thamas E. Franks MM

GENERAL AMERICAN TRANSPORTATIDN CDRP.
135 S. LaSalle St., Chicago 90, Ill. (Tel. FInancial 6-4100)
Dir.-Purch.: C. Ingraham
Asst. Dir.-Purch.: W. Graham
Purch. Agent: E. Rathenbaum

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsian System PS
Graund Support GS
Graund Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Develapment R&D
Materials & Metals MM

GENERAL AUTOMATIC CORP.
12 Carlton Ave., Mountain View, Wayne, N. J. (Tel. CLifford 6-2756)
Sales Mgr.: Mort D. Barron GS, CO, TS, TR

GENERAL BOX CO.
1825 Miner St., Des Plaines, Ill. (Tel. VAnderbilt 4-4181)
V. P. & Dir.-Purch.: C. Claude Watkins
V. P. & Sales Mgr.: David B. Forrester

GENERAL CABLE CORP.
420 Lexington Ave., New York 17, N. Y. (Tel. LExington 2-2920)
V. P.-Purch.: E. B. McGrew
V. P.-Sales: H. G. Richardson
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM

GENERAL CEMENT MFG. CO., DIV.-TEXTRON INC.
400 S. Wyman St., Rockford, Ill. (Tel. WOodland 8-9661)
Purch. Agent: George Kampmeir
V. P.-Sales: R. D. Gawne
MF, WN, PS, GS, GH, GE

GENERAL COIL PROOUCTS CORP.
147-12 Liberty Ave., Jamaica 35, N. Y.
Pres.: J. F. Siegel

GENERAL COMMUNICATION CO.
677 Beacon St., Boston 15, Mass. (Tel. COpley 7-6030)
Purch. Agent: J. M. Orsillo
Buyers: B. E. Johnston & D. A. Collignon
Dir.-Sales: J. L. Weis
Sales: C. E. Roche GS, CO, TS, TR, MM

GENERAL COMPONENTS INC.
225 E. 144th St., New York 51, N. Y. (Tel. MOtthaven 5-0740)
Purch. Agent: Michael Meola
Chief Engr.: Sal De Ianni
Sales Mgr.: Henry Meola
MF, WN, PS, GS, GH, GE, TR

GENERAL CRYSTAL CO., INC.
372 Wilmot Ave., Burlington, Wisc. (Tel. ROckwell 3-2425)
Treas.: J. H. Larimer
Sales Mgr.: Norden Haus TR

GENERAL DESIGN
631 30th St., San Diego, Calif. (Tel. BE 4-2090)
Dir.-Purch.: L. M. Foss
Sales Engr.: J. C. Pemberton TS, R&O

GENERAL OEVICES, INC.
P. O. Box 253, Princeton, N. J. (Tel. DAvis 9-2323)
Purch. Agent: J. B. Schmidt
Buyers: R. Torgeson & L. Irvine
Contract Mgr.: Murray Medvin GE, TR, R&O

GENERAL ELECTRIC CO., APPARATUS SALES DIV.
1 River Rd., Schenectady 5, N. Y. (Tel. FRanklin 4-2211)
Mgr.-Material: H. F. Conway
Buyer: F. J. Sullivan
Mgr.-Mil. Pwr. Supply Sales: J. R. Topper
WN, PS, GS, GE, CO, TR, R&O

GENERAL ELECTRIC CO., CATHOOE RAY TUBE OEPT.
Bldg. 6, Electronics Park, Syracuse, N. Y. (Tel. GR 6-4411)
Purch. Agent: D. R. Coffman
WN, PS, GS, GH, GE, CO, TS, TR, MM, R&O

GENERAL ELECTRIC CO., COMPUTER OEPT.
13430 N. Black Canyon Hwy., Box 270, Phoenix, Ariz. (Tel. WI 3-2351)
Purch. Mgr.: J. P. Barford
Purch., Sheet Metal Parts: S. T. Brown
Purch., Electromechanical Assemblies: S. Karp
Purch., Electrical Components: W. Adams
Mgr.-Mktg.: G. A. Hagerty
GS, CO, TS, R&O

GENERAL ELECTRIC CO., DEFENSE SYSTEMS DEPT.
Bldg. 1, Electronics Park, Syracuse, N. Y. (Tel. GRanite 6-4411)
Purch. Agent: J. M. Parmelee
Buyers: J. E. Gantley, G. P. Dittmar & J. R. Hanson
Sr. Buyer: C. F. Moore
Mktg. Mgr.: Warner R. Sinback
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&O

GENERAL ELECTRIC CO., HEAVY MILITARY ELECTRONICS OEPT.
Court St., Syracuse, N. Y. (Tel. GRanite 6-4411)
Purch. Agent: R. H. Pickett
Sales Mgr.: R. J. Brown
GS, GH, GE, CO, TS, TR, R&O

GENERAL ELECTRIC CO., INSULATOR DEPT.
S. Charles & Cromwell Sts., Baltimore, Md. (Tel. PLaza 2-8020)
Mgr.-Materials: K. W. Ashman
Buyers: R. J. Mytke & E. H. Rickels
Mgr.-Headquarters Sales: C. B. Vaughn

GENERAL ELECTRIC CO., LAMP GLASS OEPT.
Nela Park, Cleveland, Ohio (Tel. IVanhoe 6-3000)
Mktg. Mgr.: W. R. Becker

GENERAL ELECTRIC CO., LAMP METALS & COMPONENTS OEPT.
21800 Tungsten Rd., Cleveland 17, Ohio (Tel. KEnmore 1-5050)
Purch. Mgr.: F. P. Nemec, Nela Park 12, O. (Tel. GLenville 1-6600)
Mktg. Mgr.: J. W. Forbes MM

GENERAL ELECTRIC CO., METALLURGICAL PROOUCTS OEPT.
11177 E. 8 Mile Rd., Detroit 32, Mich. (Tel. JEfferson 6-9100)
Purch. Mgr.: H. Millar
Mgr.-Specialty Alloy Mfg.: J. D. Benedict
Mgr.-Sales, Specialty Alloys: J. Stevenson MM

GENERAL ELECTRIC CO., MISSILE & SPACE VEHICLE OEPT.
Lakeside Ave., Burlington, Vt. (Tel. UNiversity 3-3411)
Mgr.-Materials: G. W. Curry
Purch. Agent: J. H. Drury
Mktg. Mgr.: R. G. Loecher
MF, WN, GS, GH, CO, TS, MM

GENERAL ELECTRIC CO., MISSILE & SPACE VEHICLE OEPT. (P.A.)
3198 Chestnut St., Philadelphia 4, Pa. (Tel. EVergreen 2-7800)
Purch. Mgr.: J. P. Benzie
Mgr., Sub-contracting: K. N. Thompson
Mgr.-Mktg.: R. M. Fritz
WN, GS, GH, CO, TS, TR, MM, R&O

GENERAL ELECTRIC CO., TECHNICAL PROOUCTS OEPT.
Electronics Park, Bldg. 6, Syracuse, N. Y. (Tel. GRanite 6-4411)
Purch. Agent: F. M. Brown
Sales Mgr.: C. S. Simon
Mgr., Mktg. Oev.: C. W. Michaels TS, TR, R&O

GENERAL ELECTRIC CO., WIRE & CABLE OEPT.
1285 Boston Ave., Bridgeport 2, Conn. (Tel. EDison 4-1012)
Mgr.-Materials: R. H. Merrill
Mgr.-Mktg.: J. S. Overstreet MM

GENERAL ELECTRIC CO., X-RAY DEPT.
4855 Electric Ave., Milwaukee 1, Wisc. (Tel. EVergreen 3-3211)
Mgr.-Materials: S. D. Hayward
Mgr.-Indsl. Sales: J. W. Webster TS, TR, MM

GENERAL ELECTROOYNAMICS CORP.
4430 Forest Lane, P. O. Box 517, Garland, Texas (Tel. BRoadway 6-1161)
Purch. Agent: Joe A. Matthews
Exec. V. P.: Francis J. Salgo
Mgr., Tube Oiv.: Herman Albertine, Jr.
Mgr., Equipment Oiv.: B. W. Griffith GE, TR, R&D

GENERAL ELECTRO-MECHANICAL CORP.
785 Hertel Ave., Buffalo 7, N. Y. (Tel. BE 9685)
Purch. Agent: E. Kurtz
Sales Mgr.: E. B. Butler GS, GH

GENERAL FILTERS, INC.
43800 Grand River Ave., Novi, Mich. (Tel. Fieldbrook 9-2481)
V. P.-Purch.: Roland A. Redner
Pres.: Mrs. Grace Redner GS, GH

GENERAL FIRE EXTINGUISHER CORP., THE
8740 Washington Blvd., Culver City, Calif. (Tel. TExas 0-6644)
Purch. Agent: T. L. Windsor
V. P.-Sales: E. K. Paine GS

GENERAL GASKET INC.
Middletown, Conn. (Tel. Diamond 6-6203)
V. P.-Purch.: E. London
V. P.-Sales: D. London MF, WN, PS, GE, TR

GENERAL INSULATED WIRE WORKS
69 Gordon Ave., Providence 5, R. I. (Tel. HOpkins 1-2100)
Purch. Agent: M. Fargnoli
Sales Mgr.: C. J. Craig, Jr.

GENERAL KINETICS, INC.
555 23rd St., S., Arlington 2, Va. (Tel. OTis 4-7555)
Purch. Agent: S. P. Vanderslice
V. P.-Sales: W. L. Anderson TS

GENERAL LABORATORY ASSOCIATES, INC.
17 E. Railroad St., Norwich, N. Y. (Tel. 4-3264)
Purch. Agent: Harold H. Horton
Dir.-Sales & Service: L. A. DeMellier PS

GENERAL LOGISTICS OIV., AEROQUIP CORP.
2929 Floyd St., Burbank, Calif. (Tel. VIctoria 9-5831)
Sales Mgr.: Dick Mosher
Eastern Sales Mgr.: L. S. Haynes, Jr., Jackson, Mich. (Tel. STate 2-0361) GH, MM

GENERAL MAGNETICS, INC.
135 Bloomfield Ave., Bloomfield, N. J. (Tel. PIlgrim 8-2400)
V. P.-Sales: M. G. Tekosky
Secy.-Treas.: Ralph W. Froese GE, TR, R&D

GENERAL MOTORS CORP., ALLISON OIV.
Main & 13th Speedway, Indianapolis, Ind.

GENERAL PHONES CORP.
5711 Howe St., Pittsburgh 32, Pa. (Tel. EMerson 1-7970)
V.P.-Purch.: L. McClure Lanning TI

GENERAL PHOTO PRODUCTS CO., INC.
15 Summit Ave., Chatham, N. J. (Tel. ME 5-5200)
Mgr.: R. J. Paulas G

GENERAL PLASTICS CORP. OF NEW JERSEY
165 3rd Ave., Paterson, N. J. (Tel. ARmory 4-4710)
Purch. Agent: H. Barto
Sales: E. W. Davidson

GENERAL PRECISION LAB. INC.
63 Bedford Rd., Pleasantville, N. Y. (Tel. ROgers 9-5000)
Dir.-Purch.: A. C. Schreiber
V. P.-Avionic Sales: W. J. Tull
V. P.-Ind. Sales: B. Foulds GE, TR, R&

GENERAL PROOUCTS CORP.
Salem St., Union Springs, N. Y. (Tel. 7-7367)
Purch. Agent: D. L. Webb
Sales Mgr.: C. Howard Leaf GS, GE, CO, TS, T

GENERAL RAOIO CO.
275 Massachusetts Ave., Cambridge 39, Mass. (Tel TRowbridge 6-4400)
Purch. Mgr.: Colby E. Kelly, 22 Baker Ave., West Concord, Mass. (Tel. EMerson 9-4400, Ext. 202)
Sales Mgr.: Myron T. Smith

GENERAL R-F FITTINGS, INC.
702 Beacon St., Boston, Mass. (Tel. KEnmor 6-2290)
Purch. Agent: Robert J. Hoff
V. P.-Engrg.: Owen L. Cook
MF, PS, GS, GH, GE, CO, TS, T

GENERAL SCIENTIFIC EQUIPMENT CO.
7516 Limekiln Pike, Philadelphia 50, Pa. (Tel. HAncock 4-1550)
Purch. Agent: J. Q. Kline
Head-Sales: M. Kline
PS, GS, GH, GE, CO, TS, T

GENERAL TESTING LABS., INC.
580 Washington Ave., Carlstadt, N. J. (WEbster 9-6933)
Dir.-Purch.: R. F. Furlong
Sales Engr.: A. N. Purdy TS, R&

GENERAL TRANSISTOR CORP.
91-27 138th Pl., Jamaica 35, N. Y. (Tel. HIckory 1-1000)
Purch. Agent: John Grillo T

GENERAL TRANSISTOR WESTERN CORP.
6110 Venice Blvd., Los Angeles 34, Calif. (Tel. WEbster 3-5867)
Purch. Agent: Hugh Aspinwall
V. P.-Sales: Martin Braude GE, R&

GENERAL VACUUM CORP.
400 Border St., E. Boston 28, Mass. (Tel. LOgan 7-8800)
Purch. Agent: D. J. Tobin
Dir.-Sales: W. G. Overacker

GENISCO, INC.
2233 Federal Ave., Los Angeles 64, Calif. (Tel. BRadshaw 2-2706)
Purch. Agent: G. F. Coyle
Sales Mgr., Instrument Div.: Leon Glazerman
Sales Mgr., Mechanical Div.: M. A. White
GE, TS, R&

GENISCO, INC., INSTRUMENT OIV.
2209 Barry St., Los Angeles 64, Calif. (Tel. GRanite 8-1276)
Purch. Agent: Gerry Coyle
Sales Mgr.: Leon J. Glazerman GE, TS,

GENISTRON, INC.
2301 Federal Ave., Los Angeles 64, Calif. (Tel. BRadshaw 2-0189)
Purch. Agent: John Brunskill
Sales Mgr.: John F. Harrison TS,

GENTEX CORP.
450 Seventh Ave., New York 1, N. Y. (Tel. CHickering 4-6400)
Purch. Agent: Elmer Kugler, Carbondale, Pa. (Te CArbondale 1840)

GEORATOR CORP.
315 Tudor St., Manassas, Va. (Tel. EMpire 8-2101

Pres.: Shelley Krasnow
Purch. Agent: Worth Hatch GS, TS

GEOTRONIC LABS. INC.
1314 Cedar Hill Ave., Dallas 8, Texas (Tel. WH 6-9123)
Dir.-Purch.: D. B. Rennen GE, CO, TS, TR, R&D

GERBET HAIRSPRING CO.
Bridge St., Thomaston, Conn. (Tel. ATlas 3-4857)
Partner: Jack Weiss

GERING PRODUCTS, INC.
N. 7th St. & Monroe Ave., Kenilworth, N. J. (Tel. New York City — COrtland 7-3583; N. J. — BRidge 6-2900)
Purch. Agent: M. J. Malik
Dir.-Sales: Horton Conrad MM

G. M. GIANNINI & CO., INC.
918 E. Green St., Pasadena, Calif. (Tel. RYan 1-7152)
V. P. & Gen. Mgr.: D. R. Gero GE, TR, R&D

GIANNINI PLASMADYNE CORP.
3839 S. Main St., Santa Ana, Calif. (Tel. KImberly 5-7171)
Head Buyer: Murray Sturmer
Dir.-Sales: R. D. Webb PS, R&D

GIBSON ELECTRIC CO.
Box 559, Delmont, Pa. (Tel. HOward 8-7701)
Purch. Agent: Raymond C. Honnegan
Buyer & Asst. Purch. Agent: Miss Addie Glaub
Sales Mgr.: Frederick R. Farnham MF, WN, GH, GE, TR, MM

GILFILLAN BROS. INC.
1815 Venice Blvd., Los Angeles, Calif. (Tel. DUnkirk 1-3441)
Purch. Agent: John L. Forrest
Asst. Purch. Agent, Electrical Parts: George Steil
Asst. Purch. Agent, Outside Production-Machined Parts: William Chew
Asst. Purch. Agent, Outside Production-Sheet Metal: Joseph Copeland
V. P.-Sales: A. Jennings Brown GS, GE, CO, TS, TR, R&D

GILL ELECTRIC MFG. CORP.
624 W. Citrus Ave., Redlands, Calif. (Tel. PYramid 3-3131)
Purch. Agent: V. D. Wilson

GILLIES, DUNCAN M. GILLIES CO. INC.
56 Central, West Boylston, Mass. (Tel. TEmple 5-4445)
Pres.: Duncan M. Gillies

GILMAN, ARTY GILMAN, INC.
Gilman, Conn. (Tel. TUrner 7-4945)
Pres.: Martin J. Gilman

GILMAN BROTHERS CO., THE
Gilman, Conn. (Tel. TUrner 9-8444)
Pres.: Lawrence M. Gilman
Sales Mgr.: Rose Tangari MM

GILMORE INDUSTRIES, INC.
3015 Woodland Ave., Cleveland 20, O. (Tel. RA 1-6400)
Purch. Agent: M. Nager
V. P.-Sales: L. S. Winston GS, CO, TS, R&D

GITS BROTHERS MFG. CO.
846 S. Kilbourn Ave., Chicago 23, Ill. (Tel. LAwndale 1-3554)
Purch. Agent: R. Sherman
Sales: R. W. Barz PS, GS, TS

GLADDING, McBEAN & CO.
701 Los Feliz Blvd., Los Angeles 39, Calif. (Tel. NOrmandy 3-3361)
Purch. Agent: Boyd Moon
Sales: S. V. Saginor WN, MM, R&D

GLASS ENGRG. DIV., BRAUN-KNECHT-HEIMANN CO.
31 O'Niell Ave., Belmont, Calif. (Tel. LYtell 3-8276)
Purch. Agent: H. M. Warden
Sales Mgr.: H. Hutchings R&D

GLASSCO INSTRUMENT CO.
10 S. Fair Oaks Ave., Pasadena 2, Calif. (Tel. SYcamore 5-3278)
Factory Supt.: George Northrop
V. P.-Sales: C. W. Froude PS, GE, CO, TS

GLASSEAL PRODUCTS CO., INC.
111 E. Elizabeth Ave., Linden, N.J. (Tel. HU 6-2067)
Purch. Dept.: J. Graham
Gen. Sales Mgr.: Alexander Anderson MM

GLOBAR PLANT, REFRACTORIES DIV.-THE CARBORUNDUM CO.
Niagara Falls, N. Y. (Tel. 5715)
Sales Mgr.: D. S. Bowman MM, R&D

GLOBE AUTOMATIC SPRINKLER DIV., THE FYR-FYTER CO.
Unit 1, Box 750, Newark 1, N. J. (Tel. BIgelow 8-2200)
V. P.: C. T. Mallory MM

GLOBE ELECTRICAL MFG. CO.
1729 W. 134th St., Gardena, Calif. (Tel. FAculty 1-3311)
Purch. Agent: William Ostendorf
V. P.-Sales: Joe A. Gamache GS, GH, TR

GLOBE HOIST CO.
1000 E. Mermaid Lane, Philadelphia 18, Pa. (Tel. CHestnut Hill 7-3575)
Purch. Agent: William Craig
V. P.-Sales: Argus Leidy GH

GLOBE INDUSTRIES, INC.
1784 Stanley Ave., Dayton, O. (Tel. BAldwin 2-3741)
Purch. Agent: John Trostle
Purch.: Lester Zartman & Robert McRose
Sales Mgr.: Yale J. Holt PS, GS, GE

GLOBE INDUSTRIES, INC., SUPERMET DIV.
1460 Cincinnati St., Dayton, O.

GDE ENGRG. CO.
219 S. Mednik Ave., Los Angeles 22, Calif. (Tel. ANgeles 1-2183)
Purch. & Sales: Jack Goergl
Purch.: Bob Relly
Secy.: Kay Glen MF, WN, PS, GS, GE, TS, TR

JOHN GOMBOS CO., INC.
Webro Rd., Clifton, N. J. (Tel. PRescott 3-6633)
Buyer: J. M. Fuller
Production Control Dept.: M. Levitch
Methods Engr.: J. Marcelli
Sales Mgr.: Harold J. Schatz GE

GOOD ELECTRONIC CORP.
P. O. Box 2406, West Palm Beach, Fla. (Tel. VIctor 8-3241)
Pres.: Lewis F. Good, Sr. TS, R&D

GOOD-ALL ELECTRIC MFG. CO.
112 W. First St., Ogallala, Nebr. (Tel. 900)
Purch. Agent: Fronk Pincheon
Chief Engr.: Loren Kolste
Sales Mgr.: E. M. Sheridan GS, GE, CO, TS, TR, R&D

B. F. GOODRICH AVIATION PRODUCTS
500 S. Main St., Akron, O. (Tel. BLackstone 3-1171)
Gen. Mgr.-Sales: E. H. Fitch WN, PS, MM, R&D

B. F. GOODRICH CO., THE
Shelton, Conn. (Tel. REgent 5-4661)
Purch. Agent: Robert Nicol
Asst. Purch. Agent: Edward Grant
Buyers: Alfred Fisher & Samuel Goodman
Sales Mgr.: J. I. Gillis

B. F. GOODRICH INDUSTRIAL PRODUCTS CO.
500 S. Main St., Akron 18, O. (Tel. BLackstone 3-1171)
Dir.-Adv.: H. E. Van Petten

GODDYEAR AIRCRAFT CORP.
1210 Massillon Rd., Akron 15, O. (Tel. REpublic 3-6361)
Purch. Agent: H. A. Delaney
Mgr.-Material Purch.: A. L. Grovesmuehl
Mgr.-Subcontract Purch.: W. R. Reed

GOODYEAR TIRE & RUBBER CO., THE, AVIATION PRODUCTS DIV.
1144 E. Market St., Akron, Ohio (Tel. FRanklin 6-1411)
Dir.-Purch.: I. S. Ghorky
Buyer: A. J. Bartee
Gen. Mgr., Aviation Products Div.: E. M. Eickmann GS, GH, MM, R&D

CLAUD S. GORDON CO.
3000 S. Wallace St., Chicago 16, Ill. (Tel. VIctory 2-6525)
Purch. Agent: M. J. McDonagh
Sales Mgr.: F. C. Collins TS

GORDON ENTERPRISES
5362 N. Cahuenga Blvd., N. Hollywood, Calif. (Tel. POplar 6-3725)
Dir.-Purch.: D. M. Stern
Purch. Agents: R. Cohen & N. Powell
Sales Mgr.: G. W. Sutphin CO, TS, TR, R&D

GORDDS CORP.
250 Glenwood Ave., Bloomfield, N. J. (Tel. PIlgrim 3-6800)
Purch. Agent: G. B. Marchev GE, TS, TR

GORMAN-RUPP CO., THE
305 Bowman St., Mansfield, D. (Tel. LAfayette 4-4211)
Dir.-Purch.: C. R. Rupp
Purch. Agent: C. R. Frederick
Government Sales: R. E. Dwens
Sales Mgr.: James C. Gorman GS, GH

GORRELL & GORRELL
336 Old Hook Rd., Westwood, N. J. (Tel. NOrth 4-7757)
Dir.-Purch.: John Gorrell
Plant Mgr.-Purch.: Bert Bock
Chief Engr.-Purch.: Orvis Scudder TS

GEORGE GORTON MACHINE CO.
1321 Racine St., Racine, Wisc. (Tel. MElrose 4-6644)
Purch. Agent: Paul Paulson
Dir.-Sales: Kenneth Christopherson

GOSHEN RUBBER CO., INC.
641 E. Iowa St., Goshen, Ind. (Tel. 3-1111)
Purch. Agent: C. N. Everinghom
Sales Mgr.: Joseph L. Lantz

GOSLIN ELECTRIC & MFG. CO.
2921 W. Olive Ave., Burbank, Calif. (Tel. VIctoria 9-3025)
Purch. Agent: A. M. Galbraith GE, TS, TR, R&D

GOULDS PUMPS INC.
300 Fall St., Seneca Falls, N. Y. (Tel. LOgan 8-5811)
Purch. Agent: C. H. Kissel
V. P. & Sales Mgr.: E. E. Backlund GS

GOW-MAC INSTRUMENT CO.
100 Kings Rd., Madison, N. J. (Tel. FRontier 7-3450)
Pres.: James L. McFadden TS, R&D

GRAFLEX, INC.
3750 Monroe Ave., Rochester 3, N. Y. (Tel. LUdlow 6-2020)
Purch. Agent: C. S. Krembel
Asst. Purch. Agent: H. W. Griffith
Buyer-Expediter: A. M. McGovern
Contract Sales Mgr.: G. W. Lehman GE, TR

GRAFO COLLOIDS CORP.
310 Wilkes Place, Sharon, Pa. (Tel. DI 6-5023)
Asst. Secy.-Purch.: D. M. Zarella
Sales Mgr.: E. W. Willson PS, GS

GRAMM TRAILER CORP.
425 E. O'Connor Ave., Lima, Ohio (Tel. CA 9-7015)
Purch. Agent: V. D. Buchanan
Sales Mgr., Military Products: William J. Saelzler GS, GH, GE, CO, TR

GRAND CENTRAL ROCKET CO.
Box 111, Redlands, Calif. (Tel. PYramid 3-2211)
Dir.-Material: C. Dean Currier
Dir.-Mfg. & Test.: Angus Scott
Dir.-Tech. Services: Kenneth H. Jacobs
V. P. & Gen. Mgr.: Dr. Cledo Brunetti PS, TS, R&D

GRANT CHEMICAL CO., INC.
1911 N. 4th St., Baton Rouge, La. (Tel. DI 4-5633)
V. P.-Sales: Edward D. Grant, Jr.
Mgr., Resin Sales: Paul Edgar MM

GRANT GEAR WORKS, INC.
161 W. 2nd St., Boston, Mass. (Tel. AN 8-4408)
Purch. Agent: J. F. Cramwell
Sales & Adv. Mgr.: F. E. Emery PS, GS

GRANT MFG. & MACHINE CO., THE
90 Missile Ave., Bridgeport 5, Conn. (Tel. FOrest 6-4557)
Purch. Dept.: 90 Silliman Ave., Bridgeport 5, Conn. (Tel. FOrest 6-4557)

GRANT PULLEY & HARDWARE CORP.
High St., West Nyack, N. Y. (Tel. NYack 7-4400)
Purch. Mgr.: Mrs. Kay Saller
Sales: Jack Vissman

GRAPHITE METALLIZING CORP.
1038 Nepperhan Ave., Yonkers, N. Y. (Tel. YOnkers 8-8400)
V. P.-Purch. & Factory Mgr.: Edward E. Williams
Gen. Mgr.-Sales: Warren W. Walker MF, WN, PS, GS, GE, CO, TS, TR

GRAY CO., INC.
60 11th Ave., N. E., Minneapolis 13, Minn. (Tel. FEderal 6-9331)
Purch. Agent: W. F. Bloedow
Asst. Purch. Agent: L. Wandel
Ind. Sales Mgr.: E. L. Niederloh PS, GS

GRAY INSTRUMENT CO.
200 E. Church Lane, Philadelphia 44, Pa. (Tel. GE 8-3168)

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

Treas.: Tom Mother
V. P.-Sales: A. R. Bechtel TS

GREAT EASTERN METAL PRODUCTS CO.
22 Woodworth Ave., Yonkers, N. Y. (Tel. GReenlead 6-7300)
Pres.: Lester Weinberg MM, R&D

GREAT LAKES CARBON CORP., ELECTRODE DIV.
18 E. 48th St., New York 17, N. Y. (Tel. ELdorado 5-6200)
Gen. Sales Mgr.: Samuel H. Reynolds
Purch. Dept.: P. O. Box 637, Pine Ave. at 58th St., Niagara Falls, N. Y. (Tel. BUtler 3-7611)
Purch.-Dir.: George H. Corney MM

GREAT LAKES MFG. CORP.
4223 Monticello Blvd., Cleveland 21, Ohio (Tel. EVergreen 2-5500)
Purch. Agent: R. A. Swanson
Buyer: S. E. Baginski
Pres.: J. A. Kanuch MF, WN, PS, GS, GH, GE, TS

GREEN INSTRUMENT CO.
385 Putnam Ave., Cambridge 39, Mass. (Tel. ELiot 4-2989)
Purch. Agent: Lynd F. Tillyer
Sales Mgr.: W. Franklin Fullerton GS

GREEN RECTIFIER CO.
1-10 30th St., Fairlawn, N. J. (Tel. SWarthmore 7-8100)
Dir.-Purch.: I. Green
MF, WN, PS, GS, GH, GE, CO, TS, TR

GREENBRIER INSTRUMENTS INC.
Ronceverte, W. Va. (Tel. Midway 7-4358)
Office Mgr.: R. L. Weikle
Sales: Dr. D. N. Campbell PS, GS, CO, TS, TR

ARNOLD GREENE TESTING LABS., INC
122 Hampshire St., Cambridge 39, Mass. (Tel. UNiversity 4-8800)
V. P.: Robert Halliday
Sales Mgr.: Ted Mongeau TS

GREENE, TWEED & CO.
340 Elm Ave., North Wales, Pa. (Tel. DXbow 9-4821)
Asst. Purch. Agent: Dorothy M. Segall
Purch. & Sales: Walter S. Josephson

GREENFIELD TAP & DIE, DIV.-UNITED-GREENFIELD CORP.
Sanderson St., Greenfield, Mass. (Tel. PR 3-3611)
Purch. Agent: Avery Bates
Sales: W. J. Eberlein MF

GREENLEAF MFG. DIV., THE, MANDREL IND. INC.
7814 Maplewood Ind. Ct., St. Louis 17, Mo. (Tel. STerling 1-9888)
Purch. Agent: P. J. Mahony
Sales Mgr.: J. L. Wimpey GE

GREER HYDRAULICS, INC.
New York International Airport, Jamaica 30, N. Y. (Tel. OL 9-9700)
Purch. Mgr.: Ralph Betschart
Gen. Sales Mgr.: Edward M. Greer
MF, PS, GS, GH, CD, TS, R&D

GREIBACH INSTRUMENTS CORP.
315 North Ave., New Rochelle, N. Y. (Tel. New Rochelle 3-7900)
Dir.-Purch.: Lester Kanarfogel
Dir.-Sales: Gunther Bielefeld TS

GREMCO, INC.
P. O. Box 7115, 3535 N. Sylvania, Ft. Worth, Tex. (Tel. TErminal 4-2836)
Purch. Agent: A. Krsak
Sales Mgr.: J. D. Taliaferro GS, GH, R&D

GRIEVE-HENDRY CO., INC.
1401 W. Carroll Ave., Chicago, Ill. (Tel. TAylor 9-0200)
Pres.: G. P. Grieve
V. P.-Sales: P. J. Calabrese TS

GRIMES MFG. CO.
515 N. Russell St., Urbana, O. (Tel. 3-5221)
Purch. Agent: John Davis
Asst. Purch. Agent: Paul Roles
V. P.-Sales: L. B. Moore
MF, GS, GE, CO, TS, TR

GRIMSON COLDR, INC.
381 Fourth Ave., New York 16, N. Y. (Tel. OREgon 9-9088)
Sales Mgr.: Pierre Boucheron

GRINNELL CO.
227 W. Exchange St., Providence 1, R. I. (Tel. TEmple 1-7000)
Purch. Agent: W. J. Duggan
Mgr., Saunders Valves Div.: A. G. Smith
Mgr., Fire Protection Div.: D. L. Swats GH

GRIP NUT CO.
Brood & Maple, South Whitney, Ind. (Tel. S. W. 112)
Purch. Agent: M. H. Rudd
V. P.-Sales: G. A. Bovenkerk MM

GRISCOM-RUSSELL CO., THE
Massillon, Ohio (Tel. TE 2-7421)
Dir.-Purch.: J. A. O'Neill
Buyer: A. D. Miller
Sales Engr.: L. H. Bradley
V. P.-Sales: C. D. Steffens
Contract Engr.: F. V. Huber PS, GS, GH

GRDOV-PIN CDRP.
1125 Hendricks Causeway, Ridgefield, N. J. (Tel. WHitney 5-6780)
Purch. Agent: H. Bernlohr
Sales Mgr.: R. G. Cummings MF, GS, GH

GRDTNES MACHINE WDRKS, INC.
5454 N. Wolcott Ave., Chicago 40, Ill. (Tel. LDngbeoch 1-7693)
Purch. Agent: George C. Cuttner
Sales Mgr.: J. F. Coleman

GROVE VALVE & REGULATOR CO.
6529 Hollis St., Oakland 8, Calif. (Tel. OLympic 5-7700)
Purch. Agent: Roy West
V. P.-Gen. Sales Mgr.: George Doty GS, GH, TS

GRUMMAN AIRCRAFT ENGINEERING CORP.
Bethpoge, L. I., N. Y. (Tel. WElls 1-1550)
Mgr.-Proc.: William N. Robertson
Purch. Agent: Norman J. Egloff
Chief Buyer, R&D: Charles Nouss
V. P.-Contracts: George F. Titterton MF, R&D

GUARDIAN ELECTRIC MFG. CO.
1621 W. Walnut St., Chicago 12, Ill. (Tel. CHesopeake 3-1100)
Purch. Agent: W. A. Rowell
Gen. Sales Mgr.: G. G. Rowell CO, TS

GUARDITE CO., DIV.-AMERICAN-MARIETTA CO.
Box 188, Wheeling, Ill. (Tel. LEhigh 7-1000)
Purch. Agent: O. L. Carter
Sales Mgr., Environmental Equip.: S. P. Voak TS

GUDEBROD BROS. SILK CO., INC.
225 W. 34th St., New York 1, N. Y. (Tel. LAckawonna 4-5858)
Purch. Dept.: 12 S. 12th St., Philadelphia 7, Pa. (Tel. WAlnut 2-1212)
Dir.-Purch.: Fred Hooven
Dir.-Sales: F. W. Krupp MM

GUDEMAN CO., THE
340 W. Huron St., Chicago 10, Ill. (Tel. DElaware 7-7400)
Purch. Agent: Robert Eggersted
V. P.-Sales: D. A. Fillmore GE, TS, TR

GUDEMAN CO. OF CALIFORNIA, INC., THE, MONROVIA DIV.
2669 S. Myrtle Ave., Monrovia, Calif. (Tel. HIllcrest 6-3101)
Dir.-Sales: Keith R. Clark

GUIDED MISSILE DIV.-DE HAVILLAND AIRCRAFT OF CANADA, LTD.
Downsview, Ontario, Canada (Tel. MElrose 3-5230)
Purch. Agent: S. M. Gilbert
Contracts Admin.: L. D. Clarke
Sales & Research Engr.: D. B. Cannon
GS, GE, CO, TS, R&D

GULTON INDUSTRIES, INC.
212 Durham Ave., Metuchen, N. J. (Tel. Liberty 9-3038)
Purch. Agent: Julius Furchheimer
Sales Coordinator: Edward Cohen GE, TS, R&D

GUNNAR LABS.
3003 26th St., W., Bradenton, Fla. (Tel. 5-2751)
Purch.: Dr. Gunnar Knos GS, TS, TR

GUSTIN-BACON MFG. CO.
210 W. 10th St., Kansas City 5, Mo. (Tel. HArrison 1-7788)
V. P. & Dir.-Purch.: M. Shields
Purch. Dept.: T. L. Fairfax, George Crowl, Ken Klann
V. P.-Sales: F. W. Muller MM

GWILLIAM CO., THE
370 Furman St., Brooklyn 1, N. Y. (Tel. MAin 4-2644)
Purch. Agent: Johannes E. Howay
Dir.-Sales: Mark R. M. Gwilliam
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&D

GYREX CORP., THE
3003 Pennsylvania Ave., Santa Monica, Calif. (Tel. EXbrook 3-0462)
Purch. Agent: W. J. Underwood, Jr.
Dir.-Sales: W. A. Borton GS, GE, CO, TR, R&D

HPL MFG. CO.
15210 Miles Ave., Clevelond 28, Ohio (Tel. WYoming 1-5000)
Purch. Agent: J. Yasenka
Sales Mgr.: M. Lorentz MM

HABERSTROH STUDIOS, INC.
9 W. 19th St., New York 11, N. Y. (Tel. AL 5-1827)
Dir.-Purch.: Alex Haberstroh

HADDAM MFG. CO., THE
Rt. 9, Haddam, Conn. (Tel. DImond 5-2303)
Purch. Agent: Mrs. K. G. Alderman
Sales Mgr.: E. T. Buxton

B. H. HADLEY, INC.
1427 S. Garey Ave., Pomona, Calif. (Tel. NAtional 9-5075)
Purch. Agent: T. R. McCoun
Dir.-Mkt.: J. T. Reilly PS, GS, TS, R&D

HAGAN CHEMICALS & CONTROLS, INC.
Box 1346, Pittsburgh 30, Pa. (Tel. WA 2-3737)
Head-Purch.: C. E. Kaufman
Sales Mgr.: T. M. Nourse TS

HAHN & CLAY
5100 Clinton Dr., Houston, Tex. (Tel. ORchard 2-1671)
Mgr.-Purch.: Billie Sommers
V. P. Purch.: Walter Clay
Gen. Mgr.-Fab. Steel: Lawrence F. Megow
V. P.-Sales: Gene Clay MF, WN, PS, GS

HALEDY ELECTRONICS CO.
57 William St., New York 5, N. Y. (Tel. WHitehall 3-3140)
Dir.-Purch.: V. Spierer
Dir.-Sales: T. Careri TS

HALLAMORE ELECTRONICS CO.
714 N. Brookhurst St., Anaheim, Calif. (Tel. PRospect 4-1010)
Purch. Agent: Donald D. Knapp
V. P.-Contracts: John R. Frost
GS, GE, CO, TS, TR

HALLER, RAYMOND & BRDWN INC., DIV.- SINGER MFG. CO.
Science Park, State College, Po. (Tel. ADams 7-7611)
Purch. Agent: James H. Smith
Mgr.-Sales: L. D. Rexroat GE, CO, TR, R&D

HALLETT MFG. CO.
5910 Bowcroft St., Los Angeles 16, Calif. (Tel. TE 0-7094)
Mgr.-Prac.: Robert D. Leeseman
V. P.-Sales: Stanley E. Estes PS, GS, GH

HALLIBURTON, INC., MFG. DIV.
4724 S. Boyle Ave., Los Angeles 58, Calif. (Tel. LUdlow 8-3181)
Purch. Agent: E. V. Kompschmidt
Sales Mgr.: J. W. Murphy
GS, GH, TS, TR, R&D

HALLICRAFTERS
4401 W. Fifth Ave., Chicago 24, Ill. (Tel. VA 6-6300)
Dir.-Purch.: Cliff Matthews
Asst. to Pres.: W. E. Peugh GS, GE, CO, TR

HALLIKAINEN INSTRUMENTS
1341 7th St., Berkeley 10, Calif. (Tel. LAndscape 4-1757)
Purch. Agent: W. C. Bagot
V. P. & Sales Mgr.: E. F. Schimbor TS, R&D

HALOGEN INSULATOR & SEAL CORP.
9960 Pacific Ave., Franklin Park, Ill. (Tel. GLadstone 5-9000)
Purch. Agent: Wolter Lucos
Head-Sales: H. L. Asp MF, P

HAMER VALVES, INC.
2919 Gardenia Ave., Box 1851, Long Beach 1, Calif. (Tel. GArfield 7-5491)
Purch. Agent: Lloyd Sheneberger
Sales Mgr.: Cleo P. Williamson

HAMILTON FOUNDRY & MACHINE CO., THE
1551 Lincoln Ave., Hamilton, Ohio

HAMILTON KENT MFG. CO.
427 W. Grant St., Kent, O. (Tel. ORchard 3-9555)
Dir.-Purch.: David Green
Dir.-Sales: E. J. Mulcahey GS, G

HAMILTON STANDARD, DIV.-UNITED AIRCRAFT CORP.
Windsor Locks, Conn. (Tel. NAtional 3-1621)
Purch. Mgr.: John Spade
Asst. Purch. Mgr.: Wendell W. Suydam
Sales Mgr.: John Burridge
MF, PS, GS, CO, TS, R&

HAMILTON WATCH CO.
Lancaster, Pa. (Tel. EXpress 4-7161)
Purch. Agent: C. S. Reese
Asst. Purch. Agent: J. H. Leaman
Mgr.-Indsl. Sales: G. White GE, TS,

AMILTON WATCH CO., HATHAWAY INSTRUMENT DIV.
5800 E. Jewell, Denver 22, Colo. (Tel. SKyline 6-8301)
Purch. Agent: F. J. Knafelec
Gen. Sales Mgr.: R. A. Miller CO, TS, R&D

AMILTON WATCH CO.-INDUSTRIAL DIV.
Columbia Ave., Lancaster, Pa. (Tel. EXpress 4-7161)
Purch. Dir.: J. H. Leaman
Dir.-Sales: Geo. C. White GE, TR, MM, R&D

AMILTON WATCH CO., MILITARY PRODUCTS DIV.
Lancaster, Pa. (Tel. EXpress 4-7161)
Purch. Agent: Clarence S. Reese
Asst. Purch. Agent: J. H. Leaman
Mgr.-Customer Engrg. Military Prods. Div.: George F. Roberts
MF, WN, PS, GS, GE, CD, TS, TR

AMLIN, INC.
1316 Sherman Ave., Evanston, Ill. (Tel. GReenleaf 5-8244)
Dir.-Purch.: Ranald Ferguson GE

AMMARLUND MFG., CO., INC.
460 W. 34th, New York 1, N. Y. (Tel. LOngacre 5-1300)
Head-Purch.: Wm. Griffen
Gen. Sales Mgr.: H. A. McCloskey
GS, GE, CO, TS, TR, R&D

AMMEL-DAHL DIV.-GENERAL CONTROLS CO.
Warwick Industrial Park, Warwick, R. I. (Tel. STuart 1-6200)
Purch. & Prod. Coordinator: Forrest G. Brown
Sales Mgr.: William R. Kennedy
Buyer: Eugene E. Collins PS, TS

AMPDEN BRASS & ALUMINUM CO.
62 Liberty St., Springfield 1, Mass. (Tel. REpublic 6-1808)
Purch. Agent: Richard A. Wallace

AMPDEN MFG. CO., INC.
Ridge St., Three Rivers, Mass. (Tel. PAlmer 353)
Pres.: Castle Day
Purch. Agent: T. H. Lasares GE, TS

ANDICRAFT TOOLS, INC., DIV.-X-ACTO, INC.
241 Van Dam St., Long Island City 1, N. Y. (Tel. EXeter 2-3333)
Purch. Agent: Mrs. Agnes Tinkler

ANDY & HARMAN
Fulton St., New York 38, N. Y. (Tel. BEekman 3-2460)
Pres.-Sales: Paul G. Feld MM

ANSON & WILSON CO., THE
Pittsburgh 21, Pa. (Tel. PE 1-1250)
Purch. Agent: H. Cleevely
Chief Engr.: S. J. Hannon
Sales Mgr.: W. G. Weil PS, MM, R&D

ANNIFIN CO., DIV.-PARKER-HANNIFIN CORP.
4-D S. Wolf Rd., Des Plaines, Ill. (Tel. WAnderbilt 7-1171)
Gen. Secy.: M. R. Gault
Purch. Agent: Chester A. Miller
Buyer: W. W. Herrmann
Pres.-Sales: O. J. Maha GS, GH

HANSEN ELECTRONICS CO.
2717 Santa Monica Blvd., Los Angeles 46, Calif. (Tel. HO 9-3052)
Gen. Mgr.: E. K. Stokes GE, TR

HANSEN MFG. CO., THE
241 W. 150th St., Cleveland 35, Ohio (Tel. Clearwater 2-3880)
Purch. Agent: W. A. Drexler
V.P. & Gen. Sales Mgr.: L. J. Hansen GS

HANSEN MFG. CO. INC.
114 S. Hart St., Princeton, Ind. (Tel. FUlton 3-3415)
Treas.: A. C. Rothert PS, GE

HANSON-GORRILL-BRIAN, INC.
85 Hazel St., Glen Cove, N. Y. (Tel. ORiole 7-7300)
Purch. Agent: J. S. Truesdell
Sales Engr: W. K. Burlingame GS, CO, TS, TR

HAPAN CONVEYORS, INC.
65 Gibson St., Kalamazoo, Mich. (Tel. FIside 4-1675)
Buyer: James Hollis
Dir.-Sales: L. J. Riege MM

HARBOR CONTAINERS DIV.-HARBOR BOAT BUILDING CO.
25 Cannery St., Terminal Island, Calif. (Tel. Terminal 2-5381)
Purch. Mgr.: Ray Rinderkneckt, Sr.
Sales Mgr.: A. W. Wall GS
(See page 55 for Advertisement)

HARCO LABS., INC.
77 Olive St., New Haven, Conn. (Tel. STate 7-6701)
Purch. Agent: Michael M. Gagliardi
Sales Mgr.: M. B. Marshall PS, GS, CO, TS

HAR-CONN CHROME CO.
603 New Park Ave., West Hartford 10, Conn. (Tel. AD 3-6225)
Gen. Mgr. & Purch. Agent: V. C. Hickey
Secy. & Sales Mgr.: T. J. O'Brien
MF, WN, PS, GS, GH, GE, TR, MM, R&D

PAUL HARDEMAN, INC.
11558 Tennessee Ave., Los Angeles, Calif. (Tel. BRadshaw 2-7861)
Purch. Dept. Mgr.: E. J. Lull
Admin. V. P.: H. J. Coil GS, TS

HARDINGE BROTHERS, INC.
1420 College Ave., Elmira, N. Y. (Tel. REgent 4-6256)
Purch. Agent: C. R. Bauman
V. P.-Sales: H. A. Lundy

HARDMAN TOOL & ENGRG. CO.
1845 S. Bundy Dr., West Los Angeles 25, Calif. (Tel. BRadshaw 2-0266)
Dir.-Purch.: A. C. Richardson
Sales & Adv. Mgr.: Douglas D'Neol GH

HARMAN EQUIPMENT CO.
3605 E. Olympic Blvd., Los Angeles 23, Calif. (Tel. ANgeles 1-4113)
Purch. Agent: F. Van Zant
Sales Mgr., Filter Div.: G. J. Horman, Jr.
PS, GS, GH

H. M HARPER CO.
8200 Lehigh Ave., Morton Grove, Ill. (Tel. OR 4-3000)
V. P.-Purch.: Theodore Wickman
V. P.-Sales: E. A. Chonner
Purch. Agent: James Fairbairn MM

HARPER ENGRG. CO.
3308 Airport Ave., Santa Monica, Calif. (Tel. EXmont 1-6244)
Dir.-Purch.: Robert L. Voehringer
V. P.-Sales: Donald L. Cox
MF, WN, PS, GS, GH, GE, CO, TS, TR, R&D

HARPER-LEADER, INC.
1046 S. Main St., Waterbury 20, Conn. (Tel. PLaza 6-8164)
Pres.: P. J. Sloane
Secy.-Treas.: I. Cross MF, WN, PS, GE, TR

HARRIS REFRIGERATION CO.
308 River St., Cambridge 39, Mass. (Tel. UNiversity 4-4000)
Chief Engr.: Charles W. J. Harris
Sales Mgr.: Rolland S. Jamison TS

HARRISBURG STEEL CO.
Herr St., Harrisburg, Pa. (Tel. CEdar 4-8021)
Dir.-Purch.: Lee Muth
V. P.-Sales: H. M. Reeser MF, WN, PS, GS, GH

HARRISON LABS., INC.
45 Industrial Rd., Berkeley Hts, N. J. (Tel. CR 3-9123)
Purch. Agent: M. Barbour
Sales & Adv. Mgr.: A. M. Darbie
GS, GE, CO, TS, TR

HART MFG. CO., THE
147 Bartholomew Ave., Hartford, Conn. (Tel. JAckson 5-3491)
Pres.: G. H. Hart
Purch. Agent: R. W. James
Chief Engr.: H. R. Dahmer
Sales Mgr.: R. E. McIntosh WN, GS, GE, TR, R&D

***HARTFORD MACHINE SCREW CO., DIV.-STANDARD SCREW CO.**
Box 1440, Hartford 2, Conn. (Tel. JAckson 5-0821)
Purch. Agent: D. T. Bacon
Asst. Purch. Agent: M. R. Derrick
Buyers: J. Braine & R. Mullowney
Gen. Sales Mgr.: J. F. Miller MS, WN, PS, GS
*(See Pages 35, 46, 54, & 76 for Advertisement)

HARTMAN ELECTRICAL MFG. CO., THE
175 N. Diamond St., Mansfield, O. (Tel. LAfayette 4-1411)
Purch. Agent: W. M. Locke
Buyer: T. Roehm
Sales Mgr.: M. Trbovich GS, GH, GE

HARVEY ALUMINUM
19200 S. Western Ave., Torrance, Calif. (Tel. NEvada 6-2111)
Purch.: Dorsey Smith MF, PS, GS, GH, MM, R&D

HARVEY-WELLS ELECTRONICS INC.
North St., Southbridge, Mass. (Tel. POrter 4-4361)
Purch. Agent: Mario D. Angelis
Dir.-Sales: A. Carl Westbom GS, GE, CD, TS, R&D

HASKEL ENGRG. & SUPPLY CO.
1236 S. Central Ave., Glendale 4, Calif. (Tel. CHapman 5-6811); 225 11th St., San Francisco 3, Calif. (Tel. UNderhill 3-1489)
Dir.-Purch.: Carter Pierce
Sales Mgr.: Ralph W. Moss GS, CO, TS

HASKELITE MFG. CORP.
701 Ann St., N. W., Grand Rapids, Mich. (Tel. GL 8-1331)
Dir.-Purch.: F. W. Mitchell
Buyer: R. J. Willemsen
Sales Mgr.-Indsl. Div.: D. G. Slawson, Jr. MM

JOHN HASSALL, INC.
Box 2179, Westbury, L. I., N. Y. (Tel. EDgewood 4-6200)
Purch.: W. W. Smith
Sales: E. F. Karnes MM

HASTINGS PLASTICS, INC.
1551 12th St., Santa Monica, Calif. (Tel. EXbrook 3-7702)
Gen. Mgr.: Norry M. Hastings
Purch. Agent: Frank Lundstrom
MF, WN, PS, GS, GH, GE, MM, R&D

HAVEG INDUSTRIES, INC.
900 Greenbank Rd., Wilmington 8, Del. (Tel. WYman 8-2271)
Purch. Agent: P. L. Reynier
Asst. Purch. Agents: C. Wall & Dayton Simpson
Gen. Mgr.: John B. Mackenzie MF, WN, MM, R&D

***HAWS DRINKING FAUCET CO.**
4th & Page Sts., Berkeley 10, Calif. (Tel. LAndscape 5-3341)
Gen. Mgr.: J. E. Traynor
Sales Mgr.: T. R. Haws PS, GS, GH, TS, R&D
*(See Page 70 for Advertisement)

***A. W. HAYDON CO., THE**
231-D N. Elm St., Waterbury, Conn. (Tel. PLaza 6-4481)
Purch. Agent: Roy E. Ahlberg
Buyers: Fred Lawton, D. Roberts, J. Thompson
Sales Mgr.: R. J. Harrant
WN, PS, GS, GH, GE, CO, TS, TR
*(See Page 74 for Advertisement)

HAYDON DIV.-GENERAL TIME CORP.
245 E. Elm St., Torrington, Conn. (Tel. HUnter 9-3158)
Purch. Agent: J. E. Nicholas
Gen. Mgr.: C. H. Cummings

HAYDON SWITCH, INC.
536 S. Leonard St., Waterbury, Conn. (Tel. PLaza 6-7441)
Purch. Agent: John J. Leugminas
Sales Mgr.: Arthur N. Milliken WN, PS, GS, CO

C. I. HAYES, INC.
800 Wellington Ave., Cranston 10, R. I. (Tel. HOpkins 1-3400)
Purch. Agent: Roy C. Arnold
Gen. Sales Mgr.: James R. Elliott MM, R&D

HAYNES STELLITE CO., DIV.-UNION CARBIDE CORP.
1020 W. Park Ave., Kokomo, Ind. (Tel. GLadstone 2-5421)
Purch. Agent: J. H. Wallsmith
Buyers: R. S. Rees, R. M. Tudor, H. M. Wolf, J. R. Clawson
V. P.-Sales: R. L. Lerch
Gen. Sales Mgr.: C. G. Chisholm MM

HAYS CORP., THE
743 E. 8th St., Michigan City, Ind. (Tel. TRiangle 2-5561)
Purch. Agent: William Wagner
Mgr.-Sales: H. M. Twible

HAYS MFG. CO.
803 W. 12th St., Erie, Pa. (Tel. 2-3225)
Purch. Agent: P. N. Christensen
Sales Mgr.: H. H. Clemens MM

HAYWARD SCIENTIFIC GLASS CORP.
217 Magnolia Ave., Whittier, Calif. (Tel. OX 5-8213)
Secy.: Henry D. Shaw
V. P.-Sales: James L. Wood GE

HAZELTINE ELECTRONICS DIV.-HAZELTINE CORP.

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

59-25 Little Neck Pkwy., Little Neck 62, N. Y. (Tel. FLushing 7-8700)
Asst. V. P.-Purch.: B. H. Rogers
Purch.: J. J. Kelly, E. L. Roseberry
V. P.-Sales: S. M. Thomas — GS, GE, R&D

HEILAND DIV.-MINNEAPOLIS-HONEYWELL
5200 E. Evans Ave., Denver 22, Colo. (Tel. SKyline 6-3681)
Purch. Agent: R. V. Bertram
Asst. Purch. Agents: Warren Lindross & Phyllis Giffin
Mgr.-Instrument Sales: Lloyd J. Moyer — CO, TS

HEINEMANN ELECTRIC CO.
Pennsylvania Ave. & Plum St., Trenton, N. J. (Tel. EXport 4-1191)
Purch. Agent: James E. Shugars
Sales Mgr.: Edgor Bromberg

HEINTZ MFG. CO.
Front St. & Dlney Ave., Philodelphia, Pa.

HEIN-WERNER CORP.
1200 National Ave., Woukesho, Wisc. (Tel. Liberty 2-6611)
Purch. Agent: M. L. Lumb
Sales Mgr.: H. J. Scullin — MF, GS

HELDOR MFG. CO., INC.
238 Lewis St., Paterson, N. J. (Tel. ARmory 1-0900)
V. P.-Purch.: Donald Wilson
Sales Mgr.: Ray Walker — MF, WN

HELI-COIL CORP.
Shelter Rock Lane, Danbury, Conn. (Tel. Pioneer 3-7651)
Purch. Agent: Ted C. Gorman
Dir.-Sales: John E. Fasano — MF, GH, MM

HELIPOT DIV.-BECKMAN INSTRUMENTS, INC.
2500 Fullerton Rd., Fullerton, Colif. (Tel. TRojan 1-4848)
Purch. Agent: Ed Schreiber
Mktg. Mgr.: Karl Heller — PS, GS, GE, CO, TS, TR

HELWIG CARBON PRODUCTS, INC.
2550 N. 30th St., Milwaukee 10, Wisc. (Tel. HIlltop 2-7755)
Purch. Agent: N. E. Joers
V. P.-Sales: J. E. Koenitzer — GE

HEMINWAY & BARTLETT MFG. CO., THE
500 Fifth Ave., New York 36, N. Y. (Tel. LOngocre 4-0880)
Sales Mgr.: C. Duane Houk — MM

HENLOPEN MFG. CO., INC.
178 Coak St., Brooklyn 6, N. Y. (Tel. GL 6-4461)
Purch. Agent: Allan Costa
Gen. Mgr.: H. Elosua

HEPPENSTALL CO.
3000 Shelby St., Indianapolis, Ind. (Tel. ST 6-9261)
Purch. Agent & Mgr.-Ring Sales: V. H. Lanahan

HERCULES POWDER CO.
900 Market St., Wilmington 99, Del. (Tel. OLympia 8-7211)
Dir.-Purch.: Edwin S. Ladley
Dir.-Sales, Explosives Dept.: C. W. Ballard — PS, R&D

HERLO ENGRG. CORP.
549 N. Prairie Ave., Hawthorne, Calif. (Tel. DS 5-4456)
Pres. & Gen. Mgr.: R. E. Cole — PS, GS

HERTNER ELECTRIC CO., THE
12690 Elmwood Ave., Cleveland 11, O. (Tel. CLearwater 2-4242)
Purch. Agent: A. G. Lindrose
Buyer: R. E. Gariepy
Dir.-Sales: T. R. Mahoney — GS, GE, CO, TS

HERZOG MINIATURE LAMP WORKS, INC.
50-17 Fifth St., Long Island City 1, N. Y. (Tel. ST 4-2275)
Pres.: Charles Perrenod
Buyer: Luke Perrenod
Asst. Buyer: William Dwyer — GS, GH, GE, CO, TS, TR, R&D

HESCO ENGRG.
322 E. Beach Ave., Inglewood 3, Calif. (Tel. DR 8-4178)
Purch. Agent: A. T. Herring
Sales Mgr.: G. F. Wilson — GS, GH, TS, TR

HEVI-DUTY ELECTRIC CO.
2040 W. Wisconsin Ave., Milwaukee Wis. (Tel. WEst 3-9339)
Purch. Agent: G. J. Bethke
V. P.-Sales: E. E. Staples — MM, R&D

HEWITT-ROBINS, INC.
666 Glenbrook Rd., Stamford, Conn. (Tel. DAvis 4-1151)
Dir.-Purch.: C. W. Mottinger
V. P.-Sales: F. L. Griffith — MF, PS, GS, GH

HEWLETT-PACKARD CO.
275 Page Mill Rd., Palo Alto, Calif. (Tel. DAvenport 5-4451)
Purch. Agent: Robert Sundberg
Asst. Purch. Agent: Donald Anderson
V. P.-Mktg.: W. N. Eldred — TS

HEXCEL PRODUCTS INC.
2332 Fourth St., Berkeley 10, Calif. (Tel. THornwall 3-4664)
Purch. Agent: R. J. Wedemyer
V. P.-Sales: R. T. Hughes
Gen. Mgr.-Aircraft: A. C. Marshall
Gen. Mgr.-Indsl.: D. P. Bailey — MM, R&D

HEYMAN MFG. CO.
Kenilworth, N. J. (Tel. CHestnut 5-2345)
Purch. Agent: K. E. Fahnestock
Sales Mgr.: J. L. Holder

HICKS CORP., THE
1671 Hyde Park Ave., Boston 36, Mass. (Tel. HY 3-2720)
Exec. V. P.-Purch.: Fronk T. Majewski
Purch. Agent: John B. Sullivon
Purch. Agent, Asheville, N. C. Plt.: Leo Lyons (Tel. ALpine 3-5335)
Sales Mgr.: John D. Wagner — WN, PS, R&D

HI-G, INC.
Bradley Field, Windsor Locks, Conn. (Tel. NAtianal 3-3308)
Prod. Mgr.: A. Molava
V. P.-Sales: R. H. Wood — GE, TR

HIGH SPEED HAMMER CO., INC., THE
313 Norton St., Rochester 21, N. Y. (Tel. CDngress 6-6740)
Purch. Agent: G. W. Texter

HIGH VACUUM EQUIPMENT CORP.
2 Churchill Rd., Hingham, Mass. (Tel. RIverview 9-2430)
Purch. Agent: Walter Albaugh
Sales Admin.: William B. White — MF, PS, MM

HIGH VOLTAGE ENGRG. CORP.
S. Bedford St., Burlington, Mass. (Tel. BR 2-1313)
Purch. Agent: Richard Chase
V. P. & Sales Mgr.: E. Alfred Burrill — TS, R&D

HIGHLAND RIM MACHINE WORKS INC.
E. Walnut St., P. O. Box 282, Dickson, Tenn. (Tel. HIckory 6-6326)
Foreman: Spydell Davidson
Secy. & Treas.: Ralph Taylor — MF, GS, GH

E. VERNON HILL & CO.
P. O. Box 189, Lake Geneva, Wisc. (Tel. CHestnut 8-3729)
Pres.: N. Peterson — MF, PS, GS, GE, CO, TS, TR

HILL ELECTRONICS, INC.
300 N. Chestnut St., Mechonicsburg, Pa. (Tel. POplar 6-7611)
Purch. Agent: Michael Filepas
Sales Mgr.: James A. Nickerson

HILLBURN ELECTRONIC PRODS. CO.
55 Nossau Ave., Brooklyn 22, N. Y. (Tel. STagg 2-3875)
Purch.: B. S. Gilman
Sales: S. A. Shaw — GE

HILLS-McCANNA CO.
3641 W. Touhy Ave., Chicago, Ill. (Tel. ORchord 4-7080)
Purch. Agent: R. Schmidt
Sales Mgr.-Foundry Div.: R. I. Allen — MF, PS, GS

HI-LO MANUFACTURING CORP.
1122-26 W. Newport Ave., Chicago 13, Ill. (Tel. GRoceland 7-1890)
Pres.: F. J. Kloncnik
Gen. Mgr.-Sales: E. A. Goncoe — GS, GH, GE, TS, TR

HINOE & DAUCH DIV.-WEST VIRGINIA PULP & PAPER CO.
407 Decatur St., Sandusky, Ohio (Tel. MA 5-6610)
Dir.-Purch.: Gerald Swank
Asst. Purch. Agent: Harold Sortorius
Dir.-Sales: Paul Roberts — MM

HINOLE TRANSFORMER CO. INC.
Woods Church Rd., R. D. 3, Flemington, N. J. (Tel. Flemington 836)
Purch. Agent: Mrs. Anne Schrimpe — GS, GH, TR

CARL HIRSCHMANN CO., INC.
30 Pork Ave., Manhasset, L. I., N. Y. (Tel. MA 7-5300)
Purch. & Sales: M. H. Kaefer — TS

HI-SHEAR RIVET TOOL CO.
2600 W. 247th St., Torronce, Colif. (Tel. NEvado 6-9861); Moiling Address: P. O. Box 90545, Airport Station, Los Angeles 45, Colif.
Purch. Agent: Stirling Souder, 8924 Bellanca Ave., Los Angeles 45, Colif. (Tel. DRegon 8-4361)
V. P.-Sales: Guy Nash — MM, R&D

HI-SPEC ELECTRONICS CORP.
7328 Ethel Ave., North Hollywood, Colif. (Tel. PDplar 5-5075)
Pres.: John H. Mattson
V. P.-Mfg.: Chet R. Jones
V. P.-Engrg.: R. Y. Patterson — GE, TI

HI-SPEED EQUIPMENT, INC.
63 Pond St., Waltham, Mass. (Tel. TWinbrook 3-6800)
Dir.-Sales: H. J. Cedrone — TI

HITCHINER MFG. CO. INC.
P. D. Box 320, Milford, N. H. (Tel. MIlford 635)
Purch. Agent: Ralph Bodwell
Plant Engr.: L. Guertin
Gen. Mgr.: David Hoodley
Sales Mgr.: William H. Shumon — MF, P

HITEMP WIRES, INC.
1200 Shames Dr., Westbury, N. Y. (Tel. EDgewood 3-4600)
Purch. Agent: Patrick Hoode
V. P.-Sales: Walter Merck — M

HOBART BROTHERS CO.
Hobart Sq., Troy, Ohio (Tel. FEderal 2-1223)
Dir.-Purch.: B. A. Lutz
Sales Mgr.: E. C. Galbreoth — MF, WN, F

JOHN W. HOBBS CORP., DIV.-STEWART-WARNER CORP.
P. D. Box 358, Springfield, Ill. (Tel. 8-7533)
Purch. Agent: P. W. Redieske
Gen. Sales Mgr.: B. D. Booth

HOBBS MFG. CO.
26 Solisbury St., Worcester, Moss. (Tel. PLeasant 6-8361)
Purch. Agent: F. J. Woodberry
Gen. Sales Mgr.: H. K. Lambert — R

HOBSON BROTHERS, INC.
4940 W. Lawrence Ave., Chicago 30, Ill. (Tel. Avenue 3-3600)
Purch. Agent: H. L. Behm
Sales: Roy L. Hobson

HOCKS LABS.
935 N. E. Couch St., Portland 14, Dre. (Tel. BE 4-1388)
Dir.-Purch.: Art Austin
Sales Mgr.: W. G. Hocks

HOEFNER CORP.
9720 Rush St., El Monte, Calif. (Tel. CUmberland 3-4138)
Purch. Agent: Arnold E. Tapie
V. P.-Sales: Grant W. Fredericks — GH, PS,

P. R. HOFFMAN CO.
321 Cherry St., Corlisle, Pa. (Tel. 1090)
Purch. Agent: Ralph J. Loury
Chemist: Warren J. Hunt
V. P.-Sales: Leon W. McGinnes

HOFFMAN ELECTRONICS CORP., SEMICONDUCTOR DIV.
930 Pitner Ave., Evanston, Ill. (Tel. UNiversity 9-9850)
Dir.-Purch.: Mrs. Dorothy Perkins
V. P.-Mktg.: G. W. DeSousa — GS, GE, CO,

HOFFMAN ENGRG. CORP.
9th & Tyler, Anoko, Minn. (Tel. HA 1-2240)
Supt.: Philip DeJarlais
Gen. Mgr.: Reuben C. Krouik

HOFFMAN LABS. DIV., HOFFMAN ELECTRONICS CORP.
3740 S. Grand Ave., Los Angeles 7, Colif. (Tel. RIchmond 7-4488)
Dir.-Materiel: R. A. Gingrich
Dir.-Military Mktg.: J. G. Anderson — GS, GE, CO, TS, TR,

HOFMAN LABS., INC.
5 Evons Terminol, Hillside, N. J. (Tel. ELizabe 4-4016)
Exec. V. P.: James Cox
Purch. Agent: Bernard Alperstein

ALFREO HOFMANN & CO.
635 59th St., West New York, N. J. (Tel. UNion 3-1300)
Purch. Agent: J. Meehan
Sales Mgr.: E. Weikert — MF, WN, PS, GS

HOGAN LABORATORIES, INC.
155 Perry St., New York 14, N. Y. (Tel. CHelse 2-7855)
Purch. Agent: Garrett Moore
Exec. V. P.-Sales: Raymond W. Bristol

C. G. HOKANSON CO., INC.
2140 Pontius Ave., Los Angeles 25, Colif. (Tel GR 7-4231) — GS, GE, CO, TS,

OKE INC.
#1 Tenakill Park, Cresskill, N. J. (Tel. LOwell 8-9100)
Dir.-Purch.: R. MacLallen
Sales Mgr.: R. J. Moody **GS**

. F. HOLDEN CO., THE
14341 Schoefer Hwy., Detroit 27, Mich. (Tel. BRoadway 3-5405)
V. P.-Purch.: J. B. Carey
Pres.: A. F. Holden

OLEX, INC.
2751 San Juan Rd., Hollister, Calif. (Tel. MErcury 7-5306)
V. P.-Operations: George H. Anderson
Dir.-Sales: J. W. Jones **MF, WN, PS, GS, GH**

OLLAND HITCH CO.
430 W. 18th St., Holland, Mich. (Tel. EX 6-6501)
Gen. Mgr.: W. F. Beebe
Purch. Agent: L. J. Poole
Sales Mgr.: C. N. Boumon **GH**

OLLEY CARBURETOR CO.
11955 E. Nine Mile Rd., Warren, Mich. (Tel. JEfferson 6-1900)
Dir.-Purch.: N. J. Oann
Sr. Buyer: E. J. Masor
V. P. & Dir.-Sales: J. C. Holley **PS, R&D**

M. HOLLINGSHEAD CORP.
340 Cooper St., Camden 2, N. J. (Tel. WOodlawn 4-7000)
Purch. Agent: Orville Timms
Dir.-Sales & Purch.: Charles W. Griffiths **GS, MM, R&D**

OLLINGSWORTH CO., SOLDERLESS TERMINAL DIV.
Nutt & French Creek Rds., Phoenixville, Pa. (Tel. WEllington 3-8947)
Purch. Agent: John J. Gress
Sales Mgr.: J. C. Ludwick

OLTZER-CABOT DIV., NATIONAL PNEUMATIC CO., INC.
125 Amory St., Boston 19, Mass. (Tel. JAmaico 4-7000)
Purch. Agent: S. Coven
Sales Mgr.: E. B. Selig **GS, TS, TR**

OLUB INDUSTRIES, INC.
113 DeKalb Ave., Sycamore, Ill. (Tel. 2161)
Secy.-Treas.: A. R. Linden
V. P. & Sales Mgr.: Gordon W. Wetzel **MF, PS, GS, GH**

OLYOKE WIRE & CABLE CORP.
20 Main St., Holyoke, Mass. (Tel. JEfferson 3-3961)
Purch. Agent: Robert J. O'Connor
Mgr.-Sales: G. T. Miles

OMALITE CORP., THE
-13 Brookside Dr., Wilmington, Del. (Tel. OL 2-6641)
Pres.: W. R. Hoover
Shop Foreman: Harold Wilson
Dir.-Sales: Thomas J. Christeson

OMELITE, DIV.-TEXTRON INC.
Riverdale Ave., Port Chester, N. Y. (Tel. WEstmore 9-3400)
Purch. Agent: John Clork
Sales Mgr.: R. P. Straetz **GS**

OMEYCOMB CO. OF AMERICA, INC.
25 Connecticut Ave., Bridgeport, Conn. (Tel. EDison 4-3155)
Purch. Agent: Louis L. LoCroce
V. P.-Sales: F. J. Quinlan **GH, MM**

OOVIG HONOLD MFG. CO.
Chester Pike & Folcroft Ave., Folcroft, Pa. (Tel. LUdlow 3-6800)
Purch. Agent: Robert Stabb
Asst. Buyer-Raw Materials: Roy Jackson
Asst. Buyer-Subcontract Parts: Elise Vonwhy
Exec. V. P.-Sales: Norman J. Burke **MF, GS, GH**

HOOVER PRODUCTS CO.
6363 S. Laramie Ave., Chicago 38, Ill. (Tel. PORtsmouth 7-6330)
Purch. Agent: Ray Swoik
Dir.-Sales: Carl E. Voughn **GS**

HOOSIER TARPAULIN & CANVAS GOODS CO., INC.
P.O. Box 574, Indianopolis 6, Ind. (Tel. ELrose 2-9451)
V. P.-Sales: Robert T. Goldberg **MM**

HOOVER ELECTRIC CO.
2100 S. Stoner Ave., Los Angeles 25, Calif. (Tel. GRanite 8-7747)
Dir. Purch.: Lennart Rinne, 2041-2045 S. Borrington Ave., Los Angeles 25, Calif. (Tel. BRodshaw 3-3125)
Gen. Mgr.: Poul Cedwood **MF, WN, PS, GS, GH, GE**

HOOVER ELECTRONICS CO.
11W. Timonium Rd., Timonium, Md. (Tel. VAlley 5-5200)
Purch. Agent: John W. Yewell
Sales Mgr.: Thomas B. Schillo **WN, PS, GS, GH, GE, TR**

HORIZONS INC.
2905 E. 79th St., Cleveland 4, Ohio (Tel. BRoadway 1-1600)
Dir.-Sales: Stuart S. Corlton **R&D**

HORKEY-MOORE ASSOCIATES
24660 S. Crenshow Blvd., Torrance, Calif. (Tel. SPruce 5-1211)
Purch. Agent: Len Henrickson
V. P.-Dev. Planning: R. C. Chilton
Mgr.-Customer Relations: W. J. Glover **MF, GH, TS, R&D**

HOSKINS MFG. CO.
4445 Lawton Ave., Detroit 8, Mich. (Tel. TYler 5-2860)
Purch. Agent: R. J. Stefonoc
V. P.-Mktg.: R. I. Cratch **MM**

***HOUDAILLE INDUSTRIES, INC., BUFFALO HYDRAULICS DIV.**
537 E. Oelovan Ave., Buffalo, N. Y. (Tel. FIllmore 8000)
Purch. Agent: V. E. Lasker
Buyer: W. E. Thompson
Gen. Mgr. & Dir.-Sales: E. L. Spencer **MF, GH**
*(See Poge 28 for Advertisement)

E. F. HOUGHTON & CO.
303 W. Lehigh Ave., Philodelphia 33, Po. (Tel. RE 9-7100)
Dir.-Purch.: H. B. Fox
Purch. Agent: C. F. Kalmboch
V. P.-Sales: Frank Ross **GH, MM**

HOUGHTON LABORATORIES, INC.
322 Houghton Ave., Olean, N. Y. (Tel. 2-2176)
Purch. Agent: Tom Quinn
Field Sales Mgr.: J. M. Jewell **MM**

T. J. HOULIHAN CO.
2510 W. Lawrence St., Chicago 25, Ill. (Tel. LO 1-0580)
Dir.-Purch.: T. J. Houlihon **GS, GE, TS, TR**

HOUSTON FEARLESS CORP.
11801 W. Olympic Blvd., Los Angeles 64, Calif. (Tel. BRadshow 2-4331)
Dir.-Prod. & Moteriol: William Katona
Purch. Agent: F. J. Gorcia
Sales Mgr.: A. J. Kjontvedt **PS, GS, GH, TR**

HOYT ELECTRICAL INSTRUMENT WORKS, BURTON ROGERS CO.
42 Corleton St., Cambridge 42, Mass. (Tel. ELiot 4-1643) **GE, CO, TS, TR, MM, R&D**

HUBER INDUSTRIES, INC.
4974 Hillside Ave., Cincinnati, Ohio (Tel. WIllow 1-1800)
Purch. Agent: K. P. Huber
Buyer: Russell R. Roeder, Jr.
Sales Mgr.: J. E. Huber **TS, TR, R&D**

HUCK MFG. CO.
2480 Bellevue Ave., Detroit 7, Mich. (Tel. WAlnut 1-6207)
Purch. Agent: Leland W. Fox
Order Dept. Mgr.: W. J. Westrick
V. P.-Sales: George Q. Mathews **MF, WN, PS**

HUDSON CUSHION CORP.
70-25 Cypress Hills St., Ridgewood 27, L. I., N. Y. (Tel. EVergreen 6-3593)
Sales Mgr.: E. Minor **R&D**

HUDSON LAMP CO.
528 Elm St., Kearny, N. J. (Tel. WYman 1-4834)
V. P.: Philip S. Rust **GS, TR**

HUDSON WIRE CO.
62 Walter St., Ossining, N. Y. (Tel. Wilson 1-8500)
Plant Mgr.-Ossining Div.: R. R. Thompson
Purch. Agent-Winsted Div.: E. O. Goodrow, Winsted, Conn. (Tel. FRontier 9-3341)
Gen. Sales Mgr.: William H. Elliott, Jr. **MF, PS, GS, TR**

HUFFORD CORP., THE
1700 E. Grand Ave., El Segundo, Calif. (Tel. ORegon 8-6221)
Purch. Agent: A. H. Knight
Buyers: Fronk Frazee & Maurice Hagberg **GS, GH, CO, TS, MM, R&D**

HUGGINS LABS., INC.
999 E. Arques Ave., Sunnyvole, Calif. (Tel. RE 6-9330)
Purch. Agent: H. O. Horting
Sales Mgr.: V. D. Vorenhorst

HUGHES AIRCRAFT CO.
Culver City, Calif. (TeL TExas 0-7111)
Missile Mfg. Div.: P. O. Box 5555 Tucson, Ariz. (Tel. MAin 4-2711)

HUGHES PRODUCTS GROUP, HUGHES AIRCRAFT CO., SEMICONDUCTOR DIV.
Internationol Airport Sta., Los Angeles 45, Calif. (Tel. ORchord 2-5011)
Sales Mgr.: H. K. Mann **GE**

HUGHES TOOL CO., AIRCRAFT DIV.
Florence & Teale Sts., Culver City, Calif. (Tel. TExas 0-7111)
Dir.-Materiel: Milton E. Taylor
Purch. Agent: C. H. Witter
Prod. Senior Buyer: C. E. Ingolls
Non-Prod. Senior Buyer: R. L. Jones
Experimentol Procurement: H. L. Rodgers, Jr.
Dir.-Contracts Admin.: Fred C. Mehner
Senior Buyer, Dir.-Contracts Admin.: Fred C. Mehner **MF, PS, GS, GH, CO, R&D**

HUGHEY & PHILLIPS, INC.
3200 N. San Fernando Blvd., Burbank, Calif. (Tel. VIctoria 9-1104)
Purch. Agent: Larry K. Craddock
V. P. & Gen. Mgr.: J. H. Ganzenhuber **GS**

HULL CORP.
Hatboro, Pa. (Tel. OSborne 5-5000)
Chief Engr.-Vacuum: Karl Wiegman
Chief Engr.-Hydroulics: Jack Smith
V. P.-Soles: Fronk Cramton

HUMAN SCIENCES RESEARCH, INC.
1408 N. Fillmore St., The Clorendan Bldg., Arlington 1, Va. (Tel. JAckson 4-3606)
V. P.: Or. William A. Lybrond
Bus. Adminstr.: Mrs. Charlotte L. Brewer

HUMPHREY, INC.
2805 Canon St., San Diego 6, Calif. (Tel. ACademy 3-1654)
Purch. Agent: R. T. Rutherford
Chief Design Engr.: Donold G. Boker
V. P.-Sales Mgr.: John H. Bender **GE, TR**

PHILIP A HUNT CO.
Roosevelt Pl., Palisades Park, N. J. (Tel. WIndsor 4-4000)
Dir.-Adv.: R. A. Root

RODNEY HUNT MACHINE CO.
Orange, Mass. (Tel. KIngsdale 4-2511)
Purch. Agent: L. M. Phillips
Asst. Purch. Agent: J. F. H. Hart
V. P.-Sales & Mktg.: J. W. Rembe **MF**

HUNT CORP., THE
453 Lincoln St., Carlisle, Pa. (Tel. 1486)
Gen. Mgr.: Samuel Ryesky
Treas.: M. E. Cochrane
Sales Mgr.: Ronald Keorns **GS, GE, TR, R&D**

HUNTER MFG. CO.
30525 Aurora Rd., Solon, Ohio (Tel. CHurchill 8-6111)
Purch. Agent: J. C. Wolfe
Sales Mgr.: Worren A. Miller **GS, GH, GE, CO, TS, R&D**

HUNTER SPRING CO., DIV.-AMERICAN MACHINE & METALS, INC.
One Spring Ave., Lonsdale, Pa. (Tel. Ulysses 5-6815)
Purch. Agent: Horoce Machado
Sales Mgr.: G. O. Bennett **MF, PS, GS, CO, TS**

HUNTER TOOL CO.
9851 Alburtis Ave., Santo Fe Springs, Calif. (Tel. OX 2-7231)
Purch. Agent: V. L. Allison
V. P.-Sales: R. N. Hunter, Jr.

HUNTER-DOUGLAS ALUMINUM CORP.
3017 Kansas Ave., Riverside, Calif.

HUNTINGTON RUBBER MILLS
7100 S. W. Macadam Ave., Portlond, Ore. (Tel. CHerry 4-7535)
Chief Purch. Agent: Mrs. Agnes Imel
Dir.-Sales: J. S. DuVol

HUPP AVIATION CO.
6633 W. 65th St., Chicago 38, Ill. (Tel. POrtsmouth 7-2100)
Purch. Mgr.: James Bovis
Gen. Sales Mgr.: John W. Painter **MF, WN, PS, GS, GE**

CODING
Missile Frame **MF**
Warhead & Nose Cone **WN**
Propulsion System **PS**
Ground Support **GS**
Ground Handling **GH**
Guidance Equipment **GE**
Checkout Equipment **CO**
Test Equipment **TS**
Tracking & Telemetering **TR**
Research & Development **R&D**
Materials & Metals **MM**

HUPPERT, K. H., CO.
6830 Cottage Grove Ave., Chicago 37, Ill. (Tel. Midway 3-4770)
Plant Mgr.: James Matias
Sales Mgr.: R. A. Hastings

HUSSMANN AIRCRAFT DIV.
819 E. Taylor Ave., St. Louis 15, Mo. (Tel. EVergreen 2-9660)
Purch. Agent: F. A. Biller
Supvsr.-Contracts Admin.: R. O. Lakin
Asst. Sales Mgr.: L. H. Daerr MF, GS, GH, R&D

HUTCHENS & SON METAL PRODUCTS, INC.
1355 S. S. S., Springfield, Mo. (Tel. UN 6-1979)
Purch. Agent: B. G. King
V. P.-Sales: Lewis G. Hutchens MM, R&D

WALTER J. HYATT CO., THE
P. O. Box 943, Beverly Hills, Calif. (Tel. BRadshaw 2-2844)
Sales: Walter J. Hyatt MF, GS, GH, GE, TR, R&D

HYATT BEARINGS DIV., GENERAL MOTORS CORP.
Harrison, N. J. (Tel. HUmboldt 4-4000)
Purch. Agent: L. V. Farrel
Sales Mgr.: J. R. Gilmartin

HYCON EASTERN INC.
75 Cambridge Pkwy., Cambridge 42, Mass. (Tel. UNiversity 4-7200)
Purch. Agent: W. Senior
V. P.-Operations-Sales: J. R. Martin WN, GS, GE, CO, TS, TR

HYCON MFG. CO.
1030 S. Arroya Pkwy., Pasadena, Calif. (Tel. SYcamore 9-4171)
Mgr.-Prac.: Al Curry
Mgr.-Customer Rel.: M. J. Leonard
Buyers: F. Sizinski, Chuck Schultz & Harold Held GS, CO, TS, TR, R&D

HYDRA-POWER CORP.
10 Pine Court, New Rochelle, N. Y. (Tel. NE 2-2200)
Purch. Agent: J. Tranos
V. P.-Sales: E. O. Holland GS, GE, TS, R&D

HYDRAULIC PRESS MFG. CO., THE, DIV.-KOEHRING CO.
Marion Rd., Mt. Gilead, O. (Tel. 9351)
Dir.-Purch.: Carl A. Fisher
V. P.-Sales: E. L. Oehling GS, GE

HYDRO MOLDING CO. INC.
100 Sharran Ave., Plattsburgh, N. Y. (Tel. 2598)
V. P.-Purch.: M. A. Rabin MF, PS, GS, GE, TR

***HYDRO-AIRE CO., DIV.-CRANE CO.**
3000 Winona Ave., Burbank, Calif. (Tel. Victoria 9-1331)
Purch. Agent: C. E. Lenox
V. P.-Sales & Engrg.: Frank Cooper PS, GS, GH, GE, CO, TS, R&D
*(See Page 3 for Advertisement)

HYDRODYNE CORP., SKINNER SEAL DIV.
7350 Caldwater Canyon Ave., North Hollywood, Calif. (Tel. POplar 5-8001)
Purch. Agent: P. W. Wurtz
Pres.: Robert T. Skinner

HYDROMATICS, INC.
70 Okner Pkwy., Livingston, N. J. (Tel. WYman 2-4900)
Purch. Agent: Dan Maran
Sales Mgr.: Joseph Perrin PS, GS, GH, TS

HYSTER CO.
2902 N. E. Clackamas St., Portland 8, Ore. (Tel. ATlantic 8-5011)
Dir.-Sales: J. A. Cairns GH

I. D. E. A., INC.
7900 Pendleton Pike, Indianapolis, Ind. (Tel. LIberty 7-3581)
Purch. Agent: R. E. Cox
Buyer: R. Weritt
Gen. Sales Mgr.: A. C. Elles GS, GE, R&D

ILG ELECTRIC VENTILATING CO.
2850 N. Pulaski Rd., Chicago 41, Ill. (Tel. KIldare 5-1520)
V. P. I/C Purch.: S. E. Heyerick
Exec. V. P.: J. J. Friedler, Jr. GS, GH, TS

I-L-S INSTRUMENT DIV., THE MERIAM INSTRUMENT CO.
4525 W. 160th St., Cleveland 35, O. (Tel. CLearwater 2-3850)
Purch. Agent: M. E. Saltsgaver
Sales & Gen. Mgr.: R. B. Laule GS, CO, TS

I-T-E CIRCUIT BREAKER CO.
601 E. Erie Ave., Phila. 34, Pa. (Tel. GArfield 6-5700)
Purch. Agent: W. Manning TR

ITT FEDERAL DIV., INTERNATIONAL TELEPHONE & TELEGRAPH CORP.
100 Kingsland Rd., Clifton, N. J. (Tel. NUtley 2-3600)
Purch. Mgr.: H. P. Sammerer
V. P.-Sales: T. M. Douglas GS, GE, CO, TR, R&D

ITT LABS.
500 Washington Ave., Nutley, N. J. (Tel. NOrth 1-1100)
Dir.-Purch.: L. C. Mercier
Dir.-Sales: J. A. Haber WN, GS, GH, GE, CO, TS, TR, R&D

ITT LABS., FORT WAYNE
3702 Pontiac St., Fort Wayne, Ind. (Tel. E 7571)
Mgr.-Purch.: Walter Pitts R&D

ITT-KELLOGG
6650 South Cicero Ave., Chicago 38, Ill. (Tel. PO 7-6900)
Dir.-Purch.: H. O. Nordberg
V. P. & Gen. Sales Mgr.: O. C. Bailey GS, CO, TS, TR, R&D

IDEAL-AEROSMITH, INC.
3913 Evans Ave., Cheyenne, Wyo. (Tel. 7-7715)
Purch. Agent: F. E. Wheelhause
Sales Mgr.: Neil Royce PS, GS, GH, GE, CO, TS

IDEAL INDUSTRIES, INC.
1427 Park Ave., Sycamore, Ill. (Tel. 2114)
Purch. Agent: Robert O. Voss
Buyer: E. W. Whitaker
Gen. Sales Mgr.: Gordon B. Koch GE, TS, TR

IDEAL PRECISION METER CO., INC.
126 Greenpoint Ave., Brooklyn 22, N. y. (Tel. EVergreen 3-6904)
V. P.: Charles Bernstein
Pres.: Harry Leiderman

ILLINOIS CONDENSER CO.
1616 N. Throop St., Chicago, Ill. (Tel. EV 4-1300)
Purch. Agent: Ted Senelick
Sales Mgr.: L. W. Caleman TR

ILLINOIS TESTING LABORATORIES, INC.
420 N. LaSalle St., Chicago 10, Ill. (Tel. WHitehall 3-1331)
Purch. Agent: J. M. Lajka
V. P.-Sales: M. J. Rauscher MF, PS, CO, TS

ILLINOIS ZINC CO.
2959 W. 47th St., Chicago 32, Ill. (Tel. LAfayette 3-1600)
V. P.-Purch.: L. F. Johnson
V. P.-Sales: W. F. Synnatt MF, PS

ILLUMITRONIC ENGRG. CO.
680 E. Taylor, Sunnyvale, Calif. (Tel. REgent 9-2395)
Purch.: Wm. W. Smith
Sales Mgr.: Joe O. Giulie MF, PS, GS, GH, GE, TR

IMPACT-O-GRAPH CORP., THE
1900 Euclid Ave., Cleveland, O. (Tel. CHerry 1-5838)
Pres.: W. S. Mielziner PS, TS

IMPERIAL BRASS MFG. CO., THE
6300 W. Howard St., Chicago 31, Ill. (Tel. SPring 4-1700)
Purch. Agent: W. B. Burnet
V. P.-Sales Mgr., Distributor Div.: C. H. Benson
V. P.-Sales Mgr., O.E.M. Div.: J. T. Greenlee MF, PS, GS, GE, TS

IMTRA CORP.
11 University Rd., Cambridge 38, Mass. (Tel. UN 4-4350)
Pres.-Sales: William H. Farnham

INDIANA STEEL PRODUCTS CO., THE
Valparaiso, Ind. (Tel. Valparaisa 2-5601)
Purch. Agent: W. F. Eckert
V. P.: I. A. Dickey MM

INDIKON CO., INC., THE
76 Coolidge Hill Rd., Watertown 72, Mass. (Tel. WAtertown 4-2198)
Purch. Agent: Warren Robertson
Sales Mgr.: Haskell Ginns TS

INDIUM CORP. OF AMERICA, THE
1676 Lincoln Ave., Utica, N. Y. (Tel. SWift 7-1630)
V. P.-Sales: J. R. Dyer, Jr. MM

INDUCTION HEATING CORP.
181 Wythe Ave., Brooklyn 11, N. Y. (Tel. EVergreen 4-3110)
Dir.-Purch.: Arthur J. Slobin
Sales: Thomas J. Stanton PS, GS, GH, GE

INDUCTION MOTORS CORP.
570 Main St., Westbury, L. I., N. Y. (Tel. EOgewood 4-7070)
V. P.-Purch.: J. Wahryzek
Purch. Agent: M. Cufforl TR, R&D

INDUSTRIAL ACOUSTICS CO., INC.
341 Jackson Ave., New York, N. Y. (Tel. CY 2-0180)
Purch. Agent: Les Braverman
Buyers: Albert Dembiyer, James Forester, C. Spitalnic
V. P.-Sales: S. M. Patter, A. C. Hawtharne MM, R&D

INDUSTRIAL CONTROL CO.
805 Albin Ave., Lindenhurst, L. I., N. Y. (Tel. MOhawk 1-6060) PS, GE, CO, TS, TR

INDUSTRIAL DEVELOPMENT LABS., INC.
982 River Road, Edgewater, N. J. (Tel. WHitney 3-4084)
Purch. Agent: George E. Mesnick
Sales Mgr.: N. J. Seiden R&I

INDUSTRIAL ELECTRICAL WORKS, INC.
1509 Chicago St., Omaha, Neb. (Tel. ATlantic 4600)
Purch. & Sales Mgr., Reel Div.: J. C. Costella GS, GH, CO, T

INDUSTRIAL ENGRG. CORP.
525 East Woodbine, Louisville 8, Ky. (Tel. MElrose 4-3601)
Project Engr.: Floyd B. Simpson
Pres.: John Davenport GS, T

INDUSTRIAL ENGRAVERS INC.
2212 McDonald Ave., Brooklyn 23, N. Y. (Tel. HIckory 9-3200)
Pres.: J. Zatzkin MF, WN, PS, GE, CO, TS, T

INDUSTRIAL INSTRUMENTS INC.
89 Commerce Rd., Cedar Grove, N. J. (Tel. CEnter 9-6200)
Purch. Agent: H. Steinfeld
Sales Mgr.: J. H. Williamsan T

INDUSTRIAL METAL PROTECTIVES, INC.
401 Homestead Ave., Dayton 8, Ohio (Tel. BAldwin 2-6747)
V. P.-Engrg.: F. R. Fisher, Jr. M

INDSL. PROD.-DANBURY KNUDSEN DIV.-AMPHENOL-BORG ELECTRONICS CORP.
Danbury, Conn. (Tel. Ploneer 3-9271)
Mgr.-Prod. Control: Albert A. Marvin
Buyers: Walter Laesch, Theodore Davis
Sales Mgr.: Norman Cresci WN, GE, CO, TS, T

INDUSTRIAL RETAINING RING CO.
57 Cordier St., Irvington, N. J. (Tel. WAverly 6-5000)
Purch. Agent: V. A. Stabile MF,

INDUSTRIAL TECTONICS, INC.
3686 Jackson Ave., Ann Arbor, Mich. (Tel. NOrmandy 3-2451)
Dir.-Purch.: H. Fleischman
Sales Mgr.: K. W. McKenzie MF, PS, GS, GH, GE, TS, TR, R

INDUSTRIAL TELEVISION INC.
369 Lexington Ave., Clifton, N. J. (Tel. GRegary 3-0900)
Purch. Agent: Joseph Weinberg
Sales Mgr.: Robert J. Harrington GS, GE, CO,

INDUSTRIAL TEST EQUIPMENT CO.
55 E. 11th St., New York, N. Y. (Tel. GR 3-4684)
Purch. Agent: Walter Meyer
Sales Mgr.: Melvin Schreibman

INDUSTRIAL TIMER CORP.
1407 McCarter Hwy., Newark, N. J. (Tel. HUmbol 4-5600)
Purch. Agent: J. M. Ravelle
Sales Mgr.: R. A. Rassney GS, CO,

INDUSTRIAL TOOLS MFG. CORP., SUB.-PENDLETON TOOL INDUSTRIES, INC.
8150 Marbrisa Ave., Huntington Pk., Calif. (Tel. LUdlow 3-4301)
Purch. Agent: H. O. Grass
Sales Engr.: G. M. Fishering
Sales Engr.: S. K. Simpson
Sales Mgr.: H. O. Norton GS,

INDUSTRIAL TRANSFORMER CORP.
Gouldsboro, Penna. (Tel. VI 2-2111)
Purch. Agent: A. Kelly
Sales Mgr.: S. Lundy

INDUSTRIAL WINDING MACHINERY CORP.
Suite 3410, 120 Wall St., New York 5, N. Y. (Tel WHitehall 3-1754)
Dir.-Purch.: R. Harvst
Dir.-Sales: H. W. Roehrig

INDUSTRO TRANSISTOR CORP.
35-10 36th Ave., Long Island City 6, N. Y. (Tel EXeter 2-8000)
V. P.-Sales: Archie MacDougal
Sales Mgr.: Seymour Ostfeld GE,

NERTIA SWITCH DIV., SAFE LIGHTING INC.
527 Lexington Ave., New York 17, N. Y. (Tel. PLaza 5-1583)
Purch. Agent: Donald C. Wilson
Sales: Oana A. Griffin

NERTIA SWITCH, INC.
311 West 43rd St., New York 36, N. Y. (Tel. JUdson 6-5880)
Purch. Agent: John A. M. Peck
Sales Mgr.: Eugene Mogul
WN, GH, GE, CO, TS, TR, R&D

IFRAREO INOUSTRIES, INC.
62 Fourth Ave., Waltham 54, Mass. (Tel. TWinbrook 3-5400)
Gen. Sales Mgr.: E. O. Reddan GE, TS

GERSOLL KALAMAZOO DIV., BORG-WARNER CORP.
1810 N. Pitcher St., Kalamazoo, Mich. (Tel. FIreside 5-3501)
Dir.-Proc.: Harry E. Morse, 760 E. Vine St., Kalamazoo, Mich. (Tel. FIreside 2-0136)
Purch. Agents: L. A. Potratz & E. M. Anderson, 760 E. Vine St.
Buyers: E. J. Ries & L. D. Payne, 760 E. Vine St.
V. P. & Dir.-Defense Sales: A. S. Mrozek

GRAHAM CO., THE
392 North Main St., Bristol, Conn. (Tel. LUdlow 2-6321)
Purch. Agent: B. I. Downs
Asst.-Purch. Agent: W. Preston
V. P.-Sales: Allen W. Rork WN, GE

LAND ELECTRONICS CORP.
300 Rathbone Ave., Aurora, Ill. (Tel. 6-7744)
V. P.-Prod.: J. J. Pfeiffer
Materials Dept.: R. Juneau
Dir.-Sales: E. A. Thompson CO, TS

I CO CO., DIV.-BARRY CONTROLS INC.
Hollis St., Groton, Mass. (Tel. GIlbert 8-6358)
Gen. Mgr.: David L. Ammen PS, GS, TS

I TRU-LEC CORP.
220 Homestead Ave., Mt. Vernon, N. Y. (Tel. MOunt Vernon 8-3754)
Pres.: Russell Hobert GE

I TRUMENT CORP. OF FLA.
P. O. Box 1226, Melbourne, Fla. (Tel. PArkway 3-8112)
Buyer: A. O. Ashley
Contract Adm.: Charles W. Cairnes TR, R&D

I ITRUMENT OEVELOPMENT LABS., INC.
37 Mechanic St., Attleboro, Mass. (Tel. Attleboro 1-3880)
Purch. Agent: William Pendergast
Buyer: Robert Comstock
Gen. Sales Mgr.: George P. Bentley
GE, TS, TR, R&D

INSTRUMENT LABS.
35 W. Walton Place, Chicago 10, Ill. (Tel. MIchigan 2-0123)
Pur.-Purch.: John R. Fouser
Pur.-Sales: H. Taylor TS, R&D

INSTRUMENT MOTORS
35 Cait St., Irvington, N. J. (Tel. ESsex 4-9880)
Plant Supt.: Anthony Gaus
Sales Mgr.: O. Winston PS, GS, GE, TS, TR

INSTRUMENT RESISTORS CO.
936 Commerce Ave., Union, N. J. (Tel. MUrdock 8-4363)
Vice Mgr.: P. Bargerstock
Plant Mgr.: Howard G. Melick

INSTRUMENTATION DIV.-AMPEX CORP.
401 Charter St., Redwood City, Calif. (Tel. EMerson 9-1481)
Purch. Agent: Frank C. Masi
Buyers: Harold Nelsen, R. Glenn Zieber, William C. Haack
Mfg. Mgr.: Paul Weber WN, GS, CO, TS, TR, R&O

INSTRUMENTS CORP., THE
Central Ave., Baltimore 2, Md. (Tel. DIckens 1-2626)
Purch. Agent: Ed. Morton
Sales Mgr.: A. E. Clark, Jr.
PS, GS, GE, CO, TS, TR

INSTRUMENTS DIV.-PHILIPS ELECTRONICS, INC.
77 S. Fulton Ave., Mt. Vernon, N. Y. (Tel. MO 4-4500)
Purch. Agent: Jack Hemphill
Sales Mgr.: C. J. Woods TS, R&D

INSTRUMENTS FOR INDUSTRY, INC.
11 New South Rd., Hicksville, N. Y. (Tel. Verbrook 1-7100)
Purch. Agent: John T. Oaley
V.P.-Sales: Robert C. Lockwood R&D

INTEGRAL CORP.
11 Frank Road, Hicksville L. I., N. Y. (Tel. WEIls 1-4099)
V. P.-Purch.: H. Gittleson
V. P.-Sales: J. Kendall MF, WN, PS, GS, GH, TS

INTEGRATED MICA CORP.
202 Franklin Place, Woodmere, L. I., New York (Tel. FRanklin 4-2350)
Purch. Agent: Moses O. Heyman MM, R&D

INTERCONTINENTAL DYNAMICS CORP.
170 Coolidge Ave., Englewood, N. J. (Tel. LOwell 7-3600)
Purch. Agent: Harold White
Sales Mgr.: F. M. Winnai GS, GE, TS, R&O

INTERCONTINENTAL MFG. CO., INC.
Amundsen Road, P. O. Box 578, Garland, Texas (Tel. BRoadway 6-5131)
Dir.-Purch.: L. O. Barnhill
Mgr., Contract Admin.: R. E. Tarpley
MF, WN, PS, GH, MM, R&D

INTERELECTRONICS CORP.
2432 Grand Concourse St., New York 58, N. Y. (Tel. LUdlow 4-6200)
Purch. Agent: M. L. Lewis
Sales Mgr.: M. H. Pintell
PS, GS, GH, GE, CO, TS, TR

INTERFERENCE MEASUREMENT LABORATORY, INC.
907 E. 51st St., Brooklyn 3, N. Y. (Tel. INgersoll 9-1765)
Purch. Agent: E. N. Sands GE, TS, R&D

INTERLAKE STAMPING CORP.
12415 Euclid Ave., Cleveland 6, Ohio (Tel. SWeetbriar 1-7101)
Pres.: Wayne Groenstein MF

INTERNATIONAL AEROCOUSTICS CORP.
341 Jackson Ave., New York 54, N. Y. (Tel. CYpress 2-0180)
Purch. Agent: Les Broverman
Buyers: C. Spitalnic, B. Horowitz, A. De Angelis
Sales: M. Hirschorn PS, GS, GH, TS

INTERNATIONAL BALSA CORP.
86 Boyd Ave., Jersey City 4, N. J. (Tel. HEnderson 4-2044)
V. P.-Purch.: Samuel Greenhouse
Exec. V. P.-Sales: Prem Gary MM

INTERNATIONAL BUSINESS MACHINES CORP.-MILITARY PRODUCTS DIV.
590 Madison Ave., New York 22, N. Y. (Tel. PLaza 3-1900)

INTERNATIONAL ELECTRIC INDUSTRIES, INC.
468 Grand Ave., Brooklyn 38, N. Y. (Tel. NEvins 8-0211)
Purch. Agent: William Auslander
Chief Engr.-Purch.: John H. Tanges, Jr.
Sales Mgr.: Leo Margold
MF, PS, GS, GH, GE, CO, TS, TR

INTERNATIONAL ELECTRONIC INDUSTRIES, INC.
Corner Berry & Fessey Roads (P. O. Box 1368) Nashville, Tennessee (Tel. CYpress 8-4411)
Purch. Agent: W. W. Oick
National Sales Mgr.: A. M. Rowley MM

INTERNATIONAL ELECTRONIC RESEARCH CORP.
145 W. Magnolia Blvd., Burbank, Calif. (Tel. VIctoria 9-2481)
Purch. Agent: Philip Solomon
Exec. V. P. & Sales Mgr.: John E. Markley, Jr.
PS, GE, TS

INTERNATIONAL EQUIPMENT CO.
1284 Soldiers Field Rd., Boston, Mass. (Tel. STadium 2-7900)
Purch. Agent: Walter Morrison
V. P.-Sales: R. W. Schmader TS

INTERNATIONAL FERMONT MACHINERY CO., INC.
Ramapo, N. Y. (Tel. SLoatsburg 3-2791)
Purch. Dir.: M. Breen
V. P.-Purch.: D. Rohr
Dir.-Sales: C. Sugarman GS

INTERNATIONAL INSTRUMENTS INC.
Box 2954, New Haven 15, Conn. (Tel. FUlton 7-2515)
Sales Mgr.: R. C. Livingston

INTERNATIONAL NICKEL CO., THE
67 Wall St., New York 5, N. Y. (Tel. WHitehall 4-1000)
V. P.-Sales: J. A. Marsh MM

INTERNATIONAL PUMP & MACHINE WORKS
81 Dorsa Ave., Livingston, N. J. (Tel. WYman 2-5900)
Pres.: T. J. Scala
Purch.: M. D. Warchol
Ch. Engr.: F. E. Roth GS, GH, R&O

INTERNATIONAL RADIANT CORP.
111 New York Ave., Westbury, N. Y. (Tel. EOgewood 4-8820)
Mfg. Mgr.: P. Stanger
Purch. Agent: Mrs. K. LaGrega
Sales Mgr.: Karl O. Klein TS, MM

INTERNATIONAL RECTIFIER CORP.
1521 E. Grand Ave., El Segundo, Calif. (Tel. ORegon 8-6281)
Dir.-Purch.: Claire Behar
Purch. Agent: Larry Dudley
V. P.-Sales: J. T. Cataldo MM

INTERNATIONAL REGISTER CO.
2620 W. Washington Blvd., Chicago 12, Ill. (Tel. VA 6-4242)
Dir.-Purch.: H. H. Shellberg
Gen. Sales Mgr.: H. H. Rosenheim

INTERNATIONAL RESEARCH ASSOCIATES
2221 Warwick Ave., Santa Monica, Calif. (Tel. TExas 0-4415)
Pres.: L. E. Brown
Purch.: T. Reynolds GS, GE, CO, TS, R&O

INTERNATIONAL RESEARCH & DEVELOPMENT CORP.
P. O. Box 55, 6150 Huntley Rd., Worthington, Ohio (Tel. TU 5-5376)
V. P.-Engrg.: T. Ongaro
Sr. Engineers: G. H. Thomas & Paul Ryan
Sales Mgr.: O. L. Bernhard GS, TS

INTERNATIONAL RESISTANCE CO.
401 N. Broad St., Philadelphia 8, Pa. (Tel. WAlnut 2-2166)
Mgr.-Purch.: Henry Zaccaria
Buyers: Irene Smith & John H. Cummings
Dir.-Sales: George O. Butler TS, MM, R&D

INTERNATIONAL WAX REFINING CO.
99 E. Hawthorne Ave., Valley Stream, N. Y. (Tel. LOcust 1-2500)
Purch.: Frank W. Clarke MF, WN, PS

INTERNATIONAL WIRE & CABLE CO.
1665 N. Milwaukee Ave., Chicago, Ill. (Tel. BR 8-2362)
Sales Mgr.: Sidney Gracen

INTERSTATE ELECTRONICS CORP.
707 E. Vermont Ave., Anaheim, Calif. (Tel. PRospect 4-6540)
Purch. Agent: Hugh F. Maguire
Mgr., Engrg. Liaison: John P. Hastings
PS, GS, CO, TR

INTERSTATE ENGRG. CORP.
600 East Vermont Ave., Anaheim, Calif. (Tel. PRospect 4-6540)
Prod. Mgr.: G. McMaster
Buyers: R. Basting, M. Hodkin, P. Rutledge
Dir.-Sales & Contracts: E. Ed Williams
MF, GS, GH, TS, R&D

INTERSTATE MFG. CORP., THE
190 Boston Post Rd., Orange, Conn. (Tel. SYcamore 9-2339)
V. P.-Purch.: L. J. Paffumi
Pres.: A. A. Espari MF, WN, PS, GS, GH, GE, R&D

INVESTMENT CASTING CO.
60 Brown Ave., Springfield, N. J. (Tel. ORexel 6-6260)
Purch. Agent: Edwin Schoffman
Sales Mgr.: E. H. Parris MF, PS

INVINCIBLE VACUUM CLEANER MFG. CO.
14th & Oavis Streets, Dover, Ohio. (Tel. 42191)
Purch. Agent: Charles Wenger
Dir.-Sales: L. M. Thomas

IRON FIREMAN MFG. CO., ELECTRONICS DIV.
2838 S. E. 9th Ave., Portland 2, Ore. (Tel. BEImont 4-6551)
Purch. Agent: A. O. Ralfe
Asst. Purch. Agent: Harold Walker
Mil. Sales Coordinator: Henry Oes Georges
GS, GH, GE, CO

ISOLANTITE MFG. CORP.
175 Warren Ave., Stirling, N. J. (Tel. MIllington 7-0385)
Pres. & Dir.-Sales: Frank J. Stevens MM

ITEK CORP.
1566 Trapelo Road, Waltham, Mass. (Tel. TWinbrook 3-8700)

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

Purch. Agent: J. J. Kistner
Prod. Sales Mgr.: B. J. Warren GS, CD, R&D

ITEMCD, INC.
4 Manhasset Ave., Port Washington, N. Y. (Tel. PArt Washington 7-8330)
Purch. Agent: Julius Rasen
Sales Mgr.: Albert J. Deeb

JEM ELECTRONICS CORP.
743 Circle Ave., Forest Park, Ill. (Tel. PResident 1-8242)
Purch. Agent: C. F. Amberg TS

JFD ELECTRDNICS CDRP.
1462 62nd St., Brooklyn, N. Y. (Tel. OEwey 1-1000)
Mgr.-Purch. & Sales: Jack Goodman GS, GE, CO, TS, TR, R&D

J-V-M MICRDWAVE CD.
9300 W. 47th St., Braakfield, Ill. (Tel. HUnter 5-2000)
Buyer: L. Rzeminski
Sales Mgr.: E. J. Jurcy

JACK & HEINTZ, INC.
17600 Braadway, Maple Heights, O.
Mailing: Cleveland 1, O. (Tel. MOntrose 2-1000)
Purch. Agent: Hugh W. Lloyd
V. P.-Sales: R. J. Eschbarn
V. P.-Operatians: C. F. Herbold GS, GH, TS, R&D

JACDBSDN NUT MFG. CDRP.
Bax 177, Kenilwarth, N. J. (Tel. MUrdock 6-0200)
Purch. Agent: Joe Marane
Sales Mgr.: C. W. Aagoard MF, PS

JAIDINGER MFG. CD., INC.
1921 W. Hubbard St., Chicago 22, Ill. (Tel. HA 1-1090)
Purch. Agent: Robert Krajei
Chief Engr.: William Krieg
Sales: J. H. Jaidinger GS, CH, CO

JALBERT AERDLDGY LAB.
40 N. W. 20th St., P. O. Bax 155, Baca Raton, Fla. (Tel. 9094)
Dir.-Purch.: Oamina C. Jalbert

JAMES, PDND & CLARK, INC.
2181 E. Foothill Blvd., Pasadena, Calif. (Tel. SYcamare 3-9195)
Purch. Agent: William Olsen
Sales Mgr.: P. F. Shepherd MF, WN, PS, GS, GH, CD, TS

JAMESBURY CDRP.
45 New St., Warcester, Mass. (Tel. SWift 9-4166)
Treas.-Purch.: Saul I. Reck
Sales: Julian S. Freeman PS

JAMISDN CDLD STORAGE DDDR CD.
Box 70, Hagerstawn, Md. (Tel. RE 3-3100)
Gen. Sales Mgr.: P. J. Ouffy

JAN HARDWARE MFG. CO., INC.
38-01 Queens Blvd., Lang Island City 1, N. Y. (Tel. EMpire 1-0800)
Chief Purch. Agent: M. Weiss
Dir.-Sales & Gen. Mgr.: Arthur Z. Rawe GS, CD, TS, MM, R&D

JANCD CORP.
3111 Winana Ave., Burbank, Calif. (Tel. THarnwall 8-5792)
Purch. Agent: Lester Janes
V. P.-Sales: J. T. Petersan, Jr. GS, GE, CO, TS, TR

***JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.**
4200 Surface Rd., Columbus 4, Ohia (Tel. BRaadway 6-3561)
Dir.-Prac.: R. H. Rupp
Buyers: John Huntley, Jerry Raberts, William Higgins
Gen. Sales Mgr.: J. W. Ashby GS, GH, MM, R&D
*(See Page 84 far Advertisement)

JANSKY & BAILEY, INC.
1339 Wisconsin Ave., Washingtan 7, D. C. (Tel. FEderal 3-4800)
Purch. Agent: M. Bell
V. P.-Sales: O. C. Ports CD, TS, TR, R&D

JARDUR AVIATIDN CD.
874 Braadway, New York 3, N. Y. (Tel. ALganquin 4-2238)
Dir.-Purch.: Samuel Klepper
Dir.-Sales: Herman H. Klepper

JARDUR IMPDRT CD.
874 Braadway, New York 3, N. Y. (Tel. ALganquin 4-2239)
Dir.-Purch.: Samuel Klepper
Dir.-Sales: Herman H. Klepper

JARRELL-ASH CD.
26 Farwell St., Newtanville 60, Mass. (Tel. OEcatur 2-2130)
Purch. Agent: W. Jakinen TS

JARVIS CDRP.
10 Glastanbury Tpke., Portland, Conn. (Tel. Olamond 7-3381)
Purch. Agent: Jahn Harvey
Gen. Mgr.: Edward G. Sharp
Asst. to Gen. Mgr.: S. Peter Barry MF, WN, PS, MM

JAVELIN AIRCRAFT CO. INC.
1405 S. Oliver, Wichita 17, Kans. (Tel. MU 2-0111)
Pres. & Chief Engr.: O. D. Blanton MF, GS, GH

JAVEX ELECTRONICS
P. O. Box 646, Redlands, Calif. (Tel. PYramid 3-5752)
V. P.-Sales: C. J. Reimuller

JEFFERSDN ELECTRONIC PRDDUCTS CDRP.
322 State St., Santa Barbara, Calif. (Tel. WOadland 5-8505)
Purch. Agent: William Bedford
Sr. Buyer: Frank E. Brackett
Mgr., Custamer Relatians Div.: Danald F. Barr GS, CO, TS, TR, R&D

JEFFERSDN WIRE & CABLE CDRP.
Pleasant Valley Rd., Sutton, Mass. (Tel. Unian 5-4447)
Gen. Mgr.: Michael Friedman R&D

JEFFREY MFG. CD., THE
843 N. 4th St., Columbus 16, Ohia (Tel. AX 4-3331)
Dir.-Purch.: H. J. Halliday
V. P.-Sales: J. E. M. Wilsan

JENNINGS MACHINE CDRP.
3452 Ludlaw St., Philadelphia 4, Pa. (Tel. EV 6-2420)
Purch. Agent: J. P. McIntyre
Sales Engr.: J. Robert Peace MM

JENNINGS RADIO MFG. CORP.
970 McLaughlin Ave., San Jase, Calif. (Tel. CYpress 2-4025)
Purch. Agent: Haward A. Caan
V. P.-Sales: Calvin K. Townsend GE, TS, TR

JENSEN MFG. CD.
6601 S. Laramie Ave., Chicago 38, Ill. (Tel. POrtsmauth 7-7600)
Purch. Agent: Edmund B. McGuckin
Indsl. Sales Mgr.: Horace L. White
Asst. Sales Mgr., Distributor Div.: Frank O. Lintern GH, CD, TS

JERGUSDN GAGE & VALVE CD.
Adams St., Burlingtan, Mass. (Tel. BRawning 2-3600)
Purch. Agent: H. M. Rixan
V. P.-Sales: James A. Ford

JESSALL PLASTICS
900 Farmingtan Ave., Kensingtan, Cann. (Tel. New Britain, VAlley 8-3526)
Purch. Agent: J. B. Smith
Sales Mgr.: E. J. McDanald MM

JET ELECTRDNICS CDRP.
4426 San Fernanda Rd., Glendale 4, Calif. (Tel. CItrus 1-2689)
Purch. Agent: E. A. Braga
Sales Mgr.: Jaime Baluga TR

JET TDOL CDRP.
7952 Narth Ave., Leman Grove, Calif. (Tel. HOpkins 6-0471)
Pres.: Grant Hadley MF, WN, PS, GS

JETA, INC.
957 Saw Mill River Rd., Yankers 2, N. Y. (Tel. Yankers 9-4400)
Dir.-Purch.: O. Lavker
Purch. Agent: L. Balletto
Comm. Sales Mgr.: R. Calhoun GS, GH, MM

JET-HEET, INC.
152 S. Van Brunt St., Englewood, N. J. (Tel. LOwell 9-0420)
Purch. Agent: P. M. Jaachim
Sales Engr.: J. J. Oiekmann
Pres.: C. O. MacCraken R&D

JETTRON PRODUCTS, INC.
56 Raute 10, P. O. Box 274, Hanover, N. J. (Tel. TUcker 7-0571)
Pres.: Kenneth Johnsan
V. P.: Carltan P. Werner
Elec. Engr.: Frank J. Strassner R&D

JOCLIN MFG. CD., THE
Lutbery Ave., Wallingford, Conn. (Tel. COlany 9-8708)
Purch. Agent: S. F. DiGiargi
Sales Mgr.: Oovid R. Lurie WN, PS, MM

JDDEE PLASTICS CD.
36 Crescent St., Braoklyn 8, N. Y. (Tel. AP 7-4774)
Pres.: Nicholas Meglino
Purch. Agent: Mrs. Josephine Meglino

JDHNS-MANVILLE
22 E. 40th St., New York 16, N. Y. (Tel. LExington 2-7600)
Mgr.-Purch. Dept.: O. H. Lyons
Gen. Sales Mgr., Equipment: E. O. Flavin MM

JDHNS-MANVILLE SALES CDRP.
22 E. 40th St., New York 16, N. Y. (Tel. LExington 2-7600)
Dir.-Purch.: D. H. Lyons
V. P.-Sales: J. A. O'Brien MF, WN, PS, GS, MM, R&D

E. F. JDHNSON CO.
206 2nd Ave., S. W. Waseca, Minn. (Tel. 990)
Purch. Agent: M. L. Jahnson
Gen. Sales Mgr.: E. T. Herbig MM

K. W. JDHNSDN & CD., INC.
1825 Webster St., Oaytan, O. (Tel. BA 4-1078)
Dir.-Purch.: Richard M. Wilcax
Sales Mgr.: R. O. Tobey MF, GS, GH, TS, R&D

JDHNSDN ELECTRONICS INC.
P. O. Box 1675, Casselberry, Fla. (Tel. Midway 4-3311)
Purch. Agent: Merlin Baudina
Sales Mgr.: E. S. Jahnsan GS, R&D

JDHNSON MFG. CD., INC.
616 First Ave., N., Mt. Vernan, Iowa (Tel. 3651)
Mgr.-Sales: R. H. Thampson
Asst. Mgr.-Sales: O. F. Janes MM

JDHNSDN-WILLIAMS, INC.
2625 Park Blvd., Pala Alta, Calif. (Tel. OAvenpart 3-4131)
Mgr.: P. L. Williams
Chief Engr.: K. W. Johnsan GS, CO, T

JDHNSTDN & FUNK TITANIUM CDRP.
Kemraw Ave., Waaster, O. (Tel. HOward 2-7050)
Purch. Agent: Oon Gaad
Sales Coordinatar: Robert Knight MF, P

HERRICK L. JDHNSTDN, INC.
659 Marian Rd., Columbus 7, Ohia (Tel. KIckary 3-7434)
Purch. Agent: Jahn W. Dalgarn
Dir.-Mfg.: G. A. Wright MF, PS, GS, GH, T

JO-LINE TOOLS, INC.
8442 Otis St., Sauth Gate, Calif. (Tel. LOrain 7-1489)
Prod. Mgr.: R. Glen Waads
V. P.-Sales: William S. Waads G

JOMA INC.
Town Line Rd., Walcott, Conn. (Tel. PLazo 7-0040)
Pres.: Joseph M. Mocary M

HDWARD B. JDNES DIV.-CINCH MFG. CDRP.
1026 S. Hamon Ave., Chicago 24, Ill. (Tel. NEvada 2-2000)
Purch. Agent: Tam Hapkins
Sales Mgr.: C. W. Nelson GS, GH, GE, T

JDNES & LAMSON MACHINE CD.
160 Racket St., Springfield, Vt. (Tel. TUrner 5-2121)
Purch. Agent: E. F. St. Mary
Asst. Purch. Agent: Frank Barter
Mgr.-Marketing: H. A. Finch MF, WN, PS, GS, GH, TS, T

JDNES & LAUGHLIN STEEL CDRP., STAINLESS & STRIP DIV.
Bax 4606, Detrait 34, Mich. (Tel. JE 6-7200) M

JDNESVILLE PAPER TUBE CDRP.
474 Beck Rd., Jonesville, Mich. (Tel. VI 9-7141)
Dir.-Purch.: A. G. Schaerer
Dir.-Sales: W. W. Schray M

JDRDAN CD., INC., THE
3235 W. Hampton Ave., Milwaukee, Wisc. (Tel. UPtown 1-3200)
Purch. Agent: Ethel Janke
Acting Sales Mgr.: Arthur Scammell

JDRDAN ELECTRONICS, DIV.-VICTOREEN INSTRUMENT CO.
3025 W. Missian Rd., Alhambra, Calif. (Tel. CUmberland 3-6425)
Purch. Agent: Lauis Kraat
Sales Mgr.: George W. Egan GS, GE, CD, TR, R&

EARLE M. JDRGENSEN CD.
10650 S. Alameda St., Los Angeles 54, Calif. (Tel LOrain 7-1122)
Mdse. Mgr.: W. R. Lindman
Mgr.-Sales: Charles Schriber

JDY MFG. CD.
Henry W. Oliver Bldg., Pittsburgh 22, Pa. (Tel. GRant 1-2140)

Dir.-Purch.: K. Warmbein
V. P., Ind. Div.: J. P. Cartwright GS

UALL GEAR CO., INC.
1108 Goffle Rd., Hawthorne, N. J. (Tel. HA 7-4220)
Pres.: C. Juall

ULIE RESEARCH LABS., INC.
556 W. 168th St., New York City, N. Y. (Tel. LOrraine 8-8700)
Dir.-Purch.: Lucille McCulley CO, TS, TR, R&D

W ENGRG. WORKS
15920 Pin Oak Court (P.O.) Butler, Wisc. (Tel. (Milwaukee) SUnset 1-8616)
Purch. Agent: H. Charles Kaetel

AR ENGRG. CORP.
2995 Middlefield Rd., Palo Alto, Calif. (Tel. OAvenport 6-5050)
Purch. Agent: John F. Lombardi
Sales Mgr.: Frank Genochio

O. E. KAERCHER CO.
1911 36th Ave., S., Minneapolis 17, Minn. (Tel. PArkway 4-4986)
Purch.: Don Kaercher & Geo. Kaercher

HN & CO., INC.
41 Windsor St., Hartford, Conn. (Tel. CHapel 6-7431)
. P.-Purch.: Kenneth O. Jacobs
sst. Purch. Agent: James Melo
Expediter: Richard Metcalf
ales Mgr.: Robert Hamerschlag GS, TS, R&D

HN RESEARCH LABS., INC.
2 Pine St., Freeport, N. Y. (Tel. FReeport 9-8800)
sst. Purch.: Judy Wisner
. P.-Sales: Kenneth B. Boothe GS, TR, R&D

ISER AIRCRAFT & ELECTRONICS, DIV.-KAISER INDUSTRIES CORP.
. O. Box 1828, Oakland 4, Calif. (Tel. San Leandro, Calif.—LOckhaven 2-2456)
aterial Mgr.-Richmond Machining Plt.: James Tollman (Tel. Richmond, Colif.—LAndscape 6-4688)
urch. Agent-Richmond & San Leandro Plts.: J. R. Anderson (Tel. Richmond, Colif.—LAndscope 6-4688)
urch. Agent-Toledo Electronics Plt.: R. W. Gibson (Tel. Toledo, O.—RAndolph 6-1591)
urch. Agent-Phoenix Electronics Plt.: Ralph Musbach (Tel. Phoenix, Ariz.—Windsor 3-3431)
. Sales & Contract Rep.-Phoenix Electronics Plt.: Robert N. O'Hara (Tel. Phoenix, Ariz.—Windsor 3-3431)
en. Sales Mgr.-Weapons Systems Mktg. Dept.: A. L. Mapes (Tel. San Leandro, Calif.—LOckhaven 2-2456)
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&D

KAISER ALUMINUM & CHEMICAL SALES, INC.
9 N. Michigan Ave., Chicago 11, Ill. (Tel. MOhawk 4-6900) MF, PS, GH

KAISER METAL PRODUCTS, INC., FLEETWINGS DIV.
istol, Pa. (Tel. STillwell 8-8431)
oc. Mgr.: W. C. Heilbrun
P. & Gen. Mgr.: S. D. Hackley
P. & Asst. Gen. Mgr.: F. H. Bechill
rch. Mgr.: W. K. Palmer
les Mgr.: O. E. Egan MF, WN, PS, MM, R&D

KAISER STEEL CORP., FABRICATING DIV.
01 Telegraph Rd., Los Angeles 22, Calif. (Tel. RAymond 3-5411)
rch. Agent: Frank E. Cooper
P.-Gen. Mgr.: Jack J. Carlson GS, GH, TS

KAMAN AIRCRAFT CORP.
7 Market St., Kingston, Penno. (Tel. BUtler 7-2151)
rch. Agent: Clinton O. Smith
es Mgr.: John H. Uhl MF, WN, PS, GS, GH

KAO LABS.
00 S. Thompson Lane, Nashville, Tenn. (Tel. ALpine 4-3519)
rch.: Thomas J. O'Kane
es Mgr.: C. G. Montgomery MF, WN, PS, GS

KATHAL CORP., THE
Delia Place, Stamford, Conn. (Tel. OAvis 5-2206)
ef Engr.: F. J. Barto
es Mgr.: G. W. Eisenbeis

KAY LIGHT CORP.
st Ave. & Chestnut St., Mankato, Minn. (Tel. 966)
ch. Agent: Norval Biggs
s Mgr.: Stan F. Neubert GS

KAYE & CO.
12 Euclid St., Santa Monica, Calif. (Tel. EXbrook 5246)
ch. Agent: Robert Sable
s.: John R. Kauke TR

C. B. KAUPP & SONS, INC.
6-10 & 32 Newark Way, Maplewood N. J. (Tel. SOuth Orange 3-2490)
Pres.: Carl B. Kaupp, Jr.
Sec. Treas.: Clem N. Kaupp
Sales Rep.: John M. Hogan WN, PS, GE, TS, TR, MM

KAUSTINE FURNACE & TANK CORP.
1937 Thomas St., Perry, N. Y.

KAY ELECTRIC CO.
Maple Ave., Pine Brook, N. J. (Tel. CApital 6-4000)
Purch. Agent: Marsden Shaw
Gen. Sales Mgr.: John Gilmore TS

KAYDON ENGRG. CORP., THE
McCracken St., Muskegon, Mich. (Tel. 5-1641)
Oir.-Purch.: W. J. Pierre
Buyers: John Peterson, Jim Obermiller
Oir.-Sales: J. F. Oehlhoffen GS, GH, GE, TS, TR, R&O

JOSEPH KAYE & CO.
49 Hampshire St., Cambridge 39, Mass. (Tel. UNiversity 4-1386)
Joseph Kaye MF, WN, PS, GS, GE, TR

KAYNAR MFG. CO., INC.
Box 2001, Terminal Annex, Los Angeles 54, Calif. (Tel. SPruce 3-3070)
Purch. Agent: Geo Mooers
Gen. Mgr.: R. H. Randall
Sales Mgr.: K. O. Davis MF, PS, GE, R&D

***KEARFOTT CO., INC.**
1500 Main Ave., Clifton, N. J. (Tel. GRegory 2-1000)
Purch. Agent: K. Soper (Tel. CLifford 6-4000)
Dir.-Sales: W. S. Smith GS, GE, TS, MM, R&D
*(See Page 7 for Advertisement)

***KEARFOTT CO., INC., MICROWAVE DIV.**
14844 Oxnard St., Van Nuys, Calif. (Tel. STate 6-1760)
Prod. Mgr.: A. L. Lisle
Purch. Agent: R. E. MacMillan
Buyer: Loren Maxfield
Sales Mgr.: Walter K. Oau GE
*(See Page 7 for Advertisement)

KEIL ENGRG. PRODUCTS
4356 Duncan St., St. Louis 10, Mo. (Tel. OLive 2-7005)
Gen. Mgr.: R. Steedman, 6833 Manchester (Tel. STerling 1-3209)
Sales Mgr.: Norman W. Kathrinus MM

KEITHLEY INSTRUMENTS, INC.
12415 Euclid Ave., Cleveland, Ohio (Tel. SWeetbriar 5-2666)
Works Mgr.: C. G. Stevens
V. P.-Research: Julius Praglin
V. P.-Engrg.: W. E. Koeblitz TS, R&D

KELITE CORP.
1250 N. Main St., Los Angeles 12, Calif. (Tel. CApitol 2-0201)
V. P., and Tech. Oir.: Louis McOonald
V. P.-Sales: W. Sorensen MF, GH

HUGO P. KELLER, JR.
50 East 42nd St., New York 17, N. Y. (Tel. MUrrayhill 2-8450)
Pres.: Hugo P. Keller, Jr.
Sales Mgr.: R. M. Wolff MM

M. W. KELLOGG CO., THE
P. O. Box 469, Jersey City, N. J. (Tel. OElaware 3-3100)
Mgr.-Plant Purch.: T. B. Rees
Buyers: J. E. Wallis, J. O. Oalstrom, H. F. Perkins, T. F. Oriscoll
Sales Engr., Racket Oiv.: F. H. Menke MF, WN, PS

KELSEY-HAYES CO.
3600 Military Ave., Oetroit 32, Mich. (Tel. TAshmoo 5-5500)
Dir.-Purch. & Planning: W. L. Troutfetter
Gen. Mgr., Aviation Oivs.: Leslie G. Taylor
Heintz Oiv.
Front St. & Olney Ave., Philadelphia 20, Pa. (Tel. LIvingston 8-1000)
V. P.-Sales: J. M. Ward
Oir.-Purch.: W. Miller
Metols Oiv.
Middle Settlement Rd., New Hartford, N. Y. (Tel. REdwood 5-6411, Utica, N. Y.)
Purch. Agent: Robert J. Goodman
Mgr.-Sales & Mktg.: Paul W. Beamer MM
Steel Products Engrg. Div.
1205 W. Columbia St., Columbus, Ohio (Tel. FAirfax 5-1541)
Purch. Agent: J. K. Brannan
Sales Mgr.: J. S. Wilkerson
Utico Metals Div.
2415 Whitesboro St., Utica 4, N. Y. (Tel. REdwood 5-6411)
Purch. Agent: Russell W. Jones
Sales Mgr.: P. W. Beamer
Utico Turbine Parts Div.
2415 Whitesboro St., Utica 4, N. Y. (Tel. REdwood 5-6411)
Purch. Agent: Russell W. Jones
Sales Mgr.: Walter D. Hart
MF, WN, PS, GS, GH, GE, TS, TR, MM, R&D

KEMLITE LABORATORIES, INC.
1819 W. Grand Ave., Chicago 22, Ill. (Tel. TAylor 9-6050)
Purch. Agent: J. V. Daniels
MF, WN, PS, GS, GE, TS, TR

KEMP AERO PRODUCTS
Marshall Hill Rd. West Milford, N. J. (Tel. PArkway 8-3149)
Dir. af Purch.: J. L. Bishop
Buyer: L. Cocks
V. P.-Sales & Engrg.: J. Harrington PS, GS, GH, GE, R&O

KEMTRON ELECTRON PRODUCTS, INC.
14 Prince Pl., Newburyport, Mass. (Tel. HO 2-4464)
Purch. Agent: A. N. Ougar
Gen. Mgr.: E. T. Cosellini GE

KENCO MFG. CO.
5211 Telegraph Rd., Los Angeles 22, Calif. (Tel. ANgelus 8-1201)
V. P.-Purch.: T. Thornburgh
V. P.-Sales: Bob Linville

KENHOS CORP. DIV.
P. O. Box 2, Noroton Heights Station, Oarien, Conn. (Tel. Oarien OLiver 5-1504)
Pres. and Sales Mgr.: G. H. Kendall

KENNAMETAL INC.
Lloyd Ave., Latrobe, Penna. (Tel. KEystone 7-3311)
Purch. Agent: Oale R. Versaw
Sales Mgr.: Bennett Burgoon, Jr.

D. S. KENNEDY & CO.
Cohasset, Mass. (Tel. EVergreen 3-1200)
Purch. Agent: Robert Fisher
V. P.-Sales: C. W. Creaser TR, R&D

KENNEDY AIRCRAFT SUPPLY CO.
43-10, 162 St., Flushing 58, N. Y. (Tel. HIckory 5-3500)
Gen. Mgr.: Chris Kennedy
Supervisor of Sales: K. O. Shanley

KENNEDY VAN SAUN MFG. & ENGRG. CORP.
405 Park Ave., New York 22, N. Y. (Tel. PLaza 3-2200)
Oir.-Purch. Dept.: R. K. May
Asst. V. P.: H. W. Bodlaender
Mgr.-Defense Prad. Div.: F. Irving, Jr.
Asst. Mgr.-Def. Prod.: J. Cannon PS, R&D

KENSICO TUBE CO. INC.
Mount Kisco, N. Y. (Tel. MOunt Kisco 6-8046)
Pres.: Thomas Nast
V. Pres.: Gordon W. Edwards
Treas.: Philip Gennussa
Plant Engr.: Arthur L. Mortenson MM

KENT-MOORE ORGANIZATION INC.
1501 S. Jackson St., Jackson, Mich. (Tel. STate 4-8561)
Prod. & Purch. Mgr.: A. L. Schultz
Purch. Agent: D. G. Clarke
Dir.-Mfg.: L. C. Krieser R&D

KENTUCKY METAL PRODUCTS CO.
3104 S. Prestan St., Louisville 13, Ky. (Tel. MElrose 4-9421)
Purch. Agent: G. Burton
Dir.-Sales: J. L. Covert
Sales: C. Blackshear MF, WN, MM

KERN INSTRUMENTS, INC.
120 Grand St., P. O. Box 727, White Plains, N. Y. (Tel. WHite Plains 9-0101)
Exec. V. P.: F. E. Oavatz
Serv. Mgr.: Hans T. Wehrli GS, GE, TS, R&O

KERNS MFG. CORP.
45-18 Court Sq., Long Island City 1, N. Y. (Tel. STillwell 6-2550)
Purch. Agent: Arnold Novak
Gen. Mgr.: R. J. Auman MF, WN, PS

KERRCO PRODUCTS
P. O. Box 228, Havelock Sta., Lincoln 7, Nebr. (Tel. 6-5105)

CODING
Missile Frome MF
Worhead & Nose Cone WN
Prapulsion System PS
Ground Support GS
Graund Handling GH
Guidonce Equipment GE
Checkout Equipment CO
Test Equipment TS
Trocking & Telemetering TR
Research & Develapment R&D
Materiols & Metols MM

Pres.: R. W. Kerr
Sales Mgr.: D. W. Hemphill

KETAY OEPT., NOROEN OIV., UNITEO AIRCRAFT CORP.
Jericho Turnpike, Commack, N. Y. (Tel. FDrest 8-5500)
Purch. Agent: S. Schiener
Buyer: M. Gibber
Sales Mgr.: H. M. Winton

KEY RESISTOR CORP.
321 W. Redondo Beach Blvd., Gardena, Calif. (Tel. DAvis 3-5000)
Purch. Agent: J. L. Golforth
Gen. Mgr.: W. Peddie — MM

KEYSTONE CARBON CO.
1935 State St., St. Marys, Penna. (Tel. TE 41-591)
Purch. Agent: L. H. Schaut
Thermistor Sales: F. A. Brennan

KEYSTONE ELECTRONICS CORP.
49 Bleecker St., New York 12, N. Y. (Tel. GRamercy 5-4600)
Purch.: I. Rosen — MF, PS, GS, GH, GE, TS, TR

KEYSTONE PROOUCTS CO.
904-6 23rd St., Union City, N. J. (Tel. UNion 6-5400)
Purch. Agent: James A. Dllick
Sales Coordinator: E. Holewski — GS, GE, TS

KICKHAEFER MFG. CO.
901 S. Second St., Milwaukee 4, Wisc. (Tel. Mitchell 5-1630)
Pres.: Edward A. Kickhaefer
V. P.-Purch.: Ernest Davis — PS, GH, TS, TR

WALTER KIODE & CO., INC., AVIATION DIV.
1320 Main St., Belleville 9, N. J. (Tel. PLymouth 9-5000)
Oir.-Purch.: E. R. Randall
Purch. Agents: John P. Blake, G. Lukacs
Asst. Purch. Agents: J. D. Tamburro, H. S. Klimanski
Buyers: S. Stefans, S. Eckhouse, W. Weber, A. Greifenhain, M. Corio, H. Griffith, C..McCarthy — MF, PS, GS, GH, GE, CO, TS

KIELEY & MUELLER, INC.
64 Genung St., Middletown, N. Y. (Tel. Dlamond 2-2526)
Oir.-Purch.: Rex Palmer
Oir.-Sales: Joseph P. D'Conner, Jr.

KILGEN AIRCRAFT DIV.
P. D. Box 94, 8008 Carondolet Ave., Clayton (St. Louis) 5, Mo. (Tel. PArkview 7-8920)
Oir.-Sales: Eugene R. Kilgen — GS

KILGORE, INC., INTERNATIONAL FLARE-SIGNAL OIV.
200 E. Broadway, P. D. Box 31, Westerville, D. (Tel. TUxedo 2-2341)
Purch. Agent: W. D. Watkins
Asst. Purch. Agent: H. L. Zwick
Sales Mgr.-International Flare-Signal Oiv.: G. J. Bishop — PS

KIN TEL OIV.-COHU ELECTRONICS, INC.
5725 Kearny Villa Rd., San Diego 12, Colif. (Tel. BRowning 7-6700)
Purch. Agent: Robert J. Just
Pres.: R. T. Silberman — TS, R&O

KINEVOX OIV.-ELECTROMATION CO.
1646 18th St., Santa Monica, Calif. (Tel. EXbrook 5-9975)
Chief-Purch.: G. B. Blockwell
Sales Mgr.: William S. Williams — GE, TR, R&O

KINNEY MFG. OIV., THE NEW YORK AIR BRAKE CO.
3529 Washington St., Boston 30, Mass. (Tel. JAmaica 4-3220)
Purch. Agent: P. E. Bott
Buyer: R. P. Dstrond
Gen. Sales Mgr.: W. B. Mills

KING FIFTH WHEEL CO.
P. D. Box 759, Wilkes-Barre, Penna. (Tel. GRanite 4-6371)
Purch. Agent: J. J. Gatti
V. P.-Sales: J. E. Gibbons — MF, PS

KINGSTON ELECTRONICS — OIV.-KINGSTON INDUSTRIES INC.
North St., Medfield, Mass. (Tel. FLeetwood 9-4347)
Purch. Agent: N. H. Peterson
Sales Mgr.: R. W. Moulton — TS

KIP ELECTRONICS CORP.
29 Holly Place, Stamford, Conn. (Tel. DAvis 5-1551)
Supvr.-Purch.: Groydon Cochrane
V. P.-Sales: John N. Higgins

M. KIRCHBERGER & CO., INC.
250 Humphry St., Englewood, N. J. (Tel. LDwell 8-4555)
Purch. Agent: A. Kent
Sales Mgr.: T. H. Church — MM

KIRK & BLUM MFG. CO., THE
3120 Forrer St., Cincinnoti 9, Dhio (Tel. ELmhurst 1-1400)
Purch. Agent: F. G. Weber
Asst. Purch. Agent: Fred Herrle
Oir.-Sales: W. R. Meuttman — MM

H. R. KIRKLAND CO., THE
10 King St., Morristown, N. J. (Tel. JE 8-2777)
Dept. Mgrs.: Brule Kirkland, Harry P. Anson
Oir.-Sales: H. R. Kirklond

KLINCHER LOCKNUT CORP.
2153 Hillside Ave., Indianapolis 18, Ind. (Tel. WAlnut 5-9284)
Purch. Agent: Mrs. Jean Groseclose
Engr.-Purch.: E. W. Pummill
Sales Mgr.: I. J. Dienhart — MF, PS

KLING METAL SPINNING & STAMPING CO.
247 Centre St., New York, N. Y. (Tel. CAnal 6-5580)
Owner: Philip Kling — WN, MM

KLOCK CORP.
1272 Tolland Tpke., Monchester, Conn. (Tel. Mitchell 9-5291)
Pres.: F. S. Klock — MM

KNAPIC ELECTRO-PHYSICS
936 Industrial Ave., Palo Alto, Colif. (Tel. DAvenport 1-5544)
Purch. Agent: Alvin G. Pretzer
Dir.-Sales: George M. MacLeon — MM

KNOPP INC.
1307 66th St., Dakland 8, Calif. (Tel. Diympic 3-1661)
Sales Mgr.: Henry N. Muller

KOBE INC.
3040 East Slauson Ave., Huntington Park, Calif. (Tel. LUdlow 8-1271)
Purch. Agent: R. W. Warfield
Aircraft Sales Mgr.: P. H. Jomison — GH, TS, R&O

H. KOCH & SONS
P. D. Box 125, Corte Madera, Calif. (Tel. WAbash 4-3510)
Purch. Agent: H. Salkin
Gen. Mgr.: M. P. Koch — PS, GS

KOEHLER AIRCRAFT PROOUCTS CO.
409 Leo St., Daytan 59, D. (Tel. BAldwin 6-1821)
Purch. Agent: Betty Jackowitz
Gen. Sales Mgr.: R. T. McCauley — PS, GS

KOHLER CO.
Kohler, Wisc. (Tel. GLencourt 7-4441)
V. P. & Sales Mgr.: A. G. Zibell
Sales Rep.: W. C. Voight — PS, GS, GH

KOILEO KOROS INC.
1565 Dixwell Ave., New Haven 14, Conn. (Tel. CHestnut 8-5515)
Purch. Agent: D. C. McKean
V. P.-Sales: E. L. Love — MF

KOLCAST INOUSTRIES —OIV. THOMPSON RAMO WOOLORIOGE INC.
P. D. Box 250, Minervo, Ohio (Tel. 725)
Purch. Agent: A. M. Pelley
Sales Mgr.: R. C. Kramer — MM, R&O

KOLLMORGEN OPTICAL CORP.
347 King St., Northampton, Mass. (Tel. JUstice 4-0280)
Purch. Agent: Richord G. Wolsh
Asst. Purch. Agent: George Dudley
Sales Mgr.: William C. D'Donnell — GS, TS, TR, R&D

KOLLSMAN INSTRUMENT CORP., SUB.-STANDARO COIL PROOUCTS CO. INC.
80-08 45th Ave., Elmhurst 73, N. Y. (Tel. TWining 9-5600)
Purch. Agent: J. Goodrich
Gen. Sales Mgr.: Henry N. Drage

E. KONIGSLOW STAMPING & TOOL CO.
450-1-N, 9th St., Elwood, Indiana (Tel. FE 2-5342)

***KOONTZ-WAGNER ELECTRIC CO., INC.**
516 N. Michigan St., South Bend 1, Ind. (Tel. CEntral 3-8251)
Procurement Mgr.: A. W. Koehnke
Gen. Mgr.: C. D. Hills
Production Mgr.: C. H. Bill
V. P.-Sales: B. Kumm — PS, GE

*(See Page 35 for Advertisement)

KOPP GLASS, INC.
Swissvale, Pittsburgh 18, Po. (Tel. BRandywine 1-0190)
Purch. Agent: Charles Rudek
V. P.-Sales: J. L. Newton — GS, GE

KOPPERS CO., INC.
Koppers Bldg., Pittsburgh, Pa. (Tel. EXpress 1-3300)
V. P.-Purch.: P. D. Shollar
Sales Mgr.-Chem. Div.: J. W. Pool
Sales Mgr.-Metal Products Oiv.: Harry Neher

KOPPERS CO., INC., METAL PROOUCTS OIV.
200 Scott St., Baltimore 30, Md. (Tel. SAratoga 7-2500)
Dir.-Procurement: B. K. Shaner
Mktg. Mgr.: H. P. Neher — MF, PS, TS

KOROA INOUSTRIES
20 W. 46th St., New York 36, N. Y. (Tel. JU 2-1078)
Purch. Agent: Ruth B. Speaker
Sales Mgr.: George Edrich — MF, PS, GE, CO

KORRY MFG. CO.
223 8th Ave. North, Seattle 9, Wash., (Tel. MAin 4-4066)
Sales Mgr.: J. D. White
Chief Engr.: H. K. Wilson — GS, CO, TS

KRAEUTER & CO., INC.
583-585 Eighteenth Ave., Newark 3, N. J. (Tel. ESsex 3-4000)
Buyer: F. M. McCudden
V. P.-Sales: Joseph E. Buhler

KRAMER FABRICATING CO., THE
920 Fisher Bldg., Detroit 2, Mich. (Tel. TRinity 1-1800)
Sales Mgr.: Charles R. Sterritt — PS, GS, TR, MM

HERB KRECKMAN CO.
Cresco, Pa. (Tel. 2212)
Herb Kreckman — GS

KRESSILK PROOUCTS, INC.
73 Murray St., New York, N. Y. (Tel. BA 7-2492)
V. P.: Roland Tobler
V. P.-Sales: S. A. Catone — MM, R&D

HAROLD KRUGER INSTRUMENTS
313 W. Valley Blvd., San Gabriel, Calif. (Tel. ATlontic 4-3541)
Purch. Agent: Ronald D. Rossiter
Owner: Harold Kruger — TS

KRYLON, INC.
Ford & Washington Sts., Norristown, Pa. (Tel. BRoadway 9-1950)
Dir.-Purch.: William Sonsalone
V. P.-Sales: Richard C. Newbold — MF, GS, GH, MM

KULKA ELECTRIC CORP.
633-643 S. Fulton Ave., Mt. Vernon, N. Y. (Tel. Mt. Vernon 4-4024)
Treas.: William Kulka
Purch. Agent: Horry Meltzer
Sales Mgr.: Elliott Edelman — MF, WN, PS, GS, GH, GE, CO, TS, TR

KURMAN ELECTRIC CO., DIV.-NORBUTE CORP.
191 Newel St., Brooklyn 22, N. Y. (Tel. EVergreen 3-8000)
V. P.-Purch.: Julian Goodstein
Purch. Agent: Jim Barry
Sales Mgr.: Wallace Green — GS, GH, GE, CO, TS, R&D

KURZ-KASCH, INC.
1421 S. Broadway, Dayton, D. (Tel. BAldwin 3-8161)
Purch. Agent: I. H. Naas
Asst. Purch. Agent: David Dohner
V. P.-Sales: R. L. Davidson — WN, GS, GH, CO

L. A. B. CORP.
Skaneateles 1, N. Y. (Tel. SKaneateles 1161)
Purch. Agent: H. B. Mantz
Sales Mgr.: J. T. Hubbard

L. O. F. GLASS FIBERS CO.
3116 Van Dwen Blvd., Burbank, Calif. (Tel. VIctoria 9-2331)
Purch. Agent: Robert D. Eiseld
Sales Mgr.: Wm. Worcester — MF, WN, PS, GS, GE, TS

L S M MFG. CO.
202 N. Elm, Waterbury, Conn. (Tel. PLaza 4-4136)
Oir.-Purch. & Sales Mgr.: P. J. Ciarleglio

LABELON TAPE CO., INC.
450 Atlantic Ave., Rochester 9, N. Y. (Tel. HUbbard 2-3460)
Purch. Mgr.: Kurt Baum
Gen. Sales Mgr.: D. L. Allen

LAB. FOR ELECTRONICS, INC.
75 Pitts St., Boston, Mass. (Tel. RIchmond 2-3200)
Purch. Agent: W. J. Stanton
Asst. Purch. Agent: H. E. Nilson
Chief Mech. Buyer: B. P. D'Sullivan
Chief Electrical Buyer: H. Wilayto
Chief Mill Supply Buyer: H. Tungate
Oir.-Sales: R. K. Mosher — TS,

ACONIA MALLEABLE IRON CO., INC.
71 Water St., Lacania, N. H. (Tel. 53)
Supt.: Bernard P. Brisse
Treas.: W. C. Brisse GS

ADISH CO.
5481 S. Packard Ave., Cudahy, Wisc. (Tel. HUmbaldt 1-1500)
Purch. Agent: J. F. Wachs
Sales Mgr.-Forging Div.: R. F. Starz
MF, WN, PS, GS, R&D

AMB ELECTRIC CO., THE., DIV.-AMERICAN MACHINE & METALS, INC.
Lake St., Kent, Ohio (Tel. ORchard 3-3451)
Purch. Agent: S. E. Campbell
Gen. Sales Mgr.: E. L. McIntyre

AMBDA ELECTRONICS CORP.
11-11 131st St., College Point, N. Y. (Tel. INdependence 1-8500)
Purch. Agent: E. Botuck
Exec. V. P.-Sales: Simeon Westan GS

LAMINATED SHIM CO.
9304 Union St., Glenbrook, Conn. (Tel. DAvis 5-2631)
Purch. Agent: Frederick J. Thomas
V. P.-Sales: M. L. Lockwood MF, WN, PS, MM
(See Pages 58 & 59 for Advertisement)

AMPKIN LABS., INC., MR DIV.
Bradenton, Fla. (Tel. 6-1906)
Purch. Agent & Sales Mgr.: George C. Craig TS

AMSON & SESSIONS CO., THE
5000 Tiedeman Rd., Cleveland 9, O. (Tel. CLearwater 2-3700)
Dir.-Purch.: Frank J. DeCrane
Asst. Mgr.-Aircraft Sales: Don H. Kluth
V. P.-Sales: J. G. Rayburn MM

AMTEX INDUSTRIES, INC.
56 Brooklyn Ave., Westbury, N. Y. (Tel. EDgewood 3-5000)
Buyer: Irving Grimon
V. P. & Sales Mgr.: Hsing Liu MM, R&D

ANCASTER GLASS CORP.
Lancaster, Ohio (Tel. OLive 3-0311)
Purch. Agent: Homer Echard
Sales Mgr.: M. R. Hoover

AND-AIR INC.
1444 W. Wilson Ave., Chicago 31, Ill. (Tel. UNderhill 7-7550)
Purch. Agent: C. D. Mitchell
Mgr.-Field Mktg.: Radney A. Stevens
MF, GS, GH, GE, CO, TS, TR, R&D

ANDIS & GYR, INC.
15 W. 45th St., New York 36, N. Y. (Tel. JUdson 6-4644)
Exec. V. P.: M. Wiesendanger
Sales Mgr.: John J. McNiff CO, TS

ANDSVERK ELECTROMETER, CO., THE
241 Sonora Ave., Glendale, Calif. (Tel. CHapman 5-6687)
Purch. Agent: Paul Giebelman
V. P.-Sales: D. L. Collins
Mgr., Comm. Div.: D. L. Merriner
Mgr., Contract Div.: J. Larsan
Mgr., Metal Prod. Div.: W. Miller
Mgr., Micrograph: Fred Hale GE, CO, TS

ANE ELECTRONICS MFG. CORP.
254 Atall Ave., North Hollywood, Calif. (Tel. ST 7-3267)
Purch. Agent: Philip A. Mattala
Sales Mgr.: Ray E. Enter CO, TS, R&D

LANGEVIN DIV., THE W. L. MAXSON CORP.
37-37 Austell Pl., Long Island City 1, N. Y. (Tel. RAvenswood 9-1850)
Purch. Agent: Danial Ryan
Sales Mgr.: Albert Schneider MM

LANHAM HICKEY STEEL CORP.
133 W. 47th Pl., Chicago 32, Ill. (Tel. VI 7-0822)
Pur.-Sales: J. W. Davis

LAPOINTE INDUSTRIES INC.
Rockville, Conn. (Tel. TRemant 5-3351)
Purch.: E. Evans
Sales.: Y. H. Stillbach
MF, WN, GS, GH, GE, CO, TR, R&D

LAPOINTE MACHINE TOOL CO., THE
Tower St., Hudson, Mass. (Tel. HUdson 850)
Purch. Agent: Ira J. Habeshian
V. P.-Sales: Joseph P. Crosby PS, MM

LAROE INSTRUMENTS, INC.
2109B E. Montgomery Ave., Rockville, Md. (Tel. HAzelwood 7-7455)
Purch. Agent: R. L. Taylor
Sales.: William A. Linton, Jr. GE, CO, TR

CHARLES E. LARSON & SONS, INC.
3145-65 N. Keeler Ave., Chicago 39, Ill. (Tel. SP 2-9700)
Purch. & Sales: Charles M. Larson MM

***LAVELLE AIRCRAFT CORP.**
Sterling St., Newtown, Bucks County, Pa. (Tel. WOrth 8-3838)
V. P. & Purch. Agent: H. A. Liese
Contracts Mgr.: Frank V. Kiefer
Chief Engr.: Adalph Herzog MF, WN, PS
*(See Page 98 for Advertisement)

***LAVEZZI MACHINE WORKS**
4635 W. Lake St., Chicago 44, Ill. (Tel. ESterbrook 8-1636)
Purch. Agent: Jerome J. Kremer
Sales Mgr.: Warth Baird GS, GE, TR, R&D
*(See Page 80 for Advertisement)

LAVOIE LABS., INC.
Matawan-Freehold Rd., Morganville, N. J. (Tel. LOwell 6-2600)
Purch. Agent: G. F. Craddick
Buyers: N. Robinson & J. Higgins
Sales Admin.: J. D. Capeland GS

LAWRENCE PUMPS INC.
371 Market St., Lawrence, Mass. (Tel. MUrdock 2-5249)
V. J. Mill, Jr. GS

LEACH CORP.
Leach Inet Div.
18435 Susana Rd., Comptan, Calif. (Tel. NEvada 6-1061)
Purch. Agent: Rudy Jantz
Buyers: C. M. Riddell, J. Paar
Gen. Sales Mgr.: V. Kostuck
V. P.-Sales: J. K. Dysart
Leach Relay Div.
5915 Avalon Blvd., Los Angeles 3, Calif. (Tel. ADams 2-8221)
Purch. Agent: A. E. Rase
Buyers: Harry Sawyer, Allan Sapp GS, CO, TS

LEAMING ENGRG., INC.
3743 Cahuenga Blvd., North Hollywood, Calif. (Tel. Stanley 7-3223)
Purch. Agent: Freda S. Kraft TR, R&D

LEAR, INC.
3171 S. Bundy Dr., Santa Monica, Calif. (Tel. EXmant 8-6211)
Astronics Div.: 3171 S. Bundy Dr., Santa Monica, Calif. (Tel. EXmont 8-6211)
Head-Purch. Dept.: Robert H. Laamis
LearCal Div.: 3171 S. Bundy Dr., Santa Monica, Calif. (Tel. EXmant 8-6211)
Head-Purch. Dept.: Ray Fisher
Lear, Inc.: 100 Ionia, N. W., Grand Rapids 2, Mich. (Tel. GLendale 1-1555)
Purch. Agent: Robert S. Thies
Lear-Romec Div.: Abbe Rd., Elyria, Ohio GS, GE, CO

LEAR, INC., GRAND RAPIDS DIV.
110 Ionia Ave., N. W., Grand Rapids, Mich. (Tel. GLendale 1-1555)
Purch. Agent: R. S. Thies
V. P. & Dir.-Military Mktg. Serv.: K. R. Hahn
WN, PS, GS, GE, CO, TS, TR

LEAR INC., LEAR-ROMEC DIV.
Abbe Rd., Elyria, Ohio (Tel. FAirfax 3-3211)
Purch. Agent: W. W. Wilber
Contracts Mgr.: J. E. McKeighan PS, GS, GH

LEBANON STEEL FOUNDRY
1st Ave. & E. Lehman St., Lebanon, Pa. (Tel. CR 3-1611)
Dir.-Purch.: C. R. Mease
Sales Mgr.-Spec. Products: R. W. Patridge
Gen. Sales Mgr.: John H. Boyd MM

LEBEC CHEMICAL CORP.
14066 S. Garfield Blvd., Paramount, Calif. (Tel. NEvada 6-3381)
Purch. Agent: George Wolf
Pres.: John C. Plummer MM, R&D

R. K. LEBLOND MACHINE TOOL CO.
Madison & Edwards Rds., Cincinnati, O. (Tel. JEfferson 1-0910)
Purch. Agent: Wm. McK. Reis
V. P.-Sales: B. N. Brackman MF

LECTROHM, INC.
5560 Northwest Hwy., Chicago 30, Ill. (Tel. ROdney 3-1700)
Head-Purch. Dept.: I. H. Adair
Head-Sales: J. Rinaldi MM

LEDEEN INC.
3350 N. Gilman Rd., El Monte, Calif. (Tel. CUmberland 3-3163)
Purch. Agent: E. J. Hay
Sales Mgr.: Harold Rosaff GH

LEE CO., THE
Wesley Ave., Westbrook, Conn. (Tel. Saybrook, Conn. EXport 9-6228)
Pres.-Research & Dev.: Leighton Lee, II
Office Mgr.: Elenor Shields R&D

LEECRAFT MFG. CO., INC.
60 Greene St., New York 12, N. Y. (Tel. WOrth 6-2855)
Dir.-Purch.: N. R. Sherwin
Dir.-Sales: R. S. Nelson MM

LEEDS & NORTHRUP CO.
4907 Stenton Ave., Philadelphia 44, Pa. (Tel. DAvenport 9-4900)
Mgr.-Purch. Dept.: J. E. Jennings
Sales Mgr.-Engrg. Div.: H. L. Scutt CO, TS

LEETRONICS, INC.
30 Main St., Brooklyn 1, N. Y. (Tel. ULster 5-7163)
Purch. Agent: T. Dalton
Gen. Mgr.-Sales: O. M. Lerz, Jr.
PS, GS, GH, TS, R&D

LEFFINGWELL CHEMICAL CO.
P. O. Box 1187, Perry Annex, Whittier, Calif. (Tel. EDgewood 6-5774)
Purch. Agent: J. W. Kinsman MF, GS, MM

LEGRIS CO.
391 Riverdale Ave., Yonkers 5, N. Y. (Tel. YOnkers 9-6000) RS, TR, R&D

LEIMAN BROTHERS, INC.
P. O. Box 1339, 146-181 Christie St., Newark 1, N. J.
Purch. Agent: Frank Crista PS, GS

LEITCH-HUARD CORP.
Stark & Commercial Sts., Manchester, N. H. (Tel. NAtional 3-4773)
Pres.: A. J. Huard
Electronics Buyer: H. E. Newell
V. P.-Sales: D. Robert Leitch TS

L E L, INC.
380 Oak St., Copiague, L. I., N. Y. (Tel. AM 4-2200)
Purch. Agent: D. Dady
Sales: C. A. Nuebling GE, TR

LELAND AIRBORNE PRODUCTS, DIV.-AMERICAN MACHINE & FOUNDRY CO.
P. O. Box 128, 740 E. National Hwy., Vandalia, O. (Tel. TWin Oaks 8-5881)
Purch. Agent: Walter Stump
Buyers: D. Bechtal & M. Booher
Sales Mgr.: E. C. Johns GS, R&D

G. H. LELAND, INC.
123 Webster St., Daytan 2, O. (Tel. BAldwin 4-9891)
Purch. Agent: Morris M. Wright
Asst. Purch. Agent: H. E. Jacobs
Sales Mgr.: Hans G. Belitz GS, GE

LEMERT ENGRG. CO., INC.
1313 Western Ave., Plymouth, Ind. (Tel. WEbster 6-3430)
Head-Purch. Dept.: E. R. Lemert
Head-Sales: J. F. Sherrill WN, MM

LENKURT ELECTRIC CO., INC.
1105 County Rd., San Carlos, Calif. (Tel. LYtell 1-8461)
Military Purch. Mgr.: David Steinberg
Military Mktg. Mgr.: Joseph R. Sherman

LENOX INSTRUMENT CO.
2010 Chancellor St., Phila. 3, Pa. (Tel. RIttenhouse 6-6653)
Dir.-Purch.: John W. Lang

LENZ ELECTRIC MFG. CO.
1751 N. Western Ave., Chicago 47, Ill. (Tel. ARmitage 6-4454)
Purch. Agent: Charles M. Wilkins
Exec. V. P.: R. G. Zender GS, GE, TR, R&D

***WALLACE O. LEONARD, INC.**
373 S. Fair Oaks Ave., Pasadena, Calif. (Tel. RYan 1-4446)
Purch. Agent: Arthur W. Foster
Purch. Expediter: Robert L. Todd
Sales Admin.: Kenneth I. Stubbs
MF, PS, GS, GH, GE, CO, TS, TR
*(See Page 186 for Advertisement)

LERCO ELECTRONICS, INC.
501 S. Varney St., Burbank, Calif. (Tel. VIctoria 9-5556)

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

Purch. Agent: Sylvia Garmang
V. P.-Sales: Harold J. Wittmeyer
GS, GE, TS, TR, MM

LESLIE CO.
321 Leslie Bldg., Lyndhurst, N. J. (Tel. GEneva 8-8000)
Sales: James R. Grabill — GS

R. G. LETDURNEAU, INC.
2399 S. MacArthur, Langview, Texas (Tel. PLaza 3-4411)
Dir.-Purch.: Clair Weller
Asst. Dir.-Purch.: John Williamson
Defense Proj. Section: H. V. Anderson
V. P.-Sales: R. L. LeTourneau — GH

LOUIS LEVIN & SON, INC.
3610 S. Broadway, Los Angeles 7, Calif. (Tel. AOams 3-7169)
Mgr.-Purch. & Sales: Samuel Levin

LEVINTHAL ELECTRONIC PRODUCTS, INC.
3180 Hanaver St., Stanford Industrial Park, Pala Alta, Calif. (Tel. DAvenpart 6-1640)
Purch. Agent: Robert H. Shimer
PS, GS, GE, CO, TS, TR

E. B. LEWIS CO., INC.
11 Bragg St., E. Hartford, Conn. (Tel. JAcksan 8-0830)
Pres.: Ernest B. Lewis — GS, GE

***LEWIS ENGRG. CO., THE**
339 Church St., Naugatuck, Conn. (Tel. PArk 9-5253)
Purch. Agent: M. N. Forde
Chief Field Engr.: H. D. Alexander
*(See Page 5 for Advertisement) — GS, CO, TS, TR

WARNER LEWIS CO., DIV.-FRAM CORP.
817 N. Lewis Pl., Tulsa, Okla (Tel. WEbster 9-6386)
Purch. Agent: R. P. Leedy
Sales Mgr.: T. R. Bradley — GS

LEWIS & SAUNDERS
20 Bayside St., Lakeport, N. H. (Tel. LAkeside 4-2064)
Gen. Mgr.-Purch.: W. W. Saunders — PS

LIBERTY MIRROR DIV., LIBBEY-OWENS-FORD GLASS CO.
851 Third Ave., Brackenridge, Pa. (Tel. ACademy 4-1800)
Purch. Agent: C. R. MacDonald
Gen. Mgr.: J. C. Ogle, Jr. — GE, CO, TR

LIBRASCOPE INC.
808 Western Ave., Glendale, Calif. (Tel. CItrus 4-6541)
Purch. Agent: M. L. Cawen
Purch.-Components: A. N. Nelsan
MF, WN, PS, GS, GE, CO, TS, TR, R&D

LICON SWITCH & CONTROL DIV., ILLINDIS TOOL WORKS
6606 W. Dakin St., Chicago 34, Ill. (Tel. AVenue 2-4040)
Buyer: R. J. Salners
Dir.- Sales & Engrg.: J. D. Raeser — WN, GS

LIECD, INC.
3610 Oceanside Rd., Oceanside, N. Y. (Tel. RO 6-7620)
Purch. Agent: J. Mackey
Dir.-Sales: A. Zeitz — GE, TR

LIGGETT SUPPLY & EQUIPMENT CO.
2030 S. Main St., Elkhart, Ind. (Tel. 3-2930)
Dir.-Purch.: H. K. Skinner
Mgr., Special Products Div.: W. L. Lichtenberger
Chief Engr.: A. S. Kratz
Gen. Mgr.: F. O'Brien — GS, GH

LIGHT METALS, INC.
1100 E. 24th St., Indianapolis 5, Ind. (Tel. WAlnut 6-4591)
Purch. Agent: Kenneth R. Goadwin
V. P.-Sales: Thomas H. Hargitt
MF, WN, PS, GH, MM •

LINCOLN ELECTRIC CO., THE
22801 St. Clair Ave., Cleveland 17, O. (Tel. IVanhoe 1-8100)
Dir.-Purch: H. A. Burnip
Exec. V. P.-Sales: J. S. Rascoe — GS, GH

LINDBERG ENGRG. CO.
2450 W. Hubbard St., Chicago 12, Ill. (Tel. MDnroe 6-3443)
Purch Agent: E. A. Griebe
Sales Mgr.: C. F. Burling
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&D

LINDE CO., DIV.-UNIDN CARBIDE
30 E. 42nd St., New York, N. Y. (Tel. MU 7-8000)
Mgr.-Mkt. Research & Pram.: S. Hahn — MF, WN, PS

LINDGREN FOUNDRY CO.
717 Main St., Batavia, Ill. (Tel. 1800)
Purch. Agent: John E. Lindgren
Asst. to Pres.: William J. Meinhard — MM

LINEAR, INC.
State Rd. & Levick St., Philadelphia 35, Pa. (Tel. MA 4-4700)
Purch. Agent: F. Murphy, Dallas, Pa. (Tel. ORchard 4-1541)
V. P.-Sales: F. A. Lewis

LING ELECTRONICS, INC.
9937 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-7711)
Purch. Agent: Frank Burke
Dir.-Sales: Charles Theodore — GS, CO, TS

LINK AVIATION, INC.
Hillcrest, Binghamton, N. Y. (Tel. 3-6311)
Purch. Agent: M. B. Bird
Buyers: N. Totich, F. J. Sabrow & J. F. Clark
V. P.-Sales: L. L. Kelly

LINK-BELT CO.
Prudential Plaza, Chicago 1, Ill. (Tel. RAndalph 6-7790)
V. P.-Sales: David E. Davidson
Purch. Agent: Dan E. Cabb
Los Angeles 22, Calif. (Mail Address, Box 22056, 1200 Sycamore St., Montebella, Calif.)
Purch. Agent: George Samps
400 Paul Ave., San Francisca 24, Calif.
Purch. Agent: James T. McDanald
Box 10514, Sta. A., 1116 Murphy Ave., S. W., Atlanta 10, Ga.
Purch. Agent: Andrew K. Kalar
(Pershing Rd. Plt.) 300 W. Pershing Rd., Chicago 9, Ill.
Purch. Agent: Albert W. Weldan
(Caldwell Plt.) 2410 W. 18th St., Chicago 8, Ill.
Purch. Agent: Richard J. Joyce
220 S. Belmant Ave., Indianapolis, Ind.
Purch. Agent: Marvin H. Cramer
200 Lyndale Ave., N., Minneapalis 5, Minn.
Purch. Agent: Albert W. Baegner, Calmar, Pa.
Purch. Agent: F. Walter Skerrett
2045 W. Hunting Park Ave., Philadelphia 40, Pa.
Purch. Agent: William A. Cameran
Box 2563, 3203 Sauth Wayside, Haustan 1, Texas
Purch. Agent: Charles Percich
3405 Sixth Ave., S., Seattle 4, Wash. — GS, GH

LION FASTENER CD., INC.
Lester, Pa. (Tel. LEhigh 4-9600)
Plant Supt.-Purch.: Harald DIlerenshaw
Sales: T. R. Dunlevy — MF

EDWIN A. LIPPS ENGRG.
1511 Calarada Ave., Santa Monica, Calif. (Tel. EX 3-0449)
Purch. Agent: Ray E. Haney
Prod. Suprvsr.: T. F. Adams
Gen. Mgr.: B. D. Lipps — TR

LIQUIDOMETER CDRP., THE
41-03 36th St., Lang Island City 1, N. Y. (Tel. STillwell 4-1440)
Purch. Agent: Richard H. Hagan
V. P.-Sales: Harry T. Cullinan — GS, TS, R&D

G. W. LISK CO., INC
Clifton Springs, N. Y. (Tel. HOward 2-2611)
Dir.-Sales: I. A. Morris — PS, GS, GH, GE

LISLE CDRP.
807 Main St., Clarinda, Iawa (Tel. LIberty 2-2156)
Treas.: Earl Thampsan
Asst. Purch. Agent: Harry Rubin
V. P.-Sales: Edwin Lisle

LISS PRDDUCTS, INC.
1050 Secand St., Manchester, N. H. (Tel. NA 3-5711)
V. P.-Purch.: Mark Strickland
Pres.: John C. Stanhope — WN, MM, R&D

LITHIUM CDRP. DF AMERICA, INC.
1100 Title Ins. Bldg., Minneapalis 1, Minn. (Tel. FEderal 2-7541)
Dir.-Purch. & Traffic: J. W. Douglas
Mgr. Sales Dept.: J. D. Campbell — MM, R&D

LITTLEFUSE, INC.
1865 Miner St., Des Plaines, Ill. (Tel. VAnderbilt 4-1188)
Purch. Agent: Oave Shean
Dist. Sales Mgr.: Walter A. Clements

LITTON ENGRG. LABS.
P. D. Box 949, Grass Valley, Calif. (Tel. Grass Valley 1730)
Purch. Agent: Mrs. Grace Martz
Gen. Mgr.: F. L. Towne

LITTON INDUSTRIES, INC.
336 N. Foothill Rd., Beverly Hills, Calif. (Tel. CRestview 4-7411)
Public Relations: Claude Mecanis — GE, TR, R&D

LITTON INDUSTRIES, CDMPONENTS DIV.
5873 Rodeo Rd., Las Angeles 16, Calif. (Tel. VErmant 7-1228)
Purch. Agent: Jack Brophy
Dir.-Sales: R. W. Griffiths

LITTDN INDUSTRIES, MARYLAND DIV.
4900 Calvert Rd., College Park, Md. (Tel. UNian 4-5678)
Dir.-Purch.: Earl Ahern
Dir.-Sales: George Tinker — GE, CD, TS, TR

LITTON INDUSTRIES, U. S. ENGRG. CO. DIV.
5073 Rodea Rd., Las Angeles, Calif. (Tel. VE 7-1228)
Purch. Agent: Richard J. Lee
Sales: Paul J. Rabichand — MM

LIVERMONT, INC.
Myrtle & Maple Aves., Manrovia, Calif. (Tel. ELliott 9-2555)
Purch. Agent: J. F. Hubbard
Sales Mgr.: M. McLean

LIVINGSTDN ELECTRONIC CORP.
27 Runnymede Rd., Essex Fells, N. J. (Tel. CApital 6-3333)
Prad.: Charles L. Nalte
Engrg.: C. E. Smiley — GE, R&D

LOCKHEED AIRCRAFT CORP., MISSILES & SPACE DIV.
1122 Jagels Rd., P. O. Box 504, Sunnyvale, Calif. (Tel. REgent 9-9611)
Gen. Purch. Agent: L. G. Sinning
Dir.-Military Sales: G. H. Putt
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&D

LOCKREY CD., THE
P. O. Box J, Sauthampton, N. Y. (Tel. SOuthampton 1-0278)
Purch. Agent: J. Davis
Sales Mgr.: O. I. McMeekan — MM

LODGE & SHIPLEY CO., THE
3055 Calerain Ave., Cincinnati 25, Ohia (Tel. KIrby 1-4774)
Purch. Agent: John Bates
Gen. Sales Mgr.: Donald D. Edwards
Sales Pram. Mgr.: Arthur V. Baumann

LOEWY-HYDROPRESS, DIV.-BALDWIN-LIMA-HAMILTON CORP.
111 Fifth Ave., New York 3, N. Y. (Tel. DRegan 7-5030)
Purch. Mgr.: John Swanberg
Sales: Frederick F. Fielder & Paul Mayer
MF, PS, GS, GH, T

LOFSTRAND CO., THE
Sauthlawn Lane, Rackville, Md. (Tel. HAzlewood 7-7280)
Purch. Agent: G. M. Chadwick
V. P.-Sales: Henry Clark — GS, G

J. M. LOGE, SDUND ENGINEERS
2171 W. Washington Blvd., Los Angeles 18, Calif. (Tel. REpublic 4-9178)
Purch. Agent: Merle Adkins
Dir.-Sales: J. M. Lage

LOGETRDNICS INC.
500 E. Manrae Ave., Alexandria, Va. (Tel. TE 6-5180)
Purch. Agent: Arthur Hall, Jr.
Dir.-Sales: Gardon O. F. Johnsan — G

LDNDDN CHEMICAL CO., INC.
1535 N. 31st Ave., Melrase Park, Ill. (Tel. AUstin 7-9495)
Purch. Agent: R. I. Schub
Sales Mgr.: K. W. Andersan — MF, PS, GS, G

LONE STAR PLASTICS CO. INC.
124 Roberts Cut Off Rd., P. O. Box 9817, Fart Warth, Texas (Tel. PE 2-1437)
Purch. Agent: Mrs. Catherine Hare
Sales Mgr.: W. P. Fralia — M

THOMAS J. LDNG, INC.
215 Stonehinge Lane, Carle Place, L. I., N. Y. (Tel. EDgewaad 4-2300)
Asst. to V. P.: John J. Skelly
Sales Mgr.: Narman A. Terry — M

LDNGREN AIRCRAFT CD., INC.
24751 Crenshaw Blvd., Tarrance, Calif. (Tel. NEvada 6-0241)
Mgr.-Customer Relations: D. N. Ninteman
Purch. Agent: James M. Crawford — MF, GS, GH, R&

LDRD MFG. CO.
1635 W. 12th St., Erie, Pa. (Tel. 62-911)
Adv. Mgr.: J. P. Cooney

LOUTHAN MFG. CO., THE, DIV.-FERRD CORP.
2000 Harvey Ave., East Liverpaal, Dhia (Tel. FUlton 5-1538)
Supt.-Purch.: Leanard Kupchinsky
Works Mgr.: Fred A. Layne — PS, R

DVEJOY FLEXIBLE COUPLING CO.
4949 W. Lake St., Chicago 44, Ill. (Tel. ES 9-3010)
V. P.-Purch.: C. P. Hennessy
Purch. Agent: Fred Spaulding
V. P.-Sales: W. B. Briggs — GS, GH

DVEJOY TODL CO., INC.
Springfield, Vt. (Tel. TUrner 5-2195)
Sales: C. Jenness Cameron

UCAS AIRCRAFT SUPPLY CO.
17311 S. Main St., Gardena, Calif. (Tel. FAculty 1-0080)
Gen. Mgr.: Frank E. Briney
Purch. Agent: M. A. Abata
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&D

UKENS STEEL CO.
1st Ave., Coatesville, Pa. (Tel. 2000)
Purch. Agent: Albert Gudal
Dir.-Purch.: Edmund Pfeifer
Supvr.-Stores & Material: Thomas A. O'Hara
Buyers: Wilmer Montgomery, John M. Davis & Donald Davis — MM

UMATRDN ELECTRONICS, INC.
68 Urban Ave., Westbury, L. I., N. Y. (Tel. EDgewood 4-3100)
Purch. Agent: Frank Ruggiere
Sales: Gerard G. Leeds — TS, R&D

UMINDUS RESINS INC.
166 W. Washington St., Chicago, Ill. (Tel. DE 2-4667)
Pres.: W. A. McCallum — CO, R&D

UNDEY ASSOCIATES INC.
594 Main St., Waltham 54, Mass. (Tel. TWinbrook 3-6064)
Purch. Agent: E. J. W. Grenda — PS, GE, TR

UNDY MFG. CORP.
Glen Head, L. I., N. Y. (Tel. ORiole 6-1440)
Purch. Agent: Joseph A. Barbato
Buyers: Durell Piersall & Thomas Rogers
Pres.: R. C. Barbato — GS, GH, R&D

UNN LAMINATES, INC.
Oakwood Rd. & W. 11th St., Huntingtan Station, N. Y. (Tel. HAmilton 3-7200)
Purch. Agent: Edward W. Kirchner
Pres.: James S. Lunn — MF, PS, GS, GH, GE, TS, TR

URIA ENGRG. CO.
1010 Vermont Ave., N. W., Washington 5, D. C.
Purch. Dept.: P. O. Box 800, Main Office, Bethlehem, Pa. (Tel. UNiversity 7-4651)
Dir.-Purch.: Earl Woolery
V. P.-Sales: Charles H. Ketcham, Jr. — GS

URIA ENGRG. CO.
1745 Eaton Ave., Bethlehem, Pa. (Tel. UNiversity 7-4651)
Purch. Agent: C. E. Topping
Asst. to Purch. Agent: R. R. Bergenstock
Buyers: C. A. Moyer & D. S. Luria
V. P.-Sales: E. G. Ball — MF, WN, PS, GS, GH, TS

UTHER MFG. CO.
8312 Varna Ave., North Hollywood, Calif. (Tel. POplar 5-4265)
Purch. Agent: Russell H. Reid
Chief Engr.: Neil Curry

UX CLOCK MFG. CO., INC.
56 Johnson St., Waterbury, Conn. (Tel. PL 6-3661)
Purch. Agent: Arthur Kunkel, Jr.
Asst. Purch. Agent: Carl Hungerford
Asst. Sales Mgr.: Eugene T. Crandall

UZERNE RUBBER CO.
Birthead Ave., Trenton, N. J. (Tel. EXpart 2-4131)
Purch. Agent: William Gummere, Jr.
Sales Mgr.: M. J. Kearney, Jr. — MM

AVCO MFG. CORP. DIV., AVCO MFG. CORP.
150 S. Main St., Stratford, Conn. (Tel. DRexel 8-8211)
Dir.-Materiel: Frank Larkins
Purch. Mgr.: George Rapuano
V. P.-Sales: H. Webster Crum — MF, WN, GS, MM
(See 3rd Cover for Advertisement)

R. L. LYNCH MFG. CO.
1231 E. Arroyo Dr., South San Gabriel, Calif. (Tel. AT 0-3810)
Pres.: R. H. Lynch
Sales: J. W. Lynch

LYNCH CARRIER SYSTEMS INC.
175 Bryant St., San Francisco 7, Calif. (Tel. EXbrook 7-1471)
Purch. Agent: J. E. Gilchrist
Sales Mgr.: E. B. Stone

LYNCOACH & TRUCK CO. INC.
113 Chestnut, Oneonta, N. Y. (Tel. 1257)
Purch. Agent: Royce Strait
Pres.: James Friery
Sales Mgr.: Charles MacLean — GS, GH

LYNDON AIRCRAFT, INC.
140 Clifford St., Newark 5, N. J. (Tel. MI 2-4090)
Purch. Agent: Wm. O'Neill
Pres.: Arthur MacArthur
MF, WN, PS, GS, GH, GE, TS, TR

LYON VAN & STORAGE CO., AIRCRAFT DIV.
2701 N. Ontario St., Burbank, Calif. (Tel. VIctoria 9-3317)
Prod. Mgr.: William F. McCann
Gen. Mgr.: Ralph C. Butler

LYTLE ENGRG. & MFG. CO.
1404 San Mateo, S. E., Albuquerque, N. Mex. (Tel. ALpine 5-1671)
Purch. Agent: Perry Weaver
Div. Mgr.-Sales: L. V. Julihn
MF, WN, PS, GS, GH, GE, CO, TS, TR

MB MFG. CO.
781 Whalley Ave., New Haven 8, Conn. (Tel. FUlton 9-1511)
Mgr.-Purch.: Carl Verderame
Aircraft Sales Mgr.: T. MacDonald
Sales Mgr.-Vibration Test Equip.: A. C. Deichmiller
MF, PS, CO, TS, TR

M. C. MFG. CO.
P. O. Box 126, 118 Indianwood Rd., Lake Orion, Mich. (Tel. MYrtle 2-2711)
Buyer: R. Rhodes
Sales: H. P. Ott — WN, PS, GE

MF ELECTRONICS CO.
122 E. 25th St., New York 10, N. Y. (Tel. GRamercy 3-5899)
Chief Engr.: Martin J. Finkelstein
GH, GE, CO, TS, TR

MPM, INC.
9110 George Ave., Cleveland 5, O. (Tel. BRoadway 1-4456)
V. P.-Purch.: A. B. Cook
Purch. Agent: F. K. Lawton
Sales Engr.: J. M. Van Walshauser

M & Q PLASTIC PRDDUCTS
Bannard St., Freehold, N. J. (Tel. FReehold 8-6664)
V. P.-Purch.: William Menges
Pres.: Frank Dunn — MM

MSA RESEARCH CDRP.
Callery, Pa. (Tel. EVans City 3510)
Buyer: E. L. Oviott
Dir.-Mktg.: C. H. Staub — MM, R&D

M-W LABS., INC.
1824 N. Milwaukee Ave., Chicago, Ill. (Tel. DIckens 2-4020)
Plant Supt.: Norbert Sajdera
Sales Mgr.: George W. Halstan — MF, WN

MAAS & WALDSTEIN CO.
2121 McCarter Hwy., Newark 4, N. J. (Tel. HUmbolt 4-1600)
Sales Mgr.: Don Volino — MM

MACARR, INC.
2543-45 Boston Rd., New York 67, N. Y. (Tel. OL 3-3306)
Purch. Agent: Phil Bruno — GS

MACHINE PRODUCTS DIV., NEW HAVEN TRAP ROCK CO.
Route 80, N. Branford, Conn. (Tel. HUbbard 8-1692)
Purch. Agent: S. J. Barcsansky
Div. Sales Mgr.: D. A. Briggs — MF, PS, GH

MACHINERY SALES & ENGRG. CO.
422 Empire Bldg., Pittsburgh 22, Pa. (Tel. ATlantic 1-5586)
Engr.: Carl Anders

MACK TRUCKS, INC., GOV'T DIV.
1825 Conn. Ave., N. W., Washington 9, D. C. (Tel. HUdson 3-6200)
Mgr.-Gov't Div.: Richard H. McMahon

MACKAY RESEARCH LABS.
P. O. Box 738, Benson, Ariz.
Dir.-Purch.: Diane MacKay
Dir.-Sales: Sanders MacKay — R&D

MACLEOD & HANOPOL, INC.
10 Raland St., Charlestown 29, Mass. (Tel. MO 6-2171)
Pres.: A. D. MacLeod — TS

MACWHYTE WIRE ROPE CO.
2906 14th Ave., Kenosha, Wisc. (Tel. OLympic 4-5381)
Purch. Agent: John Goodwin
V. P.-Sales: F. D. Holden — MM

MAGEE-BRALLA & ASSOCIATES
3361 National Ave., San Diego 13, Calif. (Tel. BE 3-7769)
Partners: Robert C. Bralla & J. Rodgers Magee
GS, R&D

MAGLINE INC.
1802 Mercer St., Pinconning, Mich. (Tel. TRiangle 9-2411)
Purch. Agent: R. A. Austin
Sales Mgr.: F. A. Reger — MF, WN, PS, GS, MM

MAGNAFLUX CORP.
7300 W. Lawrence Ave., Chicago 31, Ill. (Tel. UNderhill 7-8000)
Purch. Agent: C. D. Ceske
Asst. Purch. Agent: L. Ondacek
V. P.-Sales & Mktg.: R. O. Schiebel — TS

MAGNASYNC MFG. CO., LTD.
5546 Satsuma Ave., N. Hollywood, Calif. (Tel. STanley 7-5493)
Electronics Purch.: George Duerr
Mechanicol Purch.: Louis Schirm
Sales Mgr.: Howard V. Auchstetter
MF, PS, GS, GH, GE, CO, TS, TR

MAGNAVOX CO., THE
2131 Bueter Rd., Ft. Wayne, Ind. (Tel. E3967)
Dir.-Purch.: Warren Friebel (Tel. E9721)
Mgr.-Gov't. Div.-Sales: David W. Martin
GE, CO, TS, R&D

MAGNECRAFT ELECTRIC CO.
3352 W. Grand Ave., Chicago 51, Ill. (Tel. EVerglade 4-6868)
Buyer: R. D. Splitt
Sales: H. D. Steinback — GE, TR

MAGNETIC CONTROLS CO.
6405 Cambridge St., Minneapolis 26, Minn. (Tel. WE 9-4691)
Purch. Agent: T. D. O'Fallon
Buyer: LaVerne Rogers
Sales Mgr.: G. R. Stoltenberg — GS, GE

MAGNETIC CORE CORP.
John & Lawrence Sts., Newburgh, N. Y. (Tel. NEwburgh 5116)
Purch. Agent: R. G. Burdick
Sales: Robert Webb — GE, MM

MAGNETIC DEVICES, INC.
712 East St., Frederick, Md. (Tel. MO 2-2144)
Purch. & Sales Dept.: F. J. Cook — GS, GH

MAGNETIC INSTRUMENT CO., INC.
546 Commerce St., Thornwood, N. Y. (Tel. ROgers 9-5312)
Purch. Agent: Richard D. Levine
Sales Mgr.: Robert J. Levine — GH, TS, R&D

MAGNETIC RESEARCH CORP.
3160 W. El Segundo Blvd., Hawthorne, Calif. (Tel. OSborne 5-1171)
Purch. Agent: James Wirosko
Sales Mgr.: William E. Brown — GS, TR, R&D

MAGNETIC SEAL CORP.
301 Sowams Rd., Barrington, R. I. (Tel. CHerry 5-4800)
Purch. Agent: Everett E. Comey (Tel. CHerry 5-4801)
Pres.-Sales: George E. Colby — MF, PS, GS

MAGNETIC SHIELD DIV.-PERFECTION MICA CO.
1322 N. Elston Ave., Chicago 22, Ill. (Tel. EVerglade 4-2122)
Purch. Agent: Henry Hucksold
MF, WN, PS, GS, GE, CO, TS, TR

MAGNETICO, INC.
6 Richter Ct., E. Northport, L. I., N. Y. (Tel. ANdrew 1-4502)
V. P.: Mark A. Barry
Mgr.-Amplifier Div.: E. Daparma — GE, TS, TR

MAGNETICS, INC.
Butler, Pa. (Tel. 7-3787)
Purch. Agent: W. J. Allen (Tel. 7-1745)
Dir.-Mktg.: R. W. Olmsted
Sales Prom. Mgr.: James W. Graham — TR, MM

MAGNETICS, INC., CONTROL DIV.
Butler, Pa. (Tel. 7-3787)
Purch. Agent: W. J. Allen (Tel. 7-1745)
Dir.-Sales Mktg.: R. W. Olmstead — TR, MM

MAGNETROL, INC.
2110 S. Marshall Blvd., Chicago 23, Ill. (Tel. BIshop 7-4000)

CODING
Missile Frome MF
Warhead & Nase Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

Purch. Agent: C. F. Sopinski
Sales Mgr.: Lester E. Stybr PS, GE

MAGTROL, INC.
240 Seneca St., Buffalo 4, N. Y. (Tel. MDhawk 7451)
Purch. Agent: James Loughlin
Sales Mgr.: John E. Traise GE, CO, TS

MAICO ELECTRONICS, INC.
21 N. 3rd St., Minneapolis 1, Minn. (Tel. FEderol 9-7041)
V. P.-Purch. & Industrial Sales: J. T. Utne
Purch. Agent: John M. Wheeler
Asst. Purch. Agent: William E. Cunninghom GS, TR, R&O

MAIDA DEVELOPMENT CO.
214 Academy St., Hampton, Va. (Tel. PArk 3-0785)
Purch. Agent: R. J. Clopton
Pres.: F. X. Maida

MALCO MANUFACTURING CO.
4025 W. Lake St., Chicago 24, Ill. (Tel. Von Buren 6-9300)
Purch. Agent: Walter J. Kulins
Sales Mgr.: Anthony Doidone MM, R&O

P. R. MALLORY & CO. INC.
3037 E. Washington St., Indianopolis 6, Ind. (Tel. MElrose 6-5353)
Dir.-Purch.: George C. Mercer
Capacitor Dept. Purch. Agent: C. A. Rieman
Purch. Mgr.-Metallurgical Div.: W. J. Topmiller
V. P.-Marketing: H. C. Buell MF, WN, PS, GS, GH, GE, CO, TS, TR

***MALLORY-SHARON METALS CORP.**
980 Worren Ave., Niles, D. (Tel. DL 2-9951)
V. P.: G. B. Brown
Dir.-Purch. & Traffic: B. E. Morquis MF, MM
*(See Page 8 for Advertisement)

MANGER ELECTRIC CO.
Miller St., Stamford, Conn. (Tel. FIreside 8-7761)
Purch. Agent: Richard Keeler
Sales Mgr.: B. L. Manger MF, PS, GS, TR

MANSFIELD FABRICATORS, INC.
541 Gront Ave., Monsfield, Dhio
V. P.-Sales: S. F. Bird

MANSON LABORATORIES, INC.
375 Fairfield Ave., Stomford, Conn. (Tel. OAvis 5-1391)
M. Leroy CO, TS, TR, R&O

MARATHON BATTERY CO.
840 Henrietta St., Wausau, Wisc. (Tel. 2-1071)
Purch. Agent: C. W. Piehl
Asst. Sales Mgr.: A. H. McEachron
Secy.-Treas.: E. D. McEachron TR

MARBLETTE CORP., THE
37-31 30th St., Long Island City 1, N. Y. (Tel. STillwell 4-8100)
Research Dir.: Max Hilrich MF

MARBON CHEMICAL DIV.-BORG-WARNER CORP.
P. D. Box 68, Washington, W. Va. (Tel. GArfield 2-5401)
Dir.-Purch.: Rhodo M. Stewort
V. P. & Sales Mgr.: O. M. Pratt
Sales Mgr.: W. A. Sulter MF

MARCO INDUSTRIES CO.
207 S. Heleno St., Anoheim, Colif. (Tel. KEystone 5-6037)
Purch. Agent & Prod. Supt.: F. C. Loehnig
Sales Mgr.: W. W. Bowles MF, PS, GS, GH, GE, TS, TR

MARCONI INSTRUMENTS
111 Cedor Lone, Englewood, N. J. (Tel. LOwell 7-0607)
Mgr.-Purch.: R. J. Bailey
Sales Mgr.: W. A. Buck TR

MARGINATOR CO.
1121 W. Magnolia Blvd., Burbonk, Calif. (Tel. Victorio 9-2877)
Pres.: Stonley Runyan
V. P.-Sales: Harold R. Foy TS

MARION INSTRUMENT DIV.-MINNEAPOLIS-HONEYWELL REGULATOR CO.
Monchester, N. H. (Tel. NAtional 5-6971)
Purch. Agent: C. Heoth
Buyer: R. Mahoney
V. P.-Sales: E. S. Maury GS, GE, CO, TS, TR

MARK PRODUCTS CO.
6412 W. Lincoln Ave., Morton Grove, Ill. (Tel. ORchard 5-4999)
E. F. Harris GS, TR

MARKEM MACHINE CO.
150 Congress St., Keene, N. H. (Tel. ELmwood 2-1130)
Purch. Agent: C. E. Titcomb
Gen. Sales Mgr.: Robert Mensel

MARKITE CORP.
155 Waverly Pl., New York 14, N. Y. (Tel. DRegon 5-1384)
Purch. Agent: Jules Livingston
V. P.-Sales: Herbert A. Gottschall GS, GE, CO, TS, TR, R&O

MARLIN-ROCKWELL CORP.
402 Chandler St., Jamestown, N. Y. (Tel. 61-541)
Dir.-Purch.: C. A. Berg
Purch. Agent: G. J. Poquin
Asst. Purch. Agent: J. C. Slagle
V. P. & Gen. Sales Mgr.: B. J. Shallow PS, GE, R&O

MARLO COIL CO.
7100 S. Grand Ave., St. Louis 11, Mo. (Tel. VE 2-5000)
Purch. Agent: K. Guillerming
V. P.-Sales: L. C. Pellegrini

MARMAN DIV., AEROQUIP CORP.
11214 Exposition Blvd., Los Angeles 64, Calif. (Tel. BRadshow 2-8511)
Purch. Agent: W. E. Flaherty
Aircraft Sales Mgr.: Ted J. Josolle MF, GS, GH, MM, R&D

MAROTTA VALVE CORP.
Boonton Ave., Boonton, N. J. (Tel. OEerfield 4-2791)
Purch. Agent: Harold Richords
Sales Mgr.: Oel Dlson GE, TS

MARQUARDT AIRCRAFT CO.
16555 Soticoy St., Von Nuys, Colif. (STote 1-2121)
Mgr.-Materiel: R. G. Froncis
Mgr.-Materiel: P. C. Taylor (Dgden Div., Dgden, Utah, Tel. EXport 4-4511)
Purch. Agent: Wayne Jordan (Pomono Div., Pomona, Colif., Tel. LYcoming 3-1311) PS, GS, CO, TS, R&O

JAS. P. MARSH CORP.
3501 Howard St., Skokie, Ill. (Tel. DRchord 3-4300)
Purch. Agent: P. Keppeler
Asst. Purch. Agent: M. Kinnison
V. P.-Sales: R. E. Barnett GS, GH, TS

MARTIN CO., THE
Middle River Plant, Boltimore 3, Md. (Tel. MUrdock 7-3800)
Dir.-Procurement: H. B. Gunther
Dir.-Sales: C. H. Welling
V. P.-Sales & Service: Jess W. Sweetser MF, WN, PS, GS, GH, GE, CO, TS, TR, R&D

MARTIN CO., THE, DENVER DIV.
P. O. Box 179, Denver 1, Colo. (Tel. PYromid 4-5211)
Dir.-Prac. Div.: C. E. Bloomer
Dir.-Sales Div.: G. J. Rauschenboch MF, GS, GH, CO, TS, R&O

MARTIN CO., THE, ORLANDO DIV.
P. D. Box 5837, Orlonda, Fla. (Tel. CHerry 1-2411)
Dir.-Procurement: Edward R. McDonald
Dir.-Sales & Weapon System Suppart: C. D. Wingate MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&O

MARVEL ENGRG. CO.
7227 N. Hamlin Ave., Chicago 45, Ill. (Tel. JUniper 8-6023)
Head-Sales: R. T. Sochor PS, GS

MARYLAND ETCHING CO., INC.
Eudowood Lane, P. O. Box 6737, Towson 4, Md. (Tel. VAlley 5-0700)
V. P. & Secy.: C. A. Anderson
Sales Mgr.: H. J. McCaughin

MARYLAND LAVA CO.
Box 127-MOG, Bel Air, Md. (Tel. Bel Air 1441)
Head-Purch.: J. B. Dinning MF, WN, PS, GE, TR

MASON-NEILAN
Nahotan St., Norwood, Mass. (Tel. NOrwood 7-4600)
Purch. Agent: F. J. Kenney
Asst. Purch. Agent: L. Rocheleou
Sales Mgr.: A. B. Powell
V. P.-Sales: C. W. Grom (Tel. ELdorodo 5-1525) New York City GS

MASSA DIV.-COHU ELECTRONICS, INC.
5 Fottler Rd., Hinghom, Moss. (Tel. RIverview 9-4800)
Purch. Agent: Robert R. Thomos
V. P. & Gen. Mgr.: Ernest A. Mossa
Buyer: Herbert Phillips WN, GS, GH, GE, CO, TS, TR, R&O

MASSACHUSETTS GEAR & TOOL CO., DIV.-GEARTRONICS CORP.
918 Moin St., W. Concord, Mass. (Tel. TWinoaks 7-2971)
Purch. Agent: G. Reid
Sales Mgr.: F. H. Kean

MAST DEVELOPMENT CO., INC.
2212 E. 12th St., Dovenport 26, Iowo (Tel. 3-9729)
Pres.: Gifford M. Mast
Purch. Agent: Vernon W. Fier
Asst. Gen. Mgr.-Sales: Leo E. Hubner GS, GH, CO, TS, TR, R&D

MASTER PRODUCTS CORP., THE
1100 Norwood St., P. O. Box 9757, Ft. Warth 7, Tex. (Tel. EDison 2-7101)
Sales Mgr.: Jess Fotherree MF, WN, PS, GS, GH, GE, R&D

MASTER SPECIALTIES CO.
956 E. 108th St., Los Angeles 59, Calif. (Tel. LOroin 4-4481)
Purch. Agent: William Smith
Head-Sales: T. W. Hallerberg GS, CO, TS

MASTER TAPE PRINTERS
3400 N. Holsted St., Chicogo 13, Ill. (Tel. EAstgate 7-3322)
Gen. Mgr.: Louis J. Dorfmeister
Head-Sales: Ruth G. Dorfmeister MF, PS, TS, TR, MM

MATHESON CO., INC., THE
932 Paterson Plonk Rd., E. Rutherford, N. J. (Tel. WEbster 3-2400)
Purch. Agent: A. Gerord
Dir.-Engrg.: A. Mossman
V. P.-Sales: H. R. Pearce PS, MM, R&D

JAS. H. MATTHEWS & CO.
3764 Forbes Ave., Pittsburgh 13, Po. (Tel. MUseum 1-8500)
Purch. Agent: G. Grcy, 3942 Forbes Ave., Pittsburgh 13, Po.
V. P.-Sales: T. J. Miers MM

W. L. MAXSON CORP., THE
475 10th Ave., New York 18, N. Y. (Tel. LDngacre 5-1900)
Purch. Mgr.: C. E. Panzica
Sales Mgr.: W. P. McNally MF, WN, PS, GS, GH, GE, CO, TS, TR, R&D

***McCORMICK SELPH ASSOCIATES, INC.**
Hollister Airport, Hollister, Colif. (Tel. MErcury 7-3731)
Purch. Agent: Jim McConnell
Dir.-Applicatians Engrg.: Hubert I. Bennett MF, WN, PS, GS, R&D
*(See 4th Cover for Advertisement)

McCOY ELECTRONICS CO.
Mount Holly Springs, Po. (Tel. HUnter 6-3411)
Purch. Agent: Erwin C. Hess
Sales Mgr.: Oovid B. Jacoby GS, GE, TS, TR

McCULLOCH MOTORS CORP.
6101 W. Century, Los Angeles 45, Calif.

JULIAN A. McDERMOTT CORP.
1639 Stephen St., Ridgewood, L. I. 27, N. Y. (Tel. GL 6-3606)
Purch. Agent: R. Wilke
Head-Sales: R. Stevens GH

McDONNELL AIRCRAFT CORP.
Lambert — St. Louis Airport, Box 516, St. Louis 66, Mo. (Tel. PErshing 1-2121)
V. P.-Procurement & Quality Contral: Lloyd Horrison
Mgr.-Purch.: W. J. Gamewell
Mgr.-Subcontracts: W. P. Becker
V. P.-Customer Service: J. F. Aldridge

McDOWELL-WELLMAN COMPANIES, THE
113 St. Clair Ave., N. E., Cleveland 14, D. (Tel. MAin 1-9934)
Dir.-Purch.: S. R. McKinnon
Asst. to Pres.: J. R. Perkins GH

McGILL MFG., CO., INC., BEARING DIV.
600 N. Lafoyette St., Valporoiso, Ind. (Tel. 2-6401)
Sales Mgr.: M. L. Brody

McKENNA LABS.
2503 Main St., Santa Monico, Colif. (Tel. EXbrook 9-8846)
Pres.: A. G. McKenna
Sales Engr.: Wolt McHenry GS, GE, TS, TR

McLEAN DEVELOPMENT LABS., INC.
P. D. Box 206, Strong Ave., Copiague, L. I., N. Y. (Tel. LIndenhurst 5-4300)
Mfg. Mgr.: Joseph A. Borile
Pres.: H. P. Dolan TS, R&D

McLEAN ENGRG. LABORATORIES
P. D. Box 228, 70 Washington Rd., Princeton, N. J. (Tel. WAlnut 4-4440)
Purch.: A. Donold Hay
Sales: W. B. Eckenhoff PS, TR

McMILLAN INDUSTRIAL CORP.
Brownville Ave., Ipswich, Mass. (Tel. ELmwood 6-2926)
Purch. Agent: Brian Abbott
V. P.-Sales: Arthur M. Brink GE, TS, MM

McPHERSON CORP.
1361 S. Broadway St., Denver, Colo. (Tel. PE 3-2481)
V. P.-Purch.: E. Byron McPherson
Sales Mgr.: W. H. Fronz, Jr. MM

MEASUREMENTS DIV., McGRAW EDISON CO.
Boonton, N. J. (Tel. Deerfield 4-2131)
Purch. Agent: H. P. Irving
Div. Sales Mgr.: Carl M. Milner TS

MECHANICAL AIR CONTROLS, INC.
10030 Capital Ave., (Oak Park) Detroit 37, Mich. (Tel. JOrdan 4-6858)
Purch. Agent: Larry Newton
Sales Mgr.: Arthur R. Schiefelbein PS, GS, GH, TS, R&D

MECHANICAL DIV.-GENERAL MILLS, INC.
1620 Central Ave., Minneapolis 13, Minn. (Tel. STerling 9-8811)
Mgr.-Purch.: A. E. Wickmon
Dir.-Sales: E. F. Coy MF, WN, PS, GS, GE, CO, TS, TR

MECHANICAL PRODUCTS, INC.
1824 River St., Jackson, Mich. (Tel. STote 2-0391)
Purch. Agent: C. C. Frost
Sales Engr.: P. R. Watson GS, CO, TS, TR

MECHANICS RESEARCH DEPT., AMERICAN MACHINE & FOUNDRY CO.
2510 S. Wabash Ave., Chicago 5, Ill. (Tel. WEbster 9-5385)
Dir.: P. Rosenberg

MECHANICS UNIVERSAL JOINT DIV., BORG-WARNER CORP.
2020 Harrison Ave., Rockford, Ill. (Tel. WOodland 3-0431)
Dir.-Purch.: E. O. Von Dusen
Asst. Dir.-Purch.: G. R. Fuehrer
Pres. & Gen. Mgr.: F. W. Rickord GH

MEDICAL SUPPLY CO.
1027 W. State St., Rockford, Ill. (Tel. WOodlond 3-9697)
Purch. Agent: C. Fred Avery
V. P.-Sales: Richard G. Babbitt

MELETRON CORP.
950 N. Highland Ave., Los Angeles 38, Calif. (Tel. HOllywood 3-4841)
Purch. Agent: Don Britton
Dir.-Market Research: Jack Nelson MF, WN, PS, GS, GH, GE, CO, TS

MENASCO MFG. CO.
805 S. San Fernando Blvd., Burbank, Calif. (Tel. VIctoria 9-3261)
Dir.-Materiel Div.: Thomas E. Merrick
Purch. Agent: William Caprine
Purch. Dept. (Tex. Div.): Edward Gibson, Box 7397 Sylvania Sta., Ft. Worth (Tel. ATlas 4-3471)
V. P.-Sales: Jack I. Hamilton (Burbank) WN, PS

E. MENAUGH CO.
4555 N. Broadway, Chicago 40, Ill. (Tel. UPtown 8-2343)
Purch.: M. M. Maher
Sales: D. A. MacIntyre PS

MENLO RESEARCH LABORATORY
P. O. Box 522, Menlo Park, Calif. (Tel. DA 1-0280)
Dir.-Purch. & Sales: Charles Weeks MF, GH, CO, MM

MEPCO, INC.
37 Abbett Ave., Morristown, N. J. (Tel. JEfferson 9-2000)
Purch. Agent: J. Brozek
Sales Mgr.: E. L. Beaudry, Jr. GE

MERCAST MFG. CORP.
2620 1st St., La Verne, Calif. (Tel. LYcoming 3-4521)
Purch. Agent: P. L. Cunninghom
Sales Mgr.: Stan Harding MF, PS

MERCK & CO., INC., ELECTRONIC CHEMICALS DIV.
Central Ave., Rahway, N. J. (Tel. FUlton 1-5000)
Dir.-Electronic Chem. Div.: Dr. George Krsek
Sales Mgr.: C. A. Gray MM

MERCURY AIR PARTS CO., INC.
P. O. Box 135, 9310 W. Jefferson Blvd., Culver City, Calif. (Tel. TE 0-5923)
Purch. Agent: I. A. Cole
Sales Mgr.: R. Cohen MF, GS, GH, MM

MERCURY TOOL & MFG. CORP.
124 Marine St., P. O. Box 95, Formingdale, N. Y. (Tel. CHopel 9-1820)
V. P.-Purch.: Frank J. Fitterer (Tel. CHopel 9-1821)
Sales: Seri S. LoDato MF, WN, PS, GS, GH, MM

MERGENTHALER LINDTYPE CO.
29 Ryerson St., Brooklyn 5, N. Y. (Tel. ULster 5-0300)
Purch.: C. Aioso
Mgr., Systems Engrg. Dept.: W. O. Grube GS, GE, CO, R&D

MERIAM INSTRUMENT CO.
10920 Madison Ave., Cleveland 2, Ohio (Tel. ATlantic 1-1100)
Purch. Agent: A. Sousy
Dir.-Sales: Leroy Rogers

MERIDIAN METALCRAFT, INC.
8739 S. Millergrove Dr., Whittier, Calif. (Tel. OXford 2-3761)
Purch. Agent: D. W. Willis
Sales Mgr.: C. M. Peterson GE, CO, TR, MM, R&D

MERIT COIL & TRANSFORMER CORP.
2027 Sherman St., Hollywood, Fla. (Tel. Wobosh 3-1536)
Purch. Agent: Walter Hendrickson (Tel. Wobash 3-4651)
Sales Mgr.: Charles C. Koch
Asst. Sales Mgr.: Fred Holland MM, R&D

MERIX CHEMICAL CO.
2234 E. 75th St., Chicago 49, Ill. (Tel. BAyport 1-8242)
Gen. Mgr.-Purch.: Eric O. Sonneman
Sales Mgr.: E. Arshock MM, R&D

MERZ ENGRG., INC.
200 S. Harding St., Indianapolis, Ind. (Tel. ME 2-7431)
Purch. Agent: Murray Davidson
Buyer: Carl Pfeifer
Sales Mgr.: L. B. Vanderhorst PS, GS

METAL CARBIDES CORP.
6001 Southern Blvd., Youngstown 12, O. (Tel. STerling 8-6541)
Purch. Agent: H. L. Sprinkel
V. P.-Sales: R. T. Beeghly MM, R&D

METAL EDGE INDUSTRIES
Gloucester Pike, Barrington, N. J. (Tel. LIncoln 7-9000)
V. P.-Sales: E. F. Collins GH

METAL FABRICATORS CORP.
63 Pond St., Walthom, Mass. (Tel. TWinbrook 3-6800)
Dir.-Sales: Horry Ferguson MF, GS, GE, TS

METAL HYDRIDES, INC.
12-24 Congress St., Beverly, Mass. (Tel. WAlker 2-1875)
Purch. Agent: J. A. Crowell
Asst. Purch. Agent: H. J. McLaughlin
Buyer: Sylvio Burke
Mgr.-Tech. Service: H. W. Kruschwitz, Jr.
Engr.-Tech. Service: R. E. Miner MM, R&D

METAL SPINNERS, INC.
5015 N. 33rd St., Milwaukee 9, Wisc. (Tel. Hilltop 5-7343)
Purch. Agent: LeRoy E. Mueller
Works Mgr.: D. V. Lawrence
Sales Mgr.: George Lauth WN, PS, GE, TR

METAL TEXTILE CORP., ELECTRONICS DIV.
647 E. First Ave., Roselle, N. J. (Tel. CHestnut 5-3000)
Purch. Agent: Minford S. Smith
Prod. Mgr.: A. R. Burghord
Sales Mgr.: William Luke, Jr. MM

METAL TREATING INSTITUTE
271 North Ave., New Rochelle, N. Y. (Tel. NEw Rochelle 6-6382)
C. E. Herington MF, WN, MM, R&D

METALECTRO LAB.
11423 Vanowen St., N. Hollywood, Calif. (Tel. POplor 5-2430)
Purch. Agent: P. E. Peoch MF, WN, PS, GS, GH, GE, TR, R&D

METAL-GLASS PRODUCTS CO.
3333 Hommond Ave., Elkhart, Ind. (Tel. 2-5510)
Purch. Agent: D. P. Gill
V. P.-Sales: Jay A. Rigdon MM

METALLIZING CO. OF LOS ANGELES INC.
1233 S. Boyle Ave., Los Angeles 23, Calif. (Tel. ANgelus 8-7108)
Asst. Mgr.-Purch.: Ray White
Pres.: Richard S. Jensen MF, MM

METALLIZING ENGRG. CO., INC.
1101 Prospect Ave., Westbury, N. Y.
Purch. Agent: R. M. Dwyer
Sales Mgr.: R. J. McWoters MM

METALLO GASKET CO.
16 Bethany St., New Brunswick, N. J. (Tel. KIlmer 5-7223)
Purch. Agent: S. S. Geipel
Asst. Purch. Agent: S. W. Geipel
Sales Mgr.-Secy.: G. K. Mordas MF, PS

METALLURGICAL, INC.
900 E. Hennepin Ave., Minneapolis, Minn. (Tel. FEderal 3-4581)
Controller: M. P. Poulson
Dir.-Sales: Ralph E. Mueller MF

METALPHOTO CORP.
6811 Superior Ave., Cleveland 3, Ohio (Tel. UTah 1-7575)
Purch. Agent: Mrs. D. J. Weston
Sales Mgr.: Roger Ferryman MM

METALS & CONTROLS CORP.
55 Forest St., Attleboro, Mass. (Tel. 1-2800)
Dir.-Purch.: E. B. Carpenter
Asst. Dir.-Purch.: Rocca Fantaccione
Buyers: William Gorman & Ralph Berry
V. P.-Sales: John Wilson MF, WN, PS, GS, GH, GE, CO, TS, TR

METALS & CONTROLS CORP., GEN. PLATE DIV.
5565 Forest St., Attleboro, Mass. (Tel. Attleboro 1-2800)
Purch. Agent: E. B. Carpenter
Sales Mgr.: John Wilson GS, MM

METALS & CONTROLS CORP., SPENCER DIV.
5565 Forest St., Attleboro, Mass. (Tel. Attleboro 1-2800)
Purch. Agent: E. B. Carpenter
Sales Mgr.: John Wilson GS, MM

METAPLAST CO., INC.
34-51 56th St., Woodside 77, N. Y. (Tel. HA 9-0843)
Manager: J. Lester

METAPLAST CORP.
Hatboro, Pa. (Tel. OSborne 5-2416)
Purch. Agent: M. B. Guenther
Plant Mgr.: Wilfred Lobley
V. P.-Sales: Lewis W. Hull WN, MM, R&D

METAVAC, INC.
45-68 162nd St., Flushing 58, N. Y. (Tel. FLushing 9-8838)
Purch. Agent: R. Finnegon
Gen. Mgr.-Sales: G. H. Fodel GE, CD, TS, TR

METEOR PRODUCTION ENGRG., INC.
1465 S. Vandeventer Ave., St. Louis 10, Mo. (Tel. Jefferson 5-3210)
Chief Engr.: D. Gers
Pres.: Horvey S. Gershenson GS, CO, TS, R&D

METERS INC.
5353 N. Keystone Ave., Indionopolis 20, Ind. (Tel. CLifford 5-3570)
Purch. & Sales: F. R. Finehout GE, CO, TS, TR

METHODE MFG. CORP.
7447 W. Wilson Ave., Chicago 47, Ill. (Tel. UNderhill 7-9600)
Purch. Agent: A. J. Dudle MM

MET-L-WOOD CORP.
6755 W. 65th St., Chicago 38, Ill. (Tel. LUdlow 5-7575)
Purch. Agent: John S. Allen
Sales Mgr.: Dwight O. Williamson MM

R. I. METPRO, INC.
230 Toronto Ave., Providence 5, R. I. (Tel. STuort 1-3050)
Pres.: James C. Murphy MF, PS, TS, TR

METRON INSTRUMENT CO.
432 Lincoln St., Denver 3, Colo. (Tel. PEarl 3-3764)
Purch. Agent: H. N. Corothers
Sales Mgr.: Edward Pike GS, CD, TS, R&D

METRONIX, INC., SUB.-ASSEMBLY PRODUCTS, INC.
75 Wilson Mills Rd., Chesterland, Ohio (Tel. 3-4436)
V. P.-Purch.: Ivan Bezugloff
Pres. & Sales Mgr.: John Saint-Amour GS, GH, CO, TS

MEYERCORD CO., THE
5323 W. Lake St., Chicago 44, Ill. (Tel. ESterbrook 8-3700)
Purch. Agent: William A. Ortlep
Sales Mgr.: R. A. Knopf

MEYERCORD CO., THE, AMC DIV.
2915 S. Voil Ave., Los Angeles, Calif. (Tel. RAymond 3-8661)

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

Purch.: Robert Bell
Div. Mgr.-Sales: John A. Cargill MF

MICA CDRP.
4031 Elenda, Culver City, Calif. (Tel. VE 9-5283)
Purch.: Ed Kazarian
Dir.-Mktg.: Milton B. Grossman MF, GE, TS, TR

MICA FABRICATING CO.
53 Central Ave., Rochelle Park, N. J. (Tel. HUbbard 7-5717)
Purch.: M. H. Cymberg
Sales: J. W. Canter MF, WN, PS, GE, TR

MICA INSULATOR DIV.-MINNESOTA MINING & MFG. CO.
797 Broadway, Schenectady 1, N. Y. (Tel. FRanklin 4-4191)
Purch. Agent: Q. F. Jardine
Asst. Purch. Agent: H. Culp
Gen. Mgr.: D. E. Horsford
Sales Mgr.: D. R. Coleman, Jr. MM

MICACRAFT PRODUCTS INC.
701 McCarter Hwy., Newark, N. J. (Tel. MArket 3-6921)
Purch. Agent: N. A. Pomar (Tel. MArket 3-4074)
Sales: C. E. Garneau, Jr. MM

MICHIGAN WIRE CLOTH CO.
2100 Howard St., Detroit 16, Mich. (Tel. TAshmoo 6-6500)
Purch. Agent: Myles Bradly
V. P.-Sales: W. H. Blodgett PS, GS

MICO INSTRUMENT CO.
80 Trowbridge St., Cambridge 38, Mass. (Tel. KIrkland 7-8660)
Purch. Agent: Miss F. E. Beede
Sales Mgr.: R. F. Walker MM

MICRO BALANCING, INC.
191 Herricks Rd., Garden City Park, L. I., N. Y. (Tel. Pioneer 6-0851)
Dir.-Purch.: Leon Santora
V. P.-Sales: D. A. Francis GS

MICRO GEE PRODUCTS, INC.
6319 W. Slauson Ave., P. O. Box 1055, Culver City, Calif. (Tel. EXmont 1-1716)
Chief Engr.: B. W. McFadden GS, GE, CO, R&D

MICRO SWITCH, DIV.-MINNEAPOLIS-HONEYWELL REG. CO.
11 W. Spring St., Freeport, Ill. (Tel. ADams 2-1122)
Purch. Agent: W. L. Young
Sales Mgr.: F. E. Wilsey

MICRO-CIRCUITS CO.
New Buffalo, Mich. (Tel. 272 WI)
Purch. Agent: M. Bradley
Pres.: R. F. Bradley MM

MICRODOT INC.
220 Pasadena Ave., South Pasadena, Calif. (Tel. RYan 1-3351)
Purch. Agent: Robert Batton
Buyer: James Gillis
Asst. Sales Mgr.: George Wedemeyer
V. P.-Sales: Guy M. Martin, Jr. WN, GS, R&D

MICROLAB
71 Okner Pkwy., Livingston, N. J. (Tel. WYman 2-5700)
Purch.: A. Alexander
Sales: Richard C. Hess GE, TR

MICROMETRICAL MFG. CO.
345 S. Main St., Ann Arbor 20, Mich. (Tel. NOrmandy 2-5626)
Purch. Agent: Herman OeMarco
Chief Engr.: Donald Parkes
Exec. V. P.: Fritz A. Zander
Sales Mgr.: Frank W. Kabat TS, R&D

MICRON GEAR CO., INC.
73 Rushmore St., Westbury, L. I., N. Y. (Tel. EDgewood 4-8880)
Purch. Agent: Bill Benjamin
Mgr.-Sales: Milo Amorosia
Gen. Mgr.: Paul Maser

MICROSONICS, INC.
Hingham Ind. Ctr., 349 Lincoln St., Rt. 3A, Hingham, Mass. (Tel. RIverview 9-3100)
Pres.: T. J. Geoghegan
Sales Mgr.: B. P. O'Sullivan GS, GE, TR, R&D

MICROTECH CDRP., SUB. FEDERAL-MOGUL-BOWER BEARINGS, INC.
1201 N. Arden Dr., El Monte, Calif. (Tel. Gilbert 3-3081)
Gen. Mgr.: Ralph H. DuBois
Comptroller: Carl H. Sjoberg
Mgr.-Sales: Frank M. Mosier MM

MICROTRAN CO. INC.
145 E. Mineola Ave., Valley Stream, N. Y. (Tel. LO 1-6050)
Purch. Agent: B. Bell
V. P.-Sales: Albert J. Eisenberg GS, TS, TR

MICROWAVE ASSOCIATES, INC.
South Ave., Burlington, Mass. (Tel. BRowning 2-3000)
Purch. Agent: Harry Merchant
V. P.-Mktg.: George S. Kariotis GE, TR

MICROWAVE DEVELOPMENT LABS., INC.
92 Broad St., Babson Park 57, Mass. (Tel. CEdar 5-6252)
Purch. Agent: Abraham Bahm
Buyers: Philip Carson & Harold Lerner
Sales Engr.: John O. Hall MM

MICROWAVE ELECTRONICS DIV., SPERRY GYROSCOPE CO.
Great Neck, N. Y. (Tel. FIeldstone 7-3600)
Purch. Agent: G. C. Hees
Sales Mgr.: George W. Lober

MICRO-WIRE TUNGSTEN & MOLYBDENUM PRODUCTS
301 Crooks Ave., Clifton, N. J. (Tel. PRescott 9-0819)
Stephen H. Meninger MF, WN, PS, GS, GH, GE

MID-CENTURY INSTRUMATIC CORP.
611 Broadway, New York, N. Y. (Tel. SPring 7-4016)
Purch. Agent: E. Nawrocki
Sales Engrg. Mgr.: Charles B. Husick

MIDGET LOUVER CO.
6-R — Wall St., Norwalk, Conn. (Tel. VOlunteer 6-2342)
Purch.: Miller Mfg. Co., Stratford, Conn.
Sales: Frank J. Scallon

MIDLAND INDUSTRIAL FINISHES CO.
E. Water St., Waukegan, Ill. (Tel. MAjestic 3-4200)
Purch. Agent: W. J. Edwards
Buyer: John Whittaker
Pres.: Edwin O. Robson
V. P. & Gen. Mgr.: G. E. Batzel MM

MIDLAND MFG. CO., INC.
3155 Fiberglas Rd., Kansas City, Kans. (Tel. FInley 2-7950)
Purch. Agent: Harlan F. Ellis
V. P.-Sales: H. G. Humann GE, TR

MIDLAND PAINT & VARNISH CO., THE
3801 E. 91st St., Cleveland 5, O. (Tel. BR 1-4050)
Purch. Agent: Frank S. Glucek MF, PS, GE, TR

MIDVALE-HEPPENSTALL CO.
Nicetown, Philadelphia 40, Pa. (Tel. BAldwin 5-5000)
Gen. Sales Mgr.: Oerek G. R. Brigg
Asst. Gen. Sales Mgr.: Kenneth O. Cole MM

MIDWEST GAGE LAB.-METROLOGY SERVICES
2500 W. Washington Blvd., Chicago 12, Ill. (Tel. MO 6-6710)
Purch. Mgr.: R. Miller
Sales Mgr.: E. E. Olds MM

MID-WEST METAL PRDDUCTS, INC.
450 E. Donovon Rd., Kansas City 15, Kans. (Tel. MAyfair 1-1980)
Asst. Mgr.-Purch.: H. W. Sanders
Mgr.-Sales: T. H. Minzet GE, TR, R&D

MIDWEST RESEARCH INSTITUTE
425 Volker Blvd., Kansas City 10, Mo. (Tel. LOgan 1-0202)
V. P. & Tech. Dir.: Dr. Max H. Thornton
Admin. Officer: Perry L. Bidstrup
Mgr.-Program Dev.: Richard W. Kunkle R&D

MID-WEST SPRING MFG. CO.
4632-40 S. Western Ave., Chicago 9, Ill. (Tel. LAfayette 3-1743)
Purch. Agent-Chicago Plant: James J. Ounne, Jr.
Purch. Agent-St. Paul Plant: Cliff Reger (Tel. HU 8-2521)
Purch. Agent-Mentone, Ind., Plant: Richard E. Middleton (Tel. EL 3-2415)
Sales: L. J. Castaldi MF, PS

MIDWESTERN INSTRUMENTS, INC.
41st & Sheridan Rd., Tulsa, Okla. (Tel. RIverside 7-1331)
Purch. Agent: B. M. Kennedy
V. P.-Sales: D. M. Holloway CO, TS, TR, R&D

MILAM ELECTRIC MFG. CO.
1100 Elmwood Ave., Providence 7, R. I. (Tel. STuart 1-2284)
V. P.-Purch.: F. B. Foster
Sales: J. A. Ruby MM

MILES REPRODUCER CO. INC.
812 Broadway, New York 3, N. Y. (Tel. SPring 7-7670)
Purch.: J. M. Kuhlik
Sales: H. B. Kuhlik TR

MILGO ELECTRONIC CORP.
7601 N. W. 37th Ave., Miami 35, Fla. (OXford 1-1220)
Purch. Agent: William Kreuter
Buyers: Walter Koth, Ronald Zoll, Herman Farer & James Kivett
Gen. Mgr.-Sales: William L. Rose GS, CO, TS, TR, R&

FRANKLIN P. MILLER & SON, INC.
36 Meadow St., East Orange, N. J. (Tel. ORange 3-4522)
Purch. Agent: H. Preyer
Sales: H. Galanty

J. W. MILLER CO.
5917 S. Main St., Los Angeles 3, Calif. (Tel. ADams 3-4294)
Purch.: L. G. Crawford, Jr.
Sales: J. R. Hummes M

SANFORD MILLER CO.
11 Lynch St., Brooklyn 11, N. Y. (Tel. ULster 8-2817) T

MILLER ASSOCIATES
P. O. Box 369, Lakeville, Conn.
Owner: R. R. Miller
Dir.-Sales: H. M. Miller R&

MILLER DIAL & NAMEPLATE CO.
4400 N. Temple City Blvd., El Monte, Calif. (Tel. Gilbert 4-4555)
Purch. Agent: Gus Bloomquist
Sales Mgr.: Richard Stevens M

MILLER ELECTRO-RESEARCH LABS.
5529 S. 5th St., Milwaukee 7, Wisc. (Tel. HUmboldt 3-6303)
A. W. Miller GE, C

MILLER-ROBINSDN CO.
7007 Avalon Blvd., Los Angeles 3, Calif. (Tel. PLeasant 2-6141)
Purch. Agent: J. B. Leavell
Sales Mgr.: Myron B. Adler PS, GS, T

MILLIPORE FILTER CORP.
Bedford, Mass. (Tel. CRestview 4-8800)
V. P.-Purch.: Walter W. Kenyon
Sales Mgr.: David B. Porter
Office Mgr.: Clifford J. Hughes CO, T

MILLITEST CORP.
88 Madison Ave., Hempstead, N. Y. (Tel. IVanhoe 9-9672)
Purch. Agent: I. Clinton
Sales Mgr.: J. Herman TS, R&

MILMAN ENGRG. CO.
1831 Pontius Ave., Los Angeles 25, Calif. (Tel. GRanite 3-0616)
Partners: Wesley B. Miller & E. I. Bruckman G

MILMANCO
620 7th Ave., Renton, Wash. (Tel. ALpine 5-8656)
Co-Mgr., Purch. & Sales: Philip B. Lundstrom
Co-Mgr., Purch.: Thomas H. Cooke
Supt.: Robert W. Burman

MILRD CONTROLS CO.
Hawthorne Ave., Park Ridge, N. J. (Tel. PArk Ridge 6-2595)
Purch.: Milton Rasen
Sales Mgr.: E. O. Burdi

MINATRON CORP.
61 Cliveden St., Belle Mead, N. J. (Tel. FLanders 9-6400)
Gen. Mgr.: C. W. Pressey TS, TI

MINCD PRODUCTS, INC.
740 Washington Ave., N., Minneapolis 1, Minn. (Tel. FEderal 8-6753)
Purch. Agent: Robert B. Anderson
V. P.-Sales: Karl Schurr GS, GE, CO, TS, TI

MINCOM DIV., MINNESOTA MINING & MFG. CO.
2049 S. Barrington Ave., Los Angeles, Calif. (Tel. GRanite 9-3751)
Purch. Agent: Ray Hunt
Sales Mgr.: Robert J. Brown TS, TI

MINE SAFETY APPLIANCES CO.
201 N. Braddock Ave., Pittsburgh 8, Pa. (Tel. CH 1-5900)
Purch. Agent (Safety Prod.): J. P. Curran
Purch. Agent (Tech. Prod.): F. J. Guenther
Sales Mgr. (Safety Prod.): F. A. King
Sales Mgr. (Tech. Prod.): N. W. Hartz T

MINIATURE PRECISION BEARINGS, INC.
Precision Pk., Keene, N. H. (Tel. ELmwood 2-0310)
Purch. Agent: Robert N. Whitney
Sales Mgr.: K. G. Broman WN, GE, TR, R&I

MINICORD CORP. OF AMERICA
1915 Atlantic Ave., Atlantic City, N. J. (Tel. 2-0488)
Dir.-Purch.: William C. Redding, Jr.
V. P.-Sales: William A. Juhrs, Sr. G

MINNEAPDLIS-HDNEYWELL REGULATOR CO., AERDNAUTICAL DIV.
2600 Ridgway Rd., Minneapolis 13, Minn. (Tel. STerling 1-8011)
Dir.-Prac.: R. B. Foster
Dir.-Prac.: S. E. Puffer, Inertial Guidance Cntr., St. Petersburg, Fla. (Tel. HEmlock 5-1151)
Purch. Agent: Matt Mehan, Missile Oev. Lab., W. Los Angeles, Calif. (Tel. BRadshaw 2-8667)
Mktg. Mgr.: R. E. Clifford
GS, GH, GE, CO, TS, R&D

MINNEAPOLIS HONEYWELL REGULATOR CO., BOSTON OIV.
40 Life St., Boston 3S, Mass. (Tel. ALgonquin 4-5200)
Purch. Agent: E. L. Hanscom
Mktg. Mgr.: C. B. Harrison GS, GE, TR

MINNEAPOLIS-HONEYWELL REGULATOR CO., DAVIES LABS. OIV.
10721 Hanna St., Beltsville, Md. (Tel. WEbster 5-2700)
Purch. Agent: John Paszkiet
Sales Mgr.: N. S. Bassett TS, TR

MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL OIV.
Wayne & Windrim Aves., Philadelphia 44, Pa. (Tel. OAvenport 9-8300)
Purch. Agent: J. Taws
Sales Mgr.: J. A. Robinson GH, CO, TS, R&O

MINNEAPDLIS-HONEYWELL REGULATOR CO., INDUSTRIAL PRODUCT GROUP
Wayne & Windrim Aves., Philadelphia 44, Pa. (Tel. OAvenport 9-8300)
Purch. Agent: J. H. Taws
Sales Mgr.: J. A. Robinson TS

MINNEAPOLIS-HONEYWELL REGULATOR CO., ORDNANCE DIV.
600 2nd St., N., Hopkins, Minn. (Tel. WEstport 8-3571)
Mgr.-Prac.: J. F. Barrett
Purch. Agent: Clifford Swisher, Minneapolis-Honeywell Ordnance Missile Engrg. Ctr., Ouarte, Calif. (Tel. ELliott 9-5311)
Dir.-Serv. Engrg.: L. E. Sheehan
MF, WN, GS, CO, TE, TR, R&D

MINNEAPOLIS-HONEYWELL REGULATOR CO., SEMICONDUCTOR PRODUCTS OIV.
2753 4th Ave., S., Minneapolis, Minn. (Tel. FEderal 2-5225)
Mgr.-Purch.: M. E. Knutson
Asst. Purch. Agent-Raw Materials: Wilbur Smisek
Sales Mgr.: R. O. Anderson

MINNESOTA MINING & MFG. CO.
900 Bush Ave., St. Paul 1, Minn. (Tel. PRospect 6-8511)
Sales Mgr.: J. M. Rogers
Prod. Mgr.: John M. Thompson MM

MINNESOTA MINING & MFG. CO.-ADHESIVES, COATINGS & SEALERS DIV.
900 Bush Ave., St. Paul, Minn. (Tel. PRospect 6-8511)
Sales Mgr.-Aircraft Prods.: A. O. Fuhrmann
Gen. Sales Mgr.: C. A. Kelley

MINNESOTA RUBBER CO.
3630 Woaddale Ave., Minneapolis 16, Minn. (Tel. WEst 9-6781)
Purch. Agent: H. L. Stocking
Dir.-Sales: Richard G. Wells MM

MIRATEL, INC.
1080 Dionne St., St. Paul 13, Minn. (Tel. HUmboldt 9-7417)
Purch. Agent: N. C. Ritter
Sales Mgr.: H. E. Kurzweg GE, TR, R&O

MIRAX CHEM. PROD. CORP., ELECTRO-MECH. DIV.; METAL CONTAINER DIV.
1999 Fyler Ave., St. Louis 9, Mo. (Tel. PLateau 2-1500)
Dir.-Purch.: Oliver C. Clerc
V. P.-Engrg.: Harvey M. Gillerman
WN, PS, GS, GH, GE, TS, R&D
(See Page 79 for Advertisement)

MICO PRECISION CASTING CO.
16 W. Gibbs St., White Hall, Mich. (Tel. 2-1515)
Purch. Agent: Howard Bartholomew
Purch. Agent-Muskegon, Mich.: M. Simms (Tel. 6-3541)
V. P.-Sales: K. Yanker PS, MM

MIKELLA INFRA-RED CO., THE
E. 73rd & Grand Ave., Cleveland 4, O. (Tel. HEnderson 1-2210)
Purch. Agent: F. Zitek PS, GS, R&D

MISILE DIV., NORTH AMERICAN AVIATION, INC.
12214 Lakewood Blvd., Downey, Calif. (Tel. SPruce 3-0610)
Dir.-Material: Mark Starr
Purch. Agent: N. C. Oapheide
MF, GS, GH, CO, R&D

MISSILE ENGRG. PRODUCTS, INC.
9th & Guava, Eau Gallie, Fla. (Tel. 4622)
V. P.-Purch.: Jack K. Van Hook
Prod. Mgr.: Oan Lathrup PS, GS, GH, GE, TS, TR

MISSILES & SPACE SYSTEMS, DIV.-UNITED AIRCRAFT CORP.
Main St., E. Hartford, Conn. (Tel. Jackson 8-4811)
Sales Mgr.: Boone T. Guyton
Supvr.-Sales Services: Richard T. Allen

MISSIMERS INC.
3206 Los Feliz Blvd., Los Angeles 39, Calif. (Tel. NOrmandy 5-4261)
V. P.: Dale J. Missimer
Engr.-Buyers: H. C. Faris & S. E. Askew
Parts Buyer: C. Lanphear

MISSOURI RESEARCH LABS., INC.
2109 Locust St., St. Louis 3, Mo. (Tel. CHestnut 1-7875)
Purch. Agent: Weber L. Ley
Exec. V. P.: Albert H. Eicher GS

E. C. MITCHELL CO.
Boston St., Middleton, Mass. (Tel. SPring 4-1191)
Everett W. Mitchell

MITCHELL CAMERA CORP.
666 W. Harvard St., Glendale 4, Calif. (Tel. CHapman 5-1086)
Purch. Agent: M. Kruescher
V. P.-Sales: J. O. McCall

MITRONICS INC.
1290 Central Ave., Hillside, N. J. (Tel. WAverly 6-2250)
Purch. Agent: Harvey Pensack
Sales Mgr.: Benjamin Friedman MM, R&O

MODEL RECTIFIER CORP.
1675 Utica Ave., Brooklyn 34, N. Y. (Tel. CLaverdale 8-6800)
Purch. Agent: Anthony Iati
Sales Mgr.: Samuel Gelber GS

MODELECTRIC PROOUCTS CORP.
1500 Bangs Ave., Asbury Park, N. J. (Tel. PR 4-2519)
Purch.: Chas. S. Nadler PS, GS, GE

MOHAWK WIRE & CABLE CORP.
320 River St., Fitchburg, Mass. (Tel. OI 3-3569)
Sales Mgr.: J. W. Resseguie GS, TR

JOHN MOHR & SONS
3200 E. 96th St., Chicago 17, Ill.
Purch. Agent: A. O. Armstrong
Sales Mgr.: R. C. Mohr GS

MOLDING CORP. OF AMERICA
40 Church St., Pawtucket, R. I. (Tel. PAwtucket 6-2100)
Purch. Agent: Sturgis Green
Sales Mgr.: Stephen Kalarian G5, GE, TR, R&D

MONA INDUSTRIES, INC.
P. O. Box 1786, Paterson 17, N. J. (Tel. ARmory 4-8220)
Dir.-Purch.: W. O. Schlimbach
Purch. Agent: Harry H. Schat
V. P.-Sales: R. H. Sommer MF, GS

MONADNOCK MILLS, SUB.-UNITED-CARR FASTENER CORP.
1977 1st Ave., San Leandro, Calif. (Tel. ELgin 7-3700)
Purch. Agent: George MacLaughlin
Sales Mgr.: George Gianandrea
MF, WN, PS, GS, GH, TS, TR

J. J. MONAGHAN CO., INC.
500 Alcott St., Denver 4, Colo. (Tel. AC 2-3558)
V. P.: Moses Taylor MM, R&D

MONARCH BEARING CO. INC.
4435 Santa Fe Ave., Los Angeles 58, Calif. (Tel. LUdlow 2-8322)
Purch. Agent: Walter Arendell
V. P.-Sales: R. E. Browning PS, R&O

MONODE INC.
3751 Prospect Ave., Cleveland 15, Ohio (Tel. ENdicott 1-3872)
V. P.: Ralph Lindsay
Sales Mgr.: Gordan K. Lanese

MONOGRAM PRECISION INDUSTRIES
8557 Higuera St., Culver City, Calif. (Tel. TExas 0-6531)
Purch. Agent: John Cargyle
Sr. Buyer: Eugene Hiatt (Tel. CH S-8625)
Buyer: William Pike
MF, GS, GH, GE, CO, MM, R&D

MONROVIA AVIATION CORP.
801 Royal Oaks Dr., Monrovia, Calif. (Tel. ELliot 8-3211)
Dir.-Purch.: Luke Gallagher
Sales Mgr.: J. L. Payne MF, GS

MONSANTO CHEMICAL CO.
800 N. Lindbergh Blvd., St. Louis 66, Mo. (Tel. WYdown 3-1000) PS

MONTGOMERY ENGRG. CO.
11111 French Rd., Detroit 34, Mich. (Tel. WAlnut 5-1170)
Mgr.: Max Wender

MOODY MACHINE PRODUCTS CO., INC.
42-46 Dudley St., Providence 5, R. I. (Tel. GAspee 1-3317)
Sales Mgr.: J. H. Moody MF, WN, PS, GS, GE

MOOG VALVE CO., INC.
Proner Airport, East Aurora, N. Y. (Tel. CY 2000)
Purch. Agent: Raymond Hawick
Sales Mgr.: Harry White GE

MOORE ASSOCIATES, INC.
2600 Spring St., Redwood City, Calif. (Tel. EM 9-0204)
Purch. Agent: Dan Sully
Sales Mgr.: James B. Bullock GS, CO, TR

MORAN CO.
115 Main St., El Segundo, Calif. (Tel. OR 8-3444)
Owner: Tom Moran MF, PS, GE, MM, R&D

MORAN INSTRUMENT CORP.
170 E. Orange Grove Ave., Pasadena, Calif. (Tel. SY 6-7158)
Prod. Foreman: A. W. Junkunc
Sales Mgr.: R. L. Marshall GS, CO, TE, TR, R&D

MORGANITE, INC.
33-02 48th Ave., Long Island City 1, N. Y. (Tel. STillwell 4-3222)
Gen. Sales Mgr.: W. C. Hass
Dir.-Purch.: M. A. DeRosa
MF, WN, PS, GS, GE, TR

MORNINGSTAR-PAISLEY, INC.
630 W. 51st St., New York 19, N. Y. (Tel. JUdson 2-3790)
Purch. Agent: N. Deutschman
V. P.-Sales: E. C. Lenz
Mgr.-Mkt. Dev.: T. L. Bannitt MM

J. I. MORRIS CO.
378 Elm St., Southbridge, Mass. (Tel. PArter 4-4394)
Asst. Mgr.: J. B. Dirlam MF, WN, PS

ROBERT E. MORRIS CO., THE
5000 Farmington Ave., P. O. Box 41, West Hartford 7, Conn. (Tel. ADams 3-3663)
Pres.: Robert E. Morris

FRANK W. MORSE CO.
354 Congress St., Box 10, Mass. (Tel. HAncock 6-5398)
Purch. Agent: Prescott B. Morse
Sales Mgr.: Richard W. Morse MM

MORSE INSTRUMENT CO., THE
21 Clinton St., Hudson, Ohio (Tel. OLympic 3-5141)
Purch. Agent: Edward C. Kenyan
V. P.-Sales: Otis E. Burgess

F. L. MOSELEY CO.
409 N. Fair Oaks Ave., Pasadena, Calif. (Tel. RYan 1-0208)
Purch. Agent: Robert Taylor
Sales: F. L. Moseley

MOSER JEWEL CO.
544 Fayette St., Perth Amboy, N. J. (Tel. HIlicrest 2-3434)
V. P.-Sales: C. H. Kalquist

MOSINEE PAPER MILLS CO.
Mosinee, Wisc. (Tel. OXbow 3-2111)
Purch. Agent: H. L. Voss
Sales Mgr.: John R. Diggs

MOSLEY ELECTRONICS, INC.
8622 St. Charles Rock Rd., St. Louis 14, Mo. (Tel. HArrison 7-4400)
Dir.-Purch.: Eugene L. Mosley
V. P.-Sales & Adv.: George E. Mobus TR

DONALD P. MOSSMAN, INC.
P. O. Box 265, Brewster, N. Y. (Tel. BRewster 9-3725)
Purch. Agent: William Cox
Sales Mgr.: Ben W. Rist GS, TS

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

MOTCH & MERRYWEATHER MACHINERY CO., THE, AVEY DIV.
25 E. Third St., Covington, Ky.

MDTOR APPLIANCE CORP.
5737 W. Park, St. Louis 10, Mo. (Tel. MI 7-1138)
Purch. Agent: Fred D'Day
Dir.-Sales: M. F. Duerkob GS, GH

***MOTOR GENERATOR CORP.**
Jackson at Water Sts., Troy, D. (Tel. FE 2-1227)
Dir.-Purch.: B. A. Lutz
Buyers: Robert Miller & L. D. Isenbarger
V. P.-Sales: D. W. Baker PS, GS, GH, GE, TR
*(See Page 90 for Advertisement)

MOTORDYNE INC.
2661 S. Myrtle Ave., Monrovia, Calif. (Tel. RYan 1-6132)
Purch. Agent: D. Hartle
Asst. Purch. Agent: Gayle Ross GS, GE, TR, R&D

MOTDRESEARCH CO.
1600 Junction Ave., Racine, Wisc. (Tel. MElrose 2-5131)
Purch. Agent: L. J. Novak
Mgr. Govt. Sales: J. G. Hiatt GS, R&D

MOTOROLA INC., MILITARY ELECTRONICS DIV.
8201 E. McDowell Rd., Phoenix, Ariz. (Tel. WH 5-4311)
Western Military Purch. Mgr.: Paul Stancik
Chicago Military Purch. Mgr.: John O'Donnell, Chicago Military Purchasing Dept., 1450 N. Cicero Ave., Chicago 51, Ill. (Tel. ESterbrook 9-6700) GS, GE, CO, TS, TR, MM, R&D

MOTDROLA INC., MILITARY MARKETING DIV.
8201 E. McDowell, Phoenix, Ariz. (Tel. WH 5-4311)
Purch. Agent: Paul Stancik
Asst. Purch. Agent: Paul Leinheiser

MOTOROLA SEMICONDUCTOR PRODUCTS DIV.
5005 E. McDowell Rd., Phoenix, Ariz. (Tel. BRidge 5-4411)
Mgr.-Purch.: R. S. Nelson
Buyer: A. Porstman
Gen. Mgr.-Sales: J. T. Hickey GE, TS, TR

MUCKLE MFG. CO.
Box 119, Owatonna, Minn. (Tel. 7249)
Purch. Agent: Robert Doyle
Sales Mgr.: S. A. Muckle

MUCON CDRP.
9 St. Francis St., Newark 5, N. J. (Tel. MI 2-1476)
Purch. Agent: B. Berkman
Sales Mgr.: M. A. Prince GE

HEINZ MUELLER ENG. CO. INC.
1906 N. Cicero Ave., Chicago 39, Ill. (Tel. NAtional 2-8977)
Purch. Agents: Henry Egert & Mrs. K. Mueller
V. P.-Sales: Milton Hoffman GE, MM, R&D

MUELLER BRASS CO.
1925 Lapeer Ave., Port Huron, Mich. (Tel. YUkon 5-5111)
Dir.-Purch.: H. F. Lewis
Asst. Purch. Agents: G. D. Postill & H. McFadden
Buyers: William Wastell, Archie Sams & Kenneth Robbins
Gen. Sales Mgr.: R. L. Gibbs

MUELLER ELECTRIC CO.
1583 E. 31st St., Cleveland 14, O. (Tel. PRospect 1-5225)
Purch. Agent: E. H. deConingh
Sales: Scott Mueller GS, GE, CO, TS, TR

MULLENBACH DIV.-ELECTRIC MACHINERY MFG. CO.
2100 E. 27th St., Los Angeles 58, Calif. (Tel. LUdlow 2-5331)
Purch. Agent: James F. Lewis
Gen. Mgr.: Wayne M. Bitting GS, GH, CO

MULTI-AMP CDRP.
465 Lehigh Ave., Union, N. J. (Tel. MUrdock 8-7112)
Purch. Agent: Jim Bates
Prod. Mgr.: E. R. Redlhammer GS, CO, TS

MULTICORE SALES CORP.
80 Shore Rd., Port Washington, N. Y. (Tel. PD 7-7700)
Dir.-Sales: Melvin Zalkin

CHARLES MUNDT & SDNS
53 Fairmount Ave., Jersey City 4, N. J. (Tel. DElaware 3-6200)
Purch. Buyer & Gen. Mgr.: Richard D. Powers MM

MUNSTON MFG. & SERVICE, INC.
Bech St., Islip, N. Y. (Tel. JUniper 1-3900)
Purch. Agent: Robert Kuhn
Sales Mgr.: Theodore Whildin GE, TR, R&D

MURPHY & MILLER, INC.
610 W. Taylor St., Chicago 7, Ill. (Tel. HArrison 7-8900)
Purch. Agent: John Petruska
Sales Mgr.: N. E. Miller TS

MUTRON CORP.
125 Perkins Ave., Brockton, Mass. (Tel. JUniper 3-0033)
Purch. Agent: Richard F. Anderson
Sales Mgr.: Hilbert T. Forsberg GS, GE, TS, TR

MYCALEX CDRP. OF AMERICA
125 Clifton Blvd., Clifton, N. J. (Tel. PRescott 9-8866)
Purch.: H. C. Westervelt
Sales: J. H. DuBois MF, WN, PS, GH, GE, CO, TS, TR

NJE CORP.
345 Carnegie Ave., Kenilworth, N. J. (Tel. CHestnut 1-1500)
Purch. Agent: Robert Schrage
Sales Mgr.: A. Lawrence Karp GS, CO, TS, TR, R&D

NRC EQUIPMENT CORP.
160 Charlemont St., Newton 61, Mass. (Tel. DEcatur 2-5800)
Purch. Agent: Loring Raymond
Asst. Purch. Agent: Norman Resnich
Sales Mgr.: Harry D. Stone PS, GS, GH, GE CO, TS, TR

N. R. K. MFG. & ENGRG. CO.
4601 W. Addison St., Chicago 41, Ill. (Tel. SPring 7-2970)
Dir.-Purch.: Peter Koppenberger
Purch. Agent: M. R. Warren
Sales Engr.: Ed Dervishian GE, TR

NYT ELECTRDNICS, INC.
2979 N. Ontario St., Burbank, Calif. (Tel. VIctorio 9-2414)
Purch. Agent: G. Graham
V. P.-Sales: R. L. Hyder GS, GE, TS, TR

***NADELLA**
66-68 Solothurnstrasse, Biel, Switzerland
*(See Page 33 for Advertisement)

GEORGE L. NANKERVIS CO.
15300 Fullerton, Detroit 27, Mich. (Tel. VErmont 8-5780)
Purch. Agent: R. I. Pieti
V. P.-Sales: H. W. Grikschiet GS, GH, GE, CO, TS, R&D

NAPOLEON PRODUCTS CO., THE
410 Filmare St., Napoleon, O. (Tel. 5361)
Pres. & Gen. Mgr.: G. M. Small
Exec. V. P.-Purch.: E. N. Yeager MF, PS

NARDA MICROWAVE CORP., THE
118-160 Herricks Rd., Mineola, N. Y. (Tel. Ploneer 6-4650)
Purch. Agent: James Orehosky
V. P.-Sales: Williom A. Bourke PS, GH, GE, CO, TS, TR, R&D

NARDA ULTRASONICS CORP., THE
625 Main St., Westbury, N. Y. (Tel. EDgewood 3-5400)
Purch. Agent: Philip McKay
Head-Sales: Paul W. Steen GS

NARMCO MFG. CO.
5159 Baltimore Dr., La Mesa, Calif. (Tel. HOpkins 9-0171)
Dir.-Purch.: R. M. Ewbank
Dir.-Sales & Engrg.: D. H. Black
Mgr.-Sales & Contracts: D. C. Price MF, WN, TR, MM, R&D

NARMCO RESINS & COATINGS CO.
600 Victoria St., Costa Mesa, Calif. (Tel. LIberty 8-1144)
Purch. Agent: Mrs. Maxine Hutchins
Asst. Buyer: Marion Edkins
Gen. Sales Mgr.: Wm. D. Rainey MM, R&D

NARROW FABRIC CO., THE
P. D. Box 742, Reading, Pa. (Tel. FRanklin 6-2891)
Dir.-Purch.: C. E. Hoffmaster
Gen. Sales Mgr.: F. S. Pierce

NASH ENGRG. CO., THE
Wilson Ave., S. Norwalk, Conn. (Tel. VOlunteer 6-3351) PS

NATIONAL AIROIL BURNER CD.
1345 E. Sedgley Ave., Philadelphia 34, Pa. (Tel. Ploneer 3-5300)
Purch. Agent: Edward P. Bailey, Jr. GS, TS

NATIONAL BERYLLIA CDRP.
4501 Dell Ave., North Bergen, N. J. (Tel.: N.Y.C.—DXford 5-1860; N. J. — UNion 5-1600)
Purch. Dept.: First & Haskell Aves., Haskell, N. J. (Tel. TEmple 9-1600)
Purch. Agent: George B. Carlisle
Mgr., Sales Div.: Don de Gruchy MF, WN, PS, MM, R&

NATIONAL CASH REGISTER CO., THE, ELECTRONICS DIV.
1401 E. El Segundo Blvd., Hawthorne, Calif. (Tel. PLymouth 7-1811)
Purch. Agent: A. G. Krumm
Buyer: A. Lloyd
Jr. Buyer: A. Wood R&

NATIDNAL CERAMIC CO.
500 Southard St., Trenton 2, N. J. (Tel. EXport 4-5373)
Prod. Mgr.: J. G. Wallis GE, CO, T

NATIONAL COIL CO.
P. D. Box 1237, Sheridan, Wyo. (Tel. DR 4-7644)
Purch. Agent: Harold Demple
Sales Mgr.: Joe Demple GE, TS, TR, R&

NATIDNAL ELECTRONICS
P. O. Box 1237, Sheridan, Wyo. (Tel. DR 4-7644)
Gen. Mgr. & Purch. Agent: Harold Demple
Sales Mgr.: John Bullinga GS, GH, GE, CO, TS, TR, R&

NATIONAL ENGRG. PRODUCTS, INC.
435 Washington Bldg., Washington 5, D. C. (Tel. REpublic 7-4473)
V. P.-Purch.: Clinton Rector MF, WN, G

NATIONAL FELT CO.
76 Summer St., Boston 10, Mass. (Tel. LIberty 2-6590) M

NATIONAL FOAM SYSTEM, INC.
Union & Adams Sts., West Chester, Pa. (Tel. DW 6-3600)
Purch. Agent: A. D. Holmes
V. P.: L. W. Boerner GH, T

NATIONAL FORGE CO.
Irvine, Warren Co., Pa. (Tel. Youngsville — LDgon 3-7522)
Purch. Agent: Willis Cooney
Asst. Purch. Agent: Paul Broderick
Dir.-Sales: James H. Kannen M

NATIONAL INSTRUMENT LABORATORIES, INC.
834 Evarts St., N. E., Washington, D. C. (Tel. NDrth 7-7582)
Purch. Agent: A. Bloom
Sales & Adv. Mgr.: D. I. Steele

NATIONAL LEAD CO.
111 Broadway, New York 6, N. Y. (Tel. REctor 2-9400)
V. P.-Sales: William J. Welch R&I

NATIONAL LOCK CD.
1902 Seventh St., Rockford, Ill. (Tel. WD 2-4455) MF, WN, PS, G

NATIONAL METALLURGICAL CDRP.
P. O. Box 656, Springfield, Ore. (Tel. Riverside 6-3233)
V. P. & Works Mgr.: W. E. Platte
Secy.-Treas.: A. H. Nelson M

NATIONAL MOLDITE CO.
250 South St., Newark, N. J. (Tel. MItchell 2-6860)
Partners: Manuel Miller & Sidney Lowenberg MM, R&I

NATIONAL PNEUMATIC CO., INC., HOLTZER-CABOT DIVS.
125 Amory St., Boston, Mass. (Tel. JAmaica 4-7000)
Dir.-Purch.: Sidney Coven
Purch. Agent: Thomas Furlong
Gen. Sales Mgr.: J. J. Anderson PS, GE, TS, TF

NATIONAL RESEARCH CORP.
70 Memorial Dr., Cambridge, Mass. (Tel. ELiot 4-5400)
Dir.-Purch.: James R. Caudill
Buyers: R. T. Davis, G. E. Ryan & B. M. Sandock
Contracts Mgr.: J. V. E. Hansen PS, GS, MM, R&D

NATIONAL RESEARCH & DEVELOPMENT CORP.
15 Sixteenth St., N. E., Atlanta, Ga. (Tel. TRinity 3-2536)
Pres.: Carsbie C. Adams R&D

NATIONAL SCREW & MFG. CO., THE
2440 E. 75th St., Cleveland 4, Ohio. (Tel. ENdicott 1-2650); 3423 S. Garfield Ave., Los Angeles 22, Calif.
Purch. Agent: J. O'Neil
Asst. Purch. Agent: Paul Frederick
Gen. Sales Mgr.: R. E. Black MF, WN, GS, GH, GE

NATIONAL SPECIALTIES CO., INC.
1902 Howell St., Ft. Wayne 7, Ind. (Tel. ANthony 2341)
Asst. Gen. Mgr.: Edward C. Doell GS

NATIDNAL SPECTRDGRAPHIC LABS., INC.
6300 Euclid Ave., Cleveland 3, Dhio (Tel. UTah 1-4664)

Purch. Agent: Mrs. Lydia Milite
V. P.-Sales: Donald R. Moore, Miami, Fla. (Tel. TUxedo 5-1691) TS, MM, R&O

ATIONAL TEL-TRONICS CORP.
52 St. Casimir Ave., Yonkers, N. Y. (Tel. YOnkers 8-6400)
Purch. Agent: William Jaris
Sales Mgr.: Charles J. Siebert GE, TR

ATIONAL TUBE DIV.-UNITED STATES STEEL CORP.
525 William Penn Pl., Pittsburgh 30, Pa. (Tel. EXpress 1-2345) GS, MM

ATIONAL ULTRASONIC CORP.
111 Montgomery Ave., Irvington 11, N. J. (Tel. ESsex 1-0550)
V. P.-Purch.: Gilbert Tint
Pres. & Gen. Mgr.: L. R. Jeffrey, Jr. MM, R&O

ATIONAL UNIDN ELECTRIC CORP.
1201 E. Bell St., Bloomington, Ill. (Tel. 7-6041)
Chief-Purch.: C. Hoover
Sales Mgr.: H. B. Graham GE, TS, TR

ATIONAL UTILITIES CORP.
826 S. Arroyo Parkway, Pasadena 2, Calif. (Tel. SYcamore 3-6663)
Purch. Agent: R. Kleeman
Sales Mgr.: Miles Abbott MF, PS, GS, GH, TS

ATIONAL VULCANIZED FIBRE CO.
Maryland Ave. & Beech Sts., Wilmington, Del. (Tel. OL 5-6371)
Dir.-Purch.: L. R. Clinton
Buyer: R. L. Jackson
Sales Mgr.: J. L. Kallaher MF, WN, PS, GE, TR, MM

ATIONAL WATER LIFT CO., DIV.-CLEVELAND PNEUMATIC INDUSTRIES, INC.
2220 Palmer Ave., Kalamazoo, Mich. (Tel. FIreside 5-8641)
Purch. Agent: Edwin W. Rector
Buyers: Harry Pindell, Richard Haaye, Joseph Krause, Fred Weissert & Jerry Hicks
Chief, Contracts Admin.: M. E. Schnurr MF, R&O

ATIONAL WELDING EQUIPMENT CO.
218 Fremont St., San Francisco 5, Calif. (Tel. YUkon 6-2868)
Pres. & Gen. Mgr.: E. L. Mathy

ATIONAL-STANDARD CO.
Howard & 8th Sts., Niles, Mich. (Tel. MUtual 3-8100)
V. P.-Purch.: J. A. Mogle
V. P.-Sales: R. W. Elder MF, PS, GS, TR, MM

ATVAR CORP.
211 Randolph Ave., Woodbridge, N. J. (Tel. FUlton 8-8800)

AVIGATION COMPUTER CORP.
1621 Snyder Ave., Philadelphia 45, Pa. (Tel. HOward 5-7700)
Purch. Agent: J. Concordia
Sales Mgr.: D. M. Biberman GE, CO, TS, TR

. V. NAYBOR LABS., INC.
26 Manorhaven Blvd., Port Washington, N. Y. (Tel. Port Washington 7-4300)
Pres.: E. V. Naybor GS, GE, TR

NZ-DAR CO.
461 Milwaukee Ave., Chicago 10, Ill. (Tel. CHesapeake 3-1630)
Purch.: Seymour Reiger
Sales: R. E. Doran MF, PS, GS, GE, TS, TR

EBEL MACHINE TOOL CORP.
3401 Central Pkwy., Cincinnati 25, Ohio (Tel. LIberty 2-3500)
Purch. Agent: Jack D. Smith
V. P.-Sales: Warren G. Rosendahl MF, WN, GS, GH

EFF INSTRUMENT CORP.
2211 E. Foothill Blvd., Pasadena, Calif. (Tel. RYan 1-5121)
Purch. Agent & Prod. Mgr.: William P. Shaw
Sales Mgr.: Donald B. Schneider GS, TS, TR

ELSON LABS., INC.
4718 Mason Ave., Hyattsville, Md. (Tel. WArfield 7-1116)
Purch. Agent: Charles E. Barker
Dir.-Sales: Ralph S. Baer GH

ELSON STUD WELDING, DIV.-GREGORY INDUSTRIES, INC.
Toledo Ave. at E. 28th St., Lorain, Ohio (Tel. CHerry 5-6931)
Dir.-Purch.: Howard P. Nalley
Dir.-Sales: R. E. McGinnis MM

ELSON VACUUM PUMP CO.
133 4th St., Berkeley 10, Calif. (Tel. AShberry 3-2277)
Mgr.-Purch.: O. B. Webb
Sales Mgr.: B. J. McClary GH, TS

MS CLARKE CO., DIV.-VITRO CORP. OF AMERICA
19 Jesup-Blair Dr., Silver Spring, Md. (Tel. JUniper 5-1000)
Purch. Agent: D. E. Lanham
Dir.-Sales: J. F. Whitehead TR

NESOR ALLOY PRDOUCTS CO.
282-4 Halsey St., Newark 2, N. J. (Tel. MItchell 2-1682)
Purch.: Herbert Jacobsen & Marvin Feldman
Dir.-Sales: Marvin Feldman MM, R&O

NETWORKS ELECTRONIC CORP.
14806 Oxnard St., Van Nuys, Calif. (Tel. St 2-3114)
Purch. Agent: Mrs. Caroline Porter
Buyer: Miss Sarah McCall TS, TR, R&D

NEUMADE PRODUCTS CORP.
250 W. 57th St., New York 19, N. Y. (Tel. JUdson 6-5810)
Exec. V. P.-Purch.: L. E. Jones

NEUTRONIC ASSDCIATES
93-14 101st Ave., Ozone Park 17, N. Y. (Tel. VI 7-7703)
Chif Engr.: Jose Hernandez GE, R&O

NEW BRITAIN MACHINE CO., THE, PRECISION PRDOUCTS DIV.
South St., New Britain, Conn. (Tel. BAldwin 9-1641)
Dir.-Purch.: R. Hulbert
Purch. Agent: J. Devokaitis
Buyer: L. Bourquin
Asst. Purch. Agent: E. Johnson
Sales Mgr.: W. R. Knowles

NEW DEPARTURE DIV., GENERAL MOTORS CORP.
269 N. Main St., Bristol, Conn. (Tel. LUdlow 2-6371)
Dir.-Purch.: William J. Ryan
Gen. Sales Mgr.: Leonard F. Swoyer MF, GE, TR, R&O

NEW ENGLAND ELECTRICAL WORKS, INC.
365 Main St., Lisbon, N. H. (Tel. 8-6620)
Exec. Asst.-Purch.: W. W. Jesseman
Treas.: L. H. Dumdey GE, TR

NEW ENGLAND ETCHING & PLATING CO., INC.
Spring St., Holyoke, Mass. (Tel. JE 2-9482)
V. P.-Sales: Walter W. Morris MM

NEW ENGLAND INSTRUMENT CO.
320 Main St., Woonsocket, R. I. (Tel. POplar 2-6232)
V. P.-Purch.: Donald McGee
Pres.: Paul Hines

NEW ENGLAND LAMINATES CO., INC.
481 Canal St., Stamford, Conn. (Tel. DAvis 4-4181)
Tech. Dir.-Purch.: Dr. D. E. Edgar
Sales Mgr.: Bruce B. Greenfield GE, MM, R&O

NEW ENGLAND SCIENTIFIC INSTRUMENTS CO.
238 Main St., Cambridge 42, Mass. (Tel. KI 7-1997)
Gen. Mgr.: Dr. Geoffrey Knight, Jr. PS, GE, CO, TS, TR

NEW ENGLAND TAPE CO., DIV.-UNITED-CARR FASTENER CORP.
30 Tower St., Hudson, Mass. (Tel. HUdson 965)
Purch. Agent: F. A. Keay
Sales: H. M. Wilkoff MM

NEW ENGLAND TRANSFORMER CO., INC.
47 McGrath Hwy., Somerville 43, Mass. (Tel. SOmerset 6-6100)
Pres. & Gen. Mgr.: H. F. S. Morris

NEW HAMPSHIRE BALL BEARINGS, INC.
Peterborough, N. H. (Tel. WAlnut 4-3311)
Purch. Agent: W. R. Reekie
Buyer: Marvin Hammer
Sales Mgr.: George Hampson GS, GE, TR

NEW PROCESS METALS, INC.
45-65 Manufacturers Place, Newark 5, N. J. (Tel. MArket 4-1380)
V. P.-Gen. Mgr.: I. S. Hirschhorn
Sales Mgr.: B. M. Berzon MM

NEW YORK AIR BRAKE CO., THE, WATERTOWN DIV.
Starbuck Ave., Watertown, N. Y. (Tel. WAtertown 7700)
Dir.-Purch.: R. R. Petersen
Purch. Asst.: H. A. Hardman
Buyers: P. F. Hoag & R. H. Madden
Gen. Sales Mgr.: H. R. Doughty, Jr. MF, PS, GS, GE

NEW YORK COIL CO., INC.
48 Second Ave., Phoenixville, Pa. (Tel. WEllington 3-3114)
Purch. Agent: Miss Doris I. Darlington
Pres. & Sales Mgr.: J. R. Zikmund GE, CO, TS, TR

NEW YORK & NEW JERSEY LUBRICANT CO.
292 Madison Ave., New York, N. Y. (Tel. LExington 2-2851)
Purch. Agent: F. Roettinger PS

NEW YDRK RUBBER CORP.
100 Park Ave., New York 17, N. Y. (Tel. OR 9-1300)
Purch. Agent: H. J. Baxter
V. P.-Sales: C. B. Allen R&O

NEW YORK SOLDER CD., INC.
684 E. 133rd St., New York 54, N. Y. (Tel. CYpress 2-3740)
Purch.: B. Gottlieb MF, PS, TR

NEW YDRK TESTING LABS., INC.
47 West St., New York, N. Y. (Tel. BD 9-6220)
Purch. Agent: J. Cassidy
Tech. Dir.: G. J. Harvey TS

NEW YORK TRANSFORMER CO. INC.
3rd Ave., Alpha, N. J. (Tel. GLencourt 4-1143)
Purch. Agent: A. Micci GS, GE, TS, TR

NEW YORK TWIST DRILL CO., INC.
276 Lafayette St., New York 12, N. Y. (Tel. WOrth 6-0SS1)
Purch. Agent: Ernest Lazarus
Exec. V. P.-Sales: Raymand M. Greenfield MM

NEWARK CDNTROLS CO.
15 Ward St., Bloomfield, N. J. (Tel. PIlgrim 8-2971)
Purch. Agent: O. Hess
Pres.: B. A. Hicks

NEWARK WIRE CLDTH CO.
351 Verona Ave., Newark, N. J. (Tel. HUmboldt 3-7700)
Purch. Agent: E. J. Korn
V. P.-Sales: J. L. Campbell MF, PS, GS, GH, GE, TR

*NEWAY EQUIPMENT CO.
P. D. Box 425, 1183 E. Laketon Ave., Muskegon, Mich. (Tel. 6-2134)
Purch. Agent: Fred Tuttle
V. P.-Sales: George Bartlett GS, GH
*(See Page S6 for Advertisement)

NEWBROOK MACHINE CDRP.
16 Mechanic St., Silver Creek, N. Y. (Tel. 44)
Purch. Agent: J. P. Shaw
Dir.-Sales: Gordon Kurtis MF, WN, PS, GS, GH, R&O

M. M. NEWMAN CORP.
79 Clifton Ave., Marblehead, Mass. (Tel. NEptune 2-0637)
Pres.: M. M. Newman MM

NEWTH RUBBER CO.
County Rd., Barrington, R. I. (Tel. CHerry 5-80S0)
Purch. Agent: Charles F. Gladding
Sales Mgr.: Richard T. Shortle MM

NEWTON CO., THE
55 Elm St., Manchester, Conn. (Tel. MI 3-1543)
Purch. Agent: Ernest Ehlers
V. P.-Sales: Norman Neslon GS, GE

NEWTON HYDRAULIC TOOLING CO.
P. O. Box 278, Auburn, Mass. (Tel. PLeasant 6-469S)
Purch. Agent: A. Pratt
Dir.-Sales: Gerald P. Welman

J. M. NEY CO., THE
Box 990, Hartford 1, Conn. (Tel. CHapel 2-2281)
Purch. Agent: Ralph Fothergill
Buyer: Sharline Singleton
Head-Sales: Fred I. Kent
Mgr., Industrial Sales Office: John Boyle MM

NICAD DIV., GOULD-NATIONAL BATTERIES, INC.
172 Pleasant St., Easthampton, Mass. (Tel. EAsthampton 1200)
Purch. Agent: A. R. Duby
Gen. Sales Mgr.: L. R. Mannheim GS, GE, R&O

NICE BALL BEARING CO.
30th & Hunting Park Ave., Philadelphia 40, Pa. (Tel. BAldwin 3-6000)
Purch. Agent: F. P. H. Dimond
V. P.-Sales: Theo E. Spilker

W. H. NICHOLS CO.
48 Woerd Ave., Waltham 54, Mass. (Tel. TWinbrook 4-06S0)
Dir.-Purch.: W. E. Neese

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

Asst. Dir.-Purch.: R. H. Stearns
Sales Mgr.: John Freeto — PS, GS, GH

NIPPERT ELECTRIC PRODUCTS CO., THE
1759 W. Mound St., Columbus 23, Ohio (Tel. BRoadway 4-1116)
V. P.-Purch: J. E. Nippert — MM

NOBLE & WESTBROOK MFG., CO., THE
Westbrook St., East Hartford 8, Conn. (Tel. BU 9-2717)
Secy.: R. H. Gunther

NON-LINEAR SYSTEMS, INC.
Del Mar, Calif. (Tel. SKyline 5-1134)
Purch. Agent: W. Clemens
Dir.-Sales: R. C. Wynne — CO, TS

NOOTER CORP.
1400 S. 2nd St., St. Louis 4, Mo. (Tel. MAin 1-6000)
Dir.-Purch.: H. H. Lurtz
V. P.-Sales: Arthur Schwarz — PS, GS

NOPCO CHEMICAL CO.
60 Park Place, Newark, N. J. (Tel. HUmboldt 3-6200)
V. P.: G. G. Stier
Purch. Agent: Foster Jones — MF, WN, PS, GS, MM

***NORD AVIATION**
12 bis, av. Bosquet, Paris (7e)
Factory: 12/18 rue Beranger—CHATILLON—sous-BAGNEUX (Seine)
Pres.: P. Mazer
*(See Page 71 for Advertisement)

NOROBERG MFG. CO.
3073 S. Chase Ave., Milwaukee, Wisc. (Tel. SHeridan 4-2345)
Gen. Purch. Agent: F. T. Finley
Mgr.-Sales: C. D. Friend — GS, MM

NOROEN KETAY CORP.
99 Park Ave., New York, N. Y.

NORMANOY ELECTRIC WIRE CORP.
125 Second St., Brooklyn 31, N. Y. (Tel. TRiangle 5-9863)
Mktg. Expediter: Lester W. Goody
Purch. Dept.: Milton Imbey — MF, GS, GH, CO, TS, TR

NORRICH PLASTICS CORP.
107-109 W. 18th St., New York 11, N. Y. (Tel. WA 4-8360)
Purch.: Norman L. Thaw
Tech. Sales Mgr.: Richard E. Thaw

NORRIS-THERMADOR CORP.
5215 S. Boyle Ave., Los Angeles 58, Calif. (Tel. LUdlow 8-7111)
Dir.-Purch.: R. R. Stoddard
V. P.-Sales, Military Products: D. P. White — MF, WN, R&O

ERNST NORRMAN LABORATORIES
Lake Geneva, Wisc. (Tel. CIrcle 5-5516)
Ernst Norrman — GE, TS, TR, R&O

NORSIO MFG. CO., INC., THE
33 Prospect St., Yonkers, N. Y. (Tel. YOnkers 5-8145)
Purch.: Jack Deutsch
Sales: Harold Deutsch — MF

NORTH AMERICAN AVIATION, INC.
(See Autonetics Div., Missile Development Div., Rocketdyne Div.)

NORTH AMERICAN ELECTRONICS INC.
212 Broad St., Lynn, Mass. (Tel. LYnn 8-2835)
Purch. Agent: Mario S. Bruno
Sales Mgr.: Raymond W. Smith

NORTH ATLANTIC INDUSTRIES, INC.
603 Main St., Westbury, N. Y. (Tel. EDgewood 4-1122)
Purch. Agent: Walter Lipkin
Sales Mgr.: John A. Gregorio — GS, CO, TS

NORTH ELECTRIC CO.
553 S. Market St., Galion, O. (Tel. HOward 8-2420)
Dir.-Mfg.: Joseph Dolland
Purch. Agent: Cal Snyder
Chief Field Engr.-Sales: Howard Brewer — GS

NORTH HILLS ELECTRIC CO., INC.
402 Sagamore Ave., Mineola, N. Y. (Tel. Pioneer 7-0555)
Pres.: S. Cramer
Buyer: S. Nuchtern — TS, TR, R&O

NORTH SHORE NAMEPLATE INC.
214-27 Northern Blvd., Bayside, N. Y. (Tel. BAyside 4-4000)
Pres.: E. T. Turney, Jr.
Head-Sales: Margaret S. Turney — MM

NORTHEAST ELECTRONICS CORP.
P. O. Box 425, Airport Rd., Concord, N. H. (Tel. CApitol 5-6641)
Purch.: R. L. Lincoln
Sales: J. J. Dwyer — TS, TR, R&D

NORTHEAST SCIENTIFIC CORP.
617 Concord Ave., Cambridge 38, Mass. (Tel. UNiversity 4-2350)
Pres.: Clement Maritz

NORTHEASTERN ENGRG. INC.
25 S. Bedford St., Manchester, N. H. (Tel. NAtional 2-6485)
Buyer: R. Harris
Head-Sales: C. N. Chagaris — CO, TS

NORTHERN ENGRG. LABORATORIES, INC.
372 Wilmot Ave., Burlington, Wisc. (Tel. RDckwell 3-7155)
Pres. & Sales Mgr.: John D. Holmbeck — GE, TR, R&O

NORTHERN ORONANCE INC., SUB.-NORTHERN PUMP CO.
Columbia Heights, Minneapolis 21, Minn. (Tel. SUnset 8-8601)
Purch. Mgr.: W. H. Bauer
Purchasing: Vern Kinney & Tony Petrangelo
Sales Mgr.: A. J. Bryant

NORTHERN PLASTICS CORP.
2nd & Market St., La Crosse, Wisc. (Tel. 4-6070)
Purch. Agent: S. L. Noe
Head-Sales: G. C. Kroening — MM

NORTHROP CORP.
9744 Wilshire Blvd., Beverly Hills, Calif. (Tel. CRestview 4-8061)
Mgr.-Purch.: J. W. Hinchliffe — MF, GS, GH, GE, CO, TS, TR, MM, R&O

NORTHROP CORP., NORTRONICS DIV.
Electronic Systems & Equipment Dept., 222 N. Prairie Ave., Hawthorne, Calif. (Tel. DRegon 8-9111)
Dir.-Materiel: R. M. Cooper
Chief Applications Engr.: T. J. Venator
Purchasing Dept.: 2031 E. Mariposa, El Segunda, Calif. (Tel. DRegon 8-0411)
Systems Support Dept.: 500 E. Orangethorpe, Anaheim, Calif. (Tel. LAmbert 5-4771)
Dir.-Materiel: C. W. Hood
Chief Applications Engr.: E. W. Warnshuis — MF, WN, GS, GH, GE, CO, TS, TR, R&O

NORTHWESTERN ELECTRIC CO.
1750 N. Springfield Ave., Chicago 47, Ill. (Tel. DIckens 2-4400)
Purch. Agent: Paul Christiansen
Gen. Sales Mgr.: George D. Craig, Jr. — GS, GH

NORTON ASSOCIATES, INC.
P. O. Box 96, Garden City, N. Y. (Tel. IV 3-2968)
V. P.-Sales: R. S. Norton — GE, TR

NORTON CO.
New Bond St., Worcester 6, Mass. (Tel. SWift 8-2511)
Gen. Purch. Agent: G. D. Seguin
Chief Buyer: H. H. Anderson — MM, R&O

NORTON CO., NEW PRODUCTS DEPT.
Worcester 6, Mass. (Tel. SW 8-2511) — WN, PS, GS, TS, MM, R&O

NORWALK CUTTER SHARPENING CO.
356 Ely Ave., South Norwalk, Conn. (Tel. VD 6-0560)
Dir.-Sales: Harold W. Nadin

NORWOOD CONTROLS UNIT, DETROIT CONTROLS DIV.
934 Washington St., Norwood, Mass. (Tel. NDrwood 7-4010)
Purch. Agent: N. T. Ross
Dir.-Sales: J. M. Devine — GS, GH, TS

NU STEEL CO.
1714 S. Ashland Ave., Chicago 8, Ill. (Tel. HAymarket 1-5760)
Pres.: Lew W. Cleminson — MM

NUCLEAR CORP. OF AMERICA, INC.
2 Richmond Pl., Denville, N. J. (Tel. OAkwood 7-4200)
Purch. Agent: Michael Buff
Sales Mgr.: David Silverstein — TS, R&D

NUCLEAR MEASUREMENTS CORP.
2464 N. Arlington Ave., Indianapolis 18, Ind. (Tel. LIberty 6-2415)
Purch. Agent: James L. Sommerville
Chief Engr.: Herbert S. Fall
Gen. Sales Mgr.: Cort L. Kegley

NUCLEAR PRODUCTS-ERCO DIV.-ACF INDUSTRIES, INC.
Riverdale, Md. (Tel. WArfield 7-4444)
Purch. Agent: R. C. Nill
Sr. Buyers: E. T. Wagner & H. L. Bloylock
Mktg. Mgr., Defense Products: Conan J. Doyle — GS, GH, CO, TS, R&I

NUCLEAR-CHICAGO CORP.
223 W. Erie, Chicago, Ill. (Tel. DE 7-3060)
Purch. Agent: Robert Young
Sales Mgr.: Mel Shepherd — MM

NUGENT ELECTRONICS CO., INC.
802 E. Eighth St., New Albany, Ind. (Tel. WHitehall 5-0211)
V. P.-Purch.: J. D. Robinson

PAUL NURCHES CO.
3250 Rida St., Pasadena, Calif. (Tel. SYcamore 6-5844)
Mgr.-Purch. & Sales: Paul Nurches — GS, CO, TS, R&I

NUTRON MFG. CO. INC.
67 Monroe Ave., Staten Island 1, N. Y. (Tel. GIbraltar 7-3229)
Secy.-Treas.: Henry Scian — GS, CO, T

NUTT-SHEL CO.
2701 S. Harbor Blvd., Santa Ana, Calif. (Tel. KImberly 5-9311)
Purch. Agent: P. Welsh
Chief Sales Engr.: R. C. Poucher — MF, P

OPW-JORDAN
6013 Wiehe Rd., Cincinnati 13, Ohio (Tel. EL 1-1352)
Asst. Plant Mgr.: M. H. Hott
Chief Sales Engr.: P. H. Coleman
Sales Engr.: R. J. Peters
Gen. Mgr.: G. B. Richards, Jr. — GS, GI

O & S RESEARCH, INC.
1811 Bannard St., East Riverton, N. J. (Tel. TAlmadge 9-2800)
Purch. Agent: Edward R. Sanders
Sales Mgr.: Donald G. Wright — WN, TS, TI

OAKITE PRODUCTS, INC.
19 Rector St., New York 6, N. Y. (Tel. WHitehall 3-0940)
Purch: Agent: R. R. Burns
Sales Mgr.: William A. Baltzell — MF, WN, PS, GS, GI

OERLIKON TOOL & ARMS CORP. OF AMERICA
P. D. Box 3049, Asheville, N. C. (Tel. ALpine 3-6464)
Chief-Procurement: William L. Hayes
Research Engr.: R. L. Hoch — WN, PS, R&I

OFFNER ELECTRONICS INC.
3900 River Rd., Schiller Park, Ill. (Tel. GLadstone 1-0050)
Purch. Agent: H. Lewis
Sales Mgr.: G. W. Little — TS, TI

OHIO CARBON CO., THE
12508 Berea Rd., Cleveland 11, O. (Tel. CL 2-6100)
Purch. Agent: R. Hawrylak
V. P.-Sales: F. C. Aurand — MM

OHIO PRECISION CASTINGS, INC.
109 Webb St., Dayton 3, O. (Tel. CLearwater 3-4183)
Pres.-Treas.: W. J. Prestel
Dir.-Purch.: Mrs. Jeanette Diener — MM

OHIO SEAMLESS TUBE DIV.-COPPERWELD STEEL CO.
Shelby, O. (Tel. 3-1010)
Purch. Agent: R. R. Underhill
Asst. Purch. Agent: R. W. Winck
Mgr.-Sales: J. E. Horner — MM

OHIO SEMICONDUCTORS, INC.
1035 W. Third Ave., Columbus 8, Ohio (Tel. AXminster 4-4938)
Pres.: Dr. W. E. Bulman
Treas.: L. A. Denton
Dir.-Marketing: H. C. Dale
Sales & Applications Mgr.: A. Jerencsik — MM, R&I

OHMART CORP., THE
2236 Bogen St., Cincinnati, Ohio

OIL-DYNE, INC.
2115 W. Marquette Rd., Chicago 36, Ill. (Tel. HEmlock 4-2300)
Purch. Agent: Andrew Pappas
Dir.-Sales: John Warren — G

OIL-RITE CORP.
2318 Waldo Blvd., Manitowoc, Wisc. (Tel. MUrray 2-2428)
Purch. Agent: Gus Lukas
Sales Mgr.: Merwin R. Scheider — G

OKONITE CO., THE, SUB.-KENNECOTT COPPER CORP.
220 Passaic St., Passaic, N. J. (Tel. PRescott 7-0400)
Purch. Agent: T. B. Woodcock
V. P.-Mktg.: C. M. Kirkland — MF, GS, GH, CO, TS, T

LIN MATHIESON CHEMICAL CORP., ENERGY DIV.
460 Park Ave., New York, N. Y. (Tel. MU 8-0500)
Branch Offices:
Niagara Falls, N. Y. (Tel. BUtler 4-7811)
Purch. Agent: J. C. Pfisterer
Product Mgr.: J. H. Heck
New Haven, Conn. (Tel. SPruce 7-7911)
Purch. Agent: F. E. Plumley
Product Mgr.: J. Jacox
East Alton, Ill. (Tel. WOodriver 4-7311)
Purch. Agent: W. A. Oakey
Product Mgr.: W. P. Turner
Washington, O. C. (Tel. Olstrict 7-2911)
V. P.-Sales: Horry A. Sosnoski PS, R&D

LIVER CORP., THE
400 W. Madison St., Chicago 6, Ill. (Tel. FRanklin 2-6969)
V. P., Dir.-Purchases: L. P. Richie
Dir.-Defense Operations: J. Hoyne
V. P.-Sales: O. W. Koegle GS

LIVER CORP., THE, A. B. FARQUHAR DIV.
142 N. Duke St., York, Penna. (Tel. 7801)
Spec. Machinery & Ord. Sales Mgr.: J. Kugle
Mech. & Hydraulic Press Sales Mgr.: P. Dunlop
Conveyor Sales Mgr.: C. W. King
Mgr.-Purch: Lester B. Hibner

LYMPIC RADIO & TELEVISION, INC.
34-01 38th Ave., Long Island City, N. Y.

MEGA ELECTRONIC CORP.
Haverhill St., Rowley, Mass. (Tel. WHitney 8-3401)
Treas.: H. B. Ribbel
Sales: P. S. Huston

MEGA LABS., INC.
Haverhill St., Rowley, Mass. (Tel. WHitney 8-7757)
Treas: H. B. Ribbel GE, CO, TS, TR

M MARK COUPLINGS, INC.
4440 York Blvd., Los Angeles 41, Calif. (Tel. CLinton 4-2278)
Purch. Agent: Kenneth Palmer
Pres.: Barry B. Willis
Chief Engr.: H. A. OeCenzo
Sales Mgr.: Howard Sherman
PS, GS, GH, CO, TS, R&D

M. ONAN & SONS INC.
2515 University Ave., S. E., Minneapolis 14, Minn. (Tel. FE 2-1155)
Dir.-Procurement: H. P. Richter
Mgr.-Purch. Dept.: L. V. Moen
Gen. Sales Mgr.: R. E. Mullin GS

NEIL-IRWIN MFG. CO.
151 Eighth Ave., Lake City, Minn. (Tel. 6301)
Purch. Agent: L. C. Wickstrom
Sales Mgr.: R. B. Maland

NSRUD CUTTER MFG. CO., INC.
100 E. Broadway, Libertyville, Ill. (Tel. 2-1560)
Purch. Agent: Norbert Vess
Sales Mgr.: Arthur R. Johnson MM

NSRUD MACHINE WORKS, INC.
4720 N. Lehigh Ave., Niles 48, Ill. (Tel. Niles 7-8700)
Purch. Agent: Frank Muscarello
V. P.-Machine Tool Sales: Albert L. Breuer
MF, WN, PS, GS

OAD ELECTRIC CO.
33 Walker St., New York 13, N. Y. (Tel. WOrth 6-0380)
Purch. Agent: J. McShay
Dir.-Sales: H. L. Opad GS, TS

OELIKA WELDING, MACHINE & SUPPLY INC.
1200 Steel St., Opelika, Ala. (Tel. SHerwood 5-3524)
Purch. Agent: J. P. Byrd
Engr.-Purch.: Wm. S. Harris
V. P.-Sales: C. Foster MF, GS, GH, TS

OPTICAL COATING LAB., INC.
2777 Sebastopol Rd., Santa Rosa, Calif. (Tel. LIberty 5-6440)
Administrative Mgr.: John McCullough
Customer Liaison Mgr.: L. Vance Fisher
Gen. Mgr.: Rolf F. Illsley
Prod. Mgr.: G. Eugene Michel GE, TR, R&D

OPTIMIZED DEVICES, INC.
44 Franklin Ave., Thornwood, N. Y. (Tel. ROgers 9-6110)
Prod. Mgr.: J. Murtha
Sales Mgr.: A. Zuch GH, GE, CO, TS, R&D

ORMECHANISMS INC.
46 E. 2nd St., Mineola, N. Y. (Tel. Pioneer 6-5576)
Purch. Agent: John Ferronte
Sales Engrg. Mgr.: Roy T. Smith R&D

ORO-METRIC TOOLS, INC.
37 Varick St., New York 13, N. Y. (Tel. ORegon 5-9076)
Sales Mgr.: A. A. Crystle
Gen. Mgr.: F. Koenig GS, GE, CO, TS, TR

ORANGE PRODUCTS, INC.
554 Mitchell St., Orange, N. J. (Tel. ORange 7-0900)
Pres.: L. W. Schaper
V. P. & Treas.: C. J. Gentile MM

ORANGE ROLLER BEARING CO., INC.
557 Main St., Orange, N. J. (Tel. ORange 3-6161)
Dir.-Purch.: James McGraw
Dir.-Sales: T. E. Cushing PS

ORBIT INSTRUMENT CORP.
656 Main St., Westbury, N. Y. (Tel. ED 4-8380)
Purch. Agent: R. Schneider
Sales Mgr.: H. Silberman GS, GE, CO, TS, TR, R&D

ORBITRAN CO., INC.
11487 Woodside Ave., Lakeside, Calif. (Tel. HIckory 3-6832)
Gen. Mgr.: E. W. Fischer GE, TR

ORCHARD INDUSTRIES, INC., ACTIONFLEX DIV.
912 West State St., Hastings, Mich. (Tel. WIndsor 5-3404)
Mgr.: Ernest H. Jocoby

ORDNANCE DIV.-FOOD MACHINERY & CHEMICAL CORP.
1105 Coleman Ave., San Jose, Calif. (Tel. CYpress 4-8124)
Mgr., Procurement: H. L. Hall
Purchasing: H. V. Rogers
Exp. Procurement: T. R. Johnson
Mgr., Application Engrg.: H. Hammond GS, GH, R&D

ORGANIC PRODUCTS CO.
2000 E. Irving Blvd., Irving, Tex. (Tel. BL 4-4342)
Gen. Mgr.: Bert Wilson
Plant Mgr.: S. S. Montgomery MM

ORRADIO INDUSTRIES, INC.
Shamrock Circle, Opelika, Ala. (Tel. SHerwood 5-5771)
Purch. Agent: Thad McEochin
V. P.-Sales: Nat Welch

ORTHO FILTER CORP.
196 Albion Ave., Paterson 2, N. J. (Tel. MUlberry 4-5858)
Purch. Agent: William Levine
Buyer: William McGravey

ORTMAN-MILLER MACHINE CO. INC.
19 143rd St., Hammond, Ind. (Tel. WEstmore 1-1710)
Dir.-Purch.: A. H. Ortman
Dir.-Sales: N. H. Ortman GS, GH, R&D

ORYX CO.
9015 Wilshire Blvd., Beverly Hills, Calif. (Tel. BRadshaw 2-6635)

OSBORNE ELECTRONIC SALES CORP.
712 S. E. Hawthorne Blvd., Portland, Ore. (Tel. BElmont 2-0161)
Purch. Agent: C. E. Stonecipher
Sales Mgr.: T. E. Murphy GE, CO, TS, MM

JOHN OSTER MFG. CO., AVIONIC DIV.
One Main St., Racine, Wisc. (Tel. MElrose 3-6331)
Purch. Agent: Roy Arcand
Asst. Purch. Agent: Robert Stratman
Buyers: Ray Carlson, Anthony Methenitis, Roy Woods, Pornell Bjerke & Hugo Zerbe
Eastern Sales Mgr.: Irving G. Epstein
Western Sales Mgr.: Ward S. Carlson PS, GS, GE, TS

OTIS ELEVATOR CO., ELECTRONIC DIV.
35 Ryerson St., Brooklyn 5, N. Y. (Tel. ULster 5-6800)
Purch. Agent: B. Katz
Mgr., Customer Relations Dept.: J. B. McKinley GS, GH, CO, TS

OVERLOAD CONTROL CO.
151 Pennsylvania Ave., Island Park, N. Y. (Tel. GEneral 2-1431)
Purch.: R. Ronnie
Sales: Earl Elwyn Smith PS, GS, TS

OWATONNA TOOL CO.
Owatonna, Minn. (Tel. 5591)
Purch. Agent: Clarence P. Kaplan
Dir.-Sales: J. A. Mullenmaster

OXFORD COMPONENTS, INC.
556 W. Monroe St., Chicago, Ill. (Tel. FInancial 6-3623)
Gen. Mgr.: T. Brown GE

OXYGEN EQUIPMENT & SERVICE CO.
8335 S. Halsted St., Chicago 20, Ill. (Tel. HUdson 3-3800)
Pres.: Albert E. McKee
Purch. Agent: Donald J. Freeburg

OZONE METAL PRODUCTS CORP.
101-32 101st St., Ozone Park 16, N. Y. (Tel. VIrginia 6-3300)
Pres.: Phillip Wiebel
Purch. Agent: E. Kulick
V. P.-Sales: W. E. Criley PS, GS

PCA ELECTRONICS INC.
16799 Schoenborn St., Sepulveda, Calif. (Tel. EMpire 2-0761)
Purch. Agent: Paul Kliebert
Sales Mgr.: Charles Rubin GS, GH, GE, CO, TS

PIC DESIGN CORP., SUB.-BENRUS WATCH CO., INC.
477 Atlantic Ave., E. Rockaway, L. I., N. Y. (Tel. LYnbrook 3-6470)
Purch. Agent: Mrs. T. Bolzer
Sales: P. Wellenberger
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&D

P.S.P. ENGRG. CO., DIV.-INDUCTION MOTORS CORP.
6058 Walker Ave., Maywood, Calif. (Tel. LUdlow 3-4785)
Dir.-Purch.: Robert Morris
Sales Mgr.: Lee Lambert GS, GE, CO, TS

PACE ELECTRICAL INSTRUMENTS CO., INC.
70-31 84th St., Glendale 27, L. I., N. Y. (Tel. OAvenport 6-3982)
Dir.-Purch.: A. S. Weingast
Industrial Sales Mgr.: G. N. Goldberger

PACE ENGRG. CO.
13035 Saticoy St., N. Hollywood, Calif. (Tel. PO 5-0453)
Purch. Agent: Sid Becker CO, TS, TR, R&D

PACIFIC AUTOMATION PRODUCTS, INC.
1000 Air Way, Glendale, Calif. (Tel. CHapman 5-6871)
Purch. Agent: Roland Eatrom
Chief Liaison Engr.-Sales: William W. Buckley GS, GH, TR

PACIFIC COAST ENGRG. CO.
Oak & Clement Sts., P. O. Orower "E", Alamedo, Calif. (Tel. LA 2-6100)
Purch. Agent: M. H. LaRue
Gen. Sales Mgr.: J. P. Tepley

PACIFIC CUT WASHER CO.
2501 E. 56th St., Huntington Park, Calif. (Tel. LUdlow 3-6781)
Gen. Mgr.: J. R. Bougher
Sales Mgr.: John Remmers MM

PACIFIC MAGNETIC CORP.
Electronic Center, Romoland, Calif. (Tel. Perris Exchange, OLympio 7-2637)
Purch. Agent: J. A. Thomas
Pres.: H. L. Mills
Dir.-Engrg.: Gordon W. Johnson
Dir.-Sales: J. A. Thomas GS, CO, TS

PACIFIC MOULDED PRODUCTS CO.
905 E. 59th St., Los Angeles 1, Calif. (Tel. ADams 1-1151)
Purch. Agent: William Okroy
V. P.-Sales: C. E. Wilson MF, WN, PS, GE, MM

PACIFIC OPTICAL CORP.
120 Glasgow, Inglewood, Calif. (Tel. ORegon 8-1139)
Purch. Agent: Fred Hansen
Pres.: John Ryde TR

PACIFIC RADIONICS
2586 E. 67th St., Long Beach 5, Calif. (Tel. NEvado 6-0545)
Purch. Agent: M. Binkley
Dir.-Sales: C. C. Moore
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&D

PACIFIC RESISTOR & CABLE CO.
2186 Colorado Ave., Santa Monica, Calif. (Tel. EX 3-0531)
Pres.: H. Guiness GS, GH, GE

PACIFIC SCIENTIFIC CO.
P. O. Box 22019, Los Angeles 22, Calif. (Tel. SPruce 3-2020)
Dir.-Sales & Serv.: Andre W. Reichel

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

Purch. Mgr.: M. R. Hartigan
Buyers: Tim Tapping, L. B. Herr, Lee Marshek

PACIFIC SEMICONDUCTORS, INC.
10451 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-4881)
Purch. Agent: Harry Rosen
Sales Mgr.: S. L. Spiegel GE, TR

PACIFIC TUBE CO.
5710 Smithway St., Los Angeles 22, Calif. (Tel. RAymond 3-1331)
Purch. Agent: W. H. Kepp
Sales Mgr.: W. P. Armstrong MF

PACIFIC UNIVERSAL PRODUCTS CORP.
168 Vista Ave., Pasadena, Calif. (Tel. RYan 1-7646)
Mgr.: Charles Chopnick
MF, PS, GS, GH, GE, CO, TS, TR

PACIFIC VALVES, INC.
3201 Walnut Ave., Long Beach, Calif. (Tel. GArfield 7-5451; NEvada 6-9811)
Dir.-Sales: Robert C. Macaulay TS

PACKARD ELECTRIC DIV.-GENERAL MOTORS CORP.
Dana St., Warren, D. (Tel. 3250-1)
Procurement Mgr.: D. E. Tritten
Buyers: L. Raymond Clutter, K. F. Dymond, G. E. Gibbons, H. H. Grebe
Dir.-Sales & Engrg.: L. C. Wolcott
MF, PS, GS, GH, GE, TS, TR, MM

***PACKARD-BELL ELECTRONICS CORP.**
12333 W. Olympic Blvd., Los Angeles 64, Calif. (Tel. BRadshaw 2-2171)
Mgr.-Material: Wm. Winckler
Purch. Agent: H. S. Crawford
Dir.-Sales & Admin.: Hugh L. Vick
GS, GH, CO, TR, R&D

*(See Page 64 for Advertisement)

PACO ELECTRONICS CO., INC.
70-31 84th St., Glendale 27, L. I., N. Y. (Tel. DAvenport 6-3982)
Dir.-Purch.: A. S. Weingast
Sales Mgr.: S. S. Sparer

PALMER THERMOMETERS, INC.
2501 Norwood Ave., Cincinnati, O. (Tel. ME 1-1500)
Purch. Agent: S. Rolfsen
Sales & Adv. Mgr.: Douglas H. Hitt
PS, GE, CO, TS, TR

PALO ALTO ENGRG. CO.
620 Page Mill Rd., Palo Alto, Calif. (Tel. DA 6-5360)
Purch. Agent: Roger Earley
Sales Engr.: Lloyd Burkhart GE, TR

***PAN AMERICAN WORLD AIRWAYS, INC., GUIDED MISSILES RANGE DIV.**
135 E. 42nd St., New York 17, N. Y. (Tel. OXford 7-6300)
Pres.: Juan T. Trippe
V. P.'s: Samuel F. Pryor, John C. Leslie & Richard S. Mitchell

*(See Page 44 for Advertisement)

PANDUIT CORP.
14461 Waverly Ave., Midlothian, Ill. (Tel. HIlltop 5-3134) (Chicago)
Sales Mgr.: J. E. Caveney

PANEL ENGRG. CORP.
222 W. Huron St., Chicago 10, Ill. (Tel. SUperior 7-8461)
Pres.: Robert K. Cameron GE, TR, R&D

PANORAMIC RADIO PRODUCTS, INC.
520 S. Fulton Ave., Mt. Vernon, N. Y. (Tel. DWens 9-4600)
V. P.-Purch.: Samuel Kleinman
MF, PS, GS, GE, CD, TS, TR

PAPER MFRS. CO.
9800 Bustleton Ave., Philadelphia 15, Pa. (Tel. DRchord 3-4500)
Dir.-Purch.: J. Walker
Chicago Fld. Sales Reps.: Robert J. Moore & Samuel Du Bois, 510 N. Dearborn St., Chicago, Ill.
N. Y. State (Northern) Fld. Sales Rep.: Don Carroll, 308 Collins Ave., Fayetteville, N. Y.
N. Y. & N. J. Fld. Sales Rep.: Joseph I. Shields (Tel. N. Y. C.—Digby 9-3720)
N. Y. C. & New England Fld. Sales Rep.: Charles R. Weber, Philadelphia office TR

PAPESCH & KOLSTAD, INC.
P. O. Box 3726, 10703 Capital Ave., Oak Park 37, Mich. (Tel. LIncoln 7-6400)
V. P.-Purch.: M. R. Popesch MF, WN, PS, GS, TS

PARAGON ELECTRIC CO.
1600 12th St., Two Rivers, Wisc. (Tel. 303) 6-3636)
Purch. Agent: W. A. Carpenter
Sales Mgr.: F. D. Strattan

PARAGON-REVOLUTE CORP.
77 South Ave., Rochester 4, N. Y. (Tel. BAker 5-2480)
Purch. Agent: W. T. Nurse
Asst. Purch. Agent: Helen Schaefer
Sales Mgr.: B. W. Johnson

PARAMETERS, INC.
195 Herricks Rd., New Hyde Park, N. Y. (Tel. Pioneer 6-0155)
Sales Mgr.: John R. Crawford MF, PS, GS, GE, TS

PARAMOUNT DESIGNS CO.
408 Jay St., Brooklyn 1, N. Y. (Tel. UL 5-6161)
Dir.-Tech. Services: Bert K. Graham
Supvr.-Field Services: S. Davidowitz
Sales Mgr.: William Varley (Tel. DVerbrook 1-1700)
GS, GE, TR, R&D

PARAMOUNT PAPER TUBE CORP.
614 S. Lafayette St., Ft. Wayne 2, Ind. (Tel. A-4197)
Gen. Mgr.: R. R. Weimer MF, PS

PARAPLEGICS MFG. CO., INC.
10066 Franklin Ave., Franklin Park, Ill. (Tel. GLadstone 5-1697)
Purch. Agent: Alvin F. Engel
Dir.-Sales: Harry G. Bendtsen GS, CO

PARISH PRESSED STEEL, DIV.-DANA CORP.
Box 1422, Robeson & Weiser Sts., Reading, Pa. (Tel. FRanklin 3-4211)
Dir.-Purch.: E. R. Kohl
Purch. Agent: W. H. Fahnestock
Buyers: C. R. Kline & E. Hartman
Sales Mgr.: S. L. Whitehall MF, WN, PS, GS, GH

PARK NAMEPLATE CO., INC.
34-10 Linden Pl., Flushing 54, N. Y. (Tel. FLushing 9-7000)
Purch. Agent: Charles Birnbach
V. P.-Sales: David Kend MM

PARKER AIRCRAFT CO.
5827 W. Century Blvd., Los Angeles 45, Calif. (Tel. SP 6-1221)
Purch. Agent, Hydraulic Div.: E. Hillock
Purch. Agent, Air & Gas Div.: W. Parker
Purch. Agent, Missile Fittings Div.: T. Janes
V. P.-Sales: A. V. Zukas GS, GH, MM, R&D

PARKER FITTINGS & HOSE DIV., PARKER-HANNIFIN CORP.
17325 Euclid Ave., Cleveland 12, Ohio (Tel. KE 1-3000)
Purch. Agent: F. A. Jenkins
Gen. Sales Mgr.: D. A. Cameron
Div. Sales Mgr.: W. D. Wynant PS, GS, GH

PARKER HYDRAULICS DIV., PARKER-HANNIFIN CORP.
17325 Euclid Ave., Cleveland 12, Ohio (KE 1-3000)
Purch. Agent: E. J. Anderson
Gen. Sales Mgr.: D. A. Cameron
Div. Sales Mgr.: E. C. Davis GS, GH

PARKER SEAL CO., DIV.-PARKER-HANNIFIN CORP.
10567 Jefferson Blvd., Culver City, Calif. (Tel. VErmont 9-1161)
Purch. Agent: Paul Glasford
V. P.-Sales: T. J. McCuistion
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&D

PARKER-HARTFORD CORP., THE
Franklin Ave., Hartford, Conn. (Tel. CHapel 6-1651)
V. P.-Purch.: Tom Daly
Sales Mgr.: Wesson Miller GE, TR

RALPH M. PARSONS CO., THE, ELECTRONICS DIV.
151 S. De Lacey Ave., Pasadena, Calif. (Tel. Los Angeles—RYan 1-0461)
Mgr.-Proc.: Daniel M. Ogden
Mgr.-Bus. Dev.: Edson C. Lee GS, CO, TS, TR

PARSONS DIAMOND PRODUCTS, INC.
22 Grassmore Ave., West Hartford 10, Conn. (Tel. ADams 6-2303)

PARTS ENGRG. CO., INC.
760 N. Marshall Ave., El Cajon, Calif. (Tel. HIckory 4-9481)
Purch. Agent: Charles W. Sandlin
Dir.-Sales: James J. Kinsella MF, PS, GH, R&D

PATTERSON, MOOS DIV.-UNIVERSAL WINDING CO., INC.
90-28 Van Wyck Expressway, Jamaica 18, N. Y. (Tel. AXtel 7-4400)
Purch. Agent: Howard L. Abeel
V. P.-Sales: Dr. Anthony M. Moos
WN, PS, GS, GH, GE, CO, TS, TR, R&D

PATWIN, DIV.-PATENT BUTTON CO.
41 Brown St., Waterbury 20, Conn. (Tel. PLaza

F. H. PAUL & STEIN BROTHERS, INC.
235 5th Ave., New York 16, N. Y. (Tel. MU 4-6370)

PAUL & BEEKMAN, INC.
1801 Courtland St., Philadelphia 40, Pa. (Tel. DAvenport 9-9050)
Works Mgr.: David R. Barnhart
V. P.-Sales: J. E. Schmidt
MF, WN, PS, GS, GH, GS, TS,

HOWARD E. PAYNE
56 Beaverbrook Dr., Dayton 32, Ohio (Tel. CHapel 4-5600)
Consultant & Representative

PEARSON ELECTRONICS, INC.
707 Urbon Lane, Palo Alto, Calif. (Tel. DA 5-3147
Pres.: Dr. Paul A. Pearson

PECK & HARVEY MFG. CORP.
5650 N. Western Ave., Chicago 45, Ill. (Tel. EDgewater 4-2200)
Purch. Agent: Burt Kemp
Sales Mgr.: S. A. Harvey R&

PEE CEE TAPE & LABEL CO.
521 N. La Brea Ave., Los Angeles 36, Calif. (Tel. WEbster 8-2134)
Purch. Agent: C. W. Richardson
Gen. Mgr.: Sydney Gevirtz
Sales Mgr.: Don Gevirtz

PEER, INC.
1220 Milton St., Benton Harbor, Mich. (Tel. WAlnut 5-8828)
Mgr.: Alton B. Parrott

PEERLESS ELECTRIC CO., THE
1401 W. Market St., Warren, Ohio (Tel. EXpress 3-1551)
Purch. Agent: R. C. Isler
Mgr., Fan & Blower Div.: Walter A. Curtis

PEERLESS ELECTRONICS INC.
5338 Alhambra Ave., Los Angeles 32, Calif. (Tel. CApitol 1-5196)
Sales: Robert Monroe
Purch. Agent: E. N. Hough GS, GH, GE, R&

PEERLESS MACHINE CO.
5338 Alhambra Ave., Los Angeles 32, Calif. (CApitol 1-5196)
Office Mgr.: E. N. Hough
Sales Mgr.: E. A. Pierson M

PEERLESS PATTERN WORKS
29 Clinton Ave., Middletown, Conn.
Alfred P. Schultze

PEERLESS PHOTO PRODUCTS INC.
Tesla Rd., Shoreham, N. Y. (Tel. 4-2817)
Purch. Agent: Pat Hajek
Sales: Arthur Taber G

PEERLESS PRODUCTS INDUSTRIES
812 N. Pulaski Rd., Chicago 51, Ill. (Tel. BElmont 5-9883)
Buyer: Walt Griffing
Sales Mgr.: V. Mathews MF, WN, PS, GS, GE, T

PEERLESS PUMP DIV., FOOD MACHINERY & CHEMICAL CORP.
301 West Ave. 26, Los Angeles 31, Calif. (Tel. CApitol 1-3151)
Purch. Agent: W. I. Nye
Sales Mgr.: E. W. Lundy PS, GS, GH, T

PEIRCE DICTATION SYSTEMS
5900 N. Northwest Hwy., Chicago 31, Ill. (Tel. RDdney 3-3220)
V. P.-Purch.: Emil C. Steinbach
Purch. Agent: Stanley L. Domin R&

PENBERTHY MFG. CO.
1242 Holden St., Detroit 2, Mich. (Tel. TRinity 5-0900)
Sales Mgr.: A. N. Lindeman GS, GH, C

PENETONE CO., THE
Tenafly, N. J. (Tel. LDwell 7-3000)
Gen. Mgr.: H. R. Haskell
Purch. Agent: C. Goldberg
Dir.-Sales: H. E. Roberts WN, PS, GS, G

PENFIELD MFG. CO., INC.
19 High School Ave., Meriden, Conn. (Tel. BE 5-1694)
Gen. Mgr.: Edward H. Clohessy

PENN FIBRE & SPECIALTY CO., INC.
2024 El Westmoreland St., Philadelphia 34, Pa. (Tel. REgent 9-5642)
V. P.-Sales: William K. Davis
Purch. Agent: William H. Frey
Asst. Purch. Agent: J. P. Dwyer, Jr.
MF, WN, PS, GE, T

ENN KEYSTONE CORP.
100 Hawkins St., P. D. Box 350, Derby, Conn. (Tel. REgent 4-3301)
Purch. Agent: Robert A. Nagel
Dir.-Engrg. & Sales: Rallin D. Vanderbeek
WN, GS, CO, R&D

ENN-MICHIGAN MFG. CORP.
220 S. Kirk St., West Lafayette, Dhio (Tel. Lincoln 5-6311)
Purch. Agent: L. F. Hawbert
Asst. Purch. Agent: William Lilja
Sales Mgr.: J. S. Hall MM

ENNSALT CHEMICALS CORP.
3 Penn Center, Philadelphia 2, Pa. (Tel. LDcust 4-4700)
Mgr., Commercial Dev. Dept.: R. W. Sloan
PS, MM, R&D

ENNSYLVANIA PUMP & COMPRESSOR CO.
Easton, Pa. (Tel. 3-4276)
Purch. Agent: R. Beadell
Sales Mgr.: W. E. Anderson GS, GH

ENN-TRAN CORP.
E. Bishop St., Ext., Bellefonte, Pa. (Tel. ELgin 5-4747)
Purch. Agent: E. E. Grine
Secy.-Treas.: N. H. Krauss

ENTA LABS., INC.
312 N. Nopal St., Santa Barbara, Calif. (Tel. WDadland 5-4581)
Purch. Agent: J. D. Thwing
Sales Mgr.: R. L. Norton GS, CO, TS, R&D

ERFECTION INDUSTRIES, DIV.-HUPP CORP.
1135 Ivanhae Rd., Cleveland 10, D. (Tel. ULster 1-6200)
Purch. Agent: J. S. Zarn
V. P., Mobile Products: F. W. Hattenrath
Mgr., Specialty Sales, Mobile Products: W. E. Hamilton
Mgr., Heater Sales, Mobile Products: H. C. Gerbath
Buyers: D. Fetzer & H. H. Haldemon GS, GH, R&D

ERFECTO CAST
5660 Kearney Villa Rd., San Diego 11, Calif. (Tel. BRowning 7-6711)
Plant Mgr.: Ralph F. Carlson
Pres.: George Wilson MM, R&D

ERFORMANCE MEASUREMENTS CO.
5301 W. McNichols Rd., Detroit 35, Mich. (Tel. VErmont 8-7879)
Purch. Agent: Harry Edwards
Sales Mgr.: Louis H. Larime CO, TS

ERKIN ENGRG. CORP.
745 Kansas St., El Segunda, Calif. (Tel. DR 8-7215)
Purch. Agent: Pat Cerello
Sales Mgr.: George W. Mousel GS, CO, TS, TR, R&D

ERKIN-ELMER CORP.
Main Ave., Norwalk, Conn. (Tel. VIctor 7-2422)
Dir.-Purch.: Patrick D'Garman
Asst. Purch. Agent: George Hodge
Electronic Buyer: Arthur Cummings
Buyers: William Dauda, David Fournier, Lew Jason
Sales-Electro-Optical Div.: C. B. Hazzard
Sales-Instrument Div.: John H. Rhodes
Sales-Vernistat Div.: Eugene W. Dunstan
GS, CO, TS, TR

ERKINS MACHINE & GEAR CO.
Circuit Ave., West Springfield, Mass. (Tel. REpublic 7-4751)
Sales Mgr.: Philip O'Shon GS, GE

ERMACEL
U. S. Hwy. #1, New Brunswick, N. J. (Tel. CHarter 7-7900)
Purch. Agent: J. S. Babiy
Buyers: J. E. Graver & G. Radcliffe
V. P.-Sales: G. A. Fitzgerald

ERMANENT FILTER CORP.
800 W. Washington Blvd., Los Angeles 7, Calif. (Tel. REpublic 1-7381)
Chief Purch. Agent: Gardner Reynolds
Sales Mgr.: Charles Schaefer PS, GS, GH, GE, TS

ERMATEX CO., INC.
300 Broadway, Huntington Sta., N. Y. (Tel. HAmilton 1-3800)
Purch. Agent: K. Carpenter, Jr.
Sales Mgr., Indsl. Div.: Frank P. Reggio GS, MM

ERMAX PRODUCTS DIV., CHISHOLM-RYDER CO., INC.
Highland & College Ave., Niagara Falls, N. Y. (Tel. BUtler 5-9186)
Dir.-Purch.: Larry Fischer
Mgr.-Permax Div.: B. B. Mitchell

ERMDFLUX PRODUCTS CO.
8101 San Fernando Rd., Glendale 4, Calif. (Tel. CHapman 55-135)
Purch. Agent: S. H. Ise
Dir.-Sales: L. M. Heineman
GS, GH, GE, CO, TS, TR

PERRY PLASTICS, INC.
3409 W. 14th St., Erie, Pa. (Tel. 6-2961)
Purch. Agent: Harold K. Siegmund
Dir.-Sales & Defense Contract Dfficer: Lincoln S. Love

PESCHEL ELECTRDNICS, INC.
R.F.D. 1, Patterson, N. Y. (Tel. TRinity 8-3251)
Pres.: Stephen S. Peschel GS, GE, CO, TS, TR

PESCO PRODUCTS DIV.-BORG-WARNER CORP.
24700 N. Miles Rd., Bedford, Dhia (Tel. MOntrose 2-2100)
Mgr.-Purch.: H. L. Sanders
Purch. Agent, Non-Prod.: G. T. Weidinger
Purch. Agent, Prod.: W. C. Erwin
V. P.-Sales: M. W. Nesbitt PS, GS, GE, R&D

PETTIBDNE MULLIKEN CORP.
4700 W. Divisian St., Chicago, Ill. (Tel. SPaulding 2-9300)
Purch. Agent: T. M. Covender
Asst. Purch. Agent: H. T. Samuels
Steel Buyer: C. R. Slacum
Fabricated Parts Buyers: L. Knapp, A. J. Salman, W. C. Hinz
Sales: J. M. Hume MF, WN, GS

PHALD PLASTICS CORP.
530 Bastan Tpke., Shrewsbury, Mass. (Tel. VIking 4-4021)
Purch. Agent: H. A. Werme
V. P.-Sales: A. N. Averill

PHAOSTRON INSTRUMENT & ELECTRDNIC CO.
151 Pasadena Ave., S. Pasadena, Calif. (Tel. CLinton 5-1471)
Purch. Agent: Al Lowenstein
V. P.-Sales: H. J. Veitch
WN, PS, GS, GE, CO, TS, TR

PHELPS DODGE CDPPER PRDDUCTS CDRP.
300 Park Ave., New York, N. Y. (Tel. PLaza 1-3200)
Purch. Agent: P. G. Lee
Mgr.-Styroflex Coble Div.-Sales: F. W. Lemly
GS, GH, CO, TS

PHILADELPHIA GEAR WDRKS, INC.
Erie Ave. & G St., Philadelphia, Pa. (Tel. GA 6-9400)
Purch. Agent: Mr. Marts
Sales Mgr.: Howard Murray PS, GS

PHILADELPHIA INSULATED WIRE CD.
200 N. 3rd St., Philadelphia 6, Pa. (Tel. MArket 7-0456)
Purch. Agent: E. B. Sheridan, Sr.
Sales Mgr.: Robert W. Campbell
GE, CD, TS, TR, MM, R&D

GEDRGE A. PHILBRICK RESEARCHES, INC.
285 Columbus Ave., Bastan 16, Mass. (Tel. CD 6-5375)
Gen. Mgr.: John F. Dawd
Sales & Appl. Engrg.: Daniel H. Sheingald R&D

PHILCO CORP., GOVERNMENT & INDUSTRIAL DIV.
4700 Wissahickan Ave., Philadelphia 44, Pa. (Tel. VIctar 3-4000)
Purch. Mgr.: John R. McAllister
Mktg. Mgr.-Govt. Prods.: Frank D. Langstroth
GS, GH, GE, CO, TS, TR, R&D

PHILCO CORP., LANSDALE TUBE CO. DIV.
Church Rd., Lansdale, Pa. (Tel. ULysses 5-4681)
Purch. Agent: A. G. McIlvaine
Buyers: Alan Daytan, W. R. Lewis, R. Haughs, E. C. Lutz, B. Carroll, C. Cressman
Asst. Buyer: Mary Barthalemew
Gen. Sales Mgr.: Cyrus H. Warshaw R&D

PHILIPS & DAVIES INC.
1030 Steiner Ave., Kentan, O. (Tel. 2-1120)
Purch. Agent: G. R. Leaffert
V. P.-Sales: J. W. Stuckey MF, WN, GS, GH, TS

PHILLIPS AVIATION CO.-MARPLES GEARS
1525 Manterey Rd., S. Pasadena, Calif. (Tel. RYan 1-1181)
Dir.-Purch.: George Bentz
Dir.-Sales: H. David McRae GS, GH, GE

PHDENIX PRODUCTS CO.
4715 N. 27th St., Milwaukee, Wis. (Tel. UP 1-1680)
Purch. Agent: H. W. Heard
Asst. Mgr., Metal Spinning Div.: Edwin Weiss
MF, WN, PS, GS, GE

PHOTOBELL CD., INC.
43 Vesey St., New York 7, N. Y. (Tel. WOrth 2-6739)
Purch. Agent: S. Faber
Gen. Mgr.: A. Edelman MF, GH, GE, CO, TS, TR

PHOTOCDN RESEARCH PRDDUCTS
421 N. Altadena Dr., Pasadena, Calif. (Tel. SYcamore 2-4131)
Purch. Agent: Jean Hicks (Tel. RYan 1-6752)
Dir.-Sales: P. C. Ganzell CD, R&D

PHOTO-CRYSTALS, INC.
15 S. First St., Geneva, Ill. (Tel. GEneva 7150)
Purch. Agent: W. A. Bailey
Secy.-Treas.: J. J. Bailey TS, R&D

PHOTDGRAMMETRY, INC.
922 Burlington Dr., Silver Spring, Md. (Tel. JUniper 5-4600)
Purch. Agent: H. B. Miracle R&D

PHDTDMATIDN, INC.
96 S. Washington Ave., Bergenfield, N. J. (Tel. DUmont 4-3411)
Dir.-Purch.: H. Sarube

PHOTOVDLT CORP.
95 Madisan Ave., New York 16, N. Y. (Tel. MUrray Hill 6-3350)
Purch. Agent: H. W. Lindemann
V. P.-Sales: B. A. Silard CD, TS, R&D

PHOTRON INSTRUMENT CD.
6516 Detroit Ave., Cleveland 2, D. (Tel. ATlantic 1-7020)
Sales: N. H. Fayerweather TS

PHYSICS RESEARCH LABDRATDRIES, INC.
P. D. Box 555, Hempstead, N. Y. (Tel. IVanhae 3-8299)
Tech. Dir.: J. B. Kelley
Mgr.: J. G. Gaward TS, R&D

PIASECKI AIRCRAFT CORP.
Island Rd., International Airpart, Philadelphia 42, Pa. (Tel. SAratoga 7-9750)
Acting Purch. Agent: William M. Collins
Treas.: J. J. Hensel
Pres.-Sales: F. N. Piasecki
MF, WN, GS, GH, R&D

PICKER X-RAY CORP.
25 S. Broadway, White Plains, N. Y. (WH 8-0080)
TS, R&D

PICKERING & CO., INC.
Sunnyside Blvd., Plainview, L. I., N. Y. (Tel. OVerbrook 1-0200)
Purch.: Richard Neuffer GS, GE, CD

PIEZD CRYSTAL CD.
265 E. Pamfret St., Carlisle, Pa. (Tel. 1495)
Dir.-Purch. & Sales: Herman Shall
V. P.: Wallace Samuelsan GE, TR

PILGRIM PRODUCTS INC.
277 Central St., West Acton, Mass. (Tel. Actan, CDlanial 3-7368)
Purch. Agent: Marie E. Haughtan
Gen. Mgr.: L. P. Wilder MM

PILDT CHEMICALS, INC.
36 Pleasant St., Watertown 72, Mass. (Tel. WAtertown 4-7775)
Business Mgr.: M. A. Sigal MM, R&D

PINES ENGRG. CO. INC.
601 Walnut St., Aurara, Ill. (Tel. TW 6-7701)
Purch. Agent: W. J. Carlson
Asst. Purch. Agent: J. J. McKeoige
Sales Mgr.: J. E. Hawking

PIONEER ALUMINUM INC.
5251 W. Imperial Hwy., Los Angeles 45, Calif. (Tel. DRegan 8-7621)
Purch. Agent: K. R. Cannan
V. P.-Sales: Vern Ammerman MF, PS, GH

PIONEER INDUSTRIES DIV., ALMAR-YDRK CD. INC.
3455 W. Vickery, Fart Warth 7, Tex. (Tel. ED 2-7387)
Pres.: A. W. Stubbeman, Sr.
V. P.-Sales: Frank B. Self TS, MM, R&D

PIONEER PARACHUTE CO., INC.
168 Farrest St., Manchester, Cann. (Tel. Mitchell 9-5211)
Pres.: Lyman H. Ford

PIONEER TOOL & ENGRG. CO.
7401 W. Lawrence Ave., Chicago 31, Ill. (Tel. UNderhill 7-7500)

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

Purch. Agent: Harry Kaminski
Sales Engr.: M. W. Punch WN, GS, GE, CO, TS

PITTSBURGH CORNING CORP.
1 Gateway Center, Pittsburgh 22, Pa. (Tel. COurt 1-2900)
V. P.-Sales: R. E. Buckley
Purch. Agent: B. B. Caffo, P. O. Box 39, Port Allegany, Pa. (Tel. Port Allegany 2-2552)
Purch. Agent: G. E. Gibbs, P. O. Box 72, Sedalia, Mo. (Tel. TAylor 6-4660) MM, R&O

PITTSBURGH-DES MOINES STEEL CO.
3476 Neville Island, Pittsburgh 25, Pa. (Tel. FE 1-3000)
Purch. Agent: G. L. Bader
V. P. & Sales Mgr.: T. W. Fauntleroy GS, GH, TS, R&D

PLASTECK, INC.
P. O. Box 551, Poteau, Okla. (Tel. 705)
Purch. Agent: J. Roy Farley
Pres.: E. A. Neugass MM

PLASTIC AGE SALES, INC.
14300 Davenport Rd., Saugus, Calif. (Tel. NEwhall 1530)
Purch. Agent: Adolf Kramer
Sales Engrg. Coordinator: Edward M. Commeford MF, WN, PS, MM, R&O

PLASTIC FILM CO., INC.
Plainfield, Conn. (Tel. Moosup, Conn., LOgan 4-2741)
Controller: George E. Hagert
V. P.-Mgr., Indsl. Sales: T. A. Lancaster

PLASTOID CORP.
42-61 24th St., Long Island City 1, N. Y. (Tel. STillwell 6-6200)
Purch. Agent: Ernest Brown
Asst. Purch. Agent: Abe Rosenberg
Sales-Serv. Mgr.: Don J. Nichols, Hamburg, N. J. (Tel. Van Dyck 7-7141) MF, PS, GS, GH, CO, TS, TR

PNEU-HYDRO VALVE CORP.
364 Glenwood Ave., East Orange, N. J. (Tel. ORange 7-1200)
Purch. Agent: Robert Demmert
Pres.: George T. Stern WN, PS, GS, GH, GE, CO, TS

PNEUMAFIL CORP.
2516 Wilkinson Blvd., Charlotte, N. C. (Tel. EXpress 9-7441)
Purch. Agent: Thomas H. Lasley
Mechtranics Sales Mgr.: J. B. Deyton, Jr.
V. P.-Sales: J. Walter Barr MM, R&D

JOSEPH E. POOGER CO., INC.
16 S. Marshall St., Philadelphia 6, Pa. (Tel. WAlnut 5-7878)
Sales Mgr.: Willard A. Lees

POLARAD ELECTRONICS CORP.
43-20 34th St., Long Island City 1, N. Y. (Tel. EXeter 2-4500)
Dir.-Purch.: L. Lieberman
Buyers: Jack Marks, B. Flax, I. Wasserman & D. Rosenbloom
Sales Mgr.: A. A. Goldberg CO, TS, TR, R&O

POLAROID CORP.
119 Windsor St., Cambridge 39, Mass. (Tel. UNiversity 4-6000)
Dir.-Purch.: P. E. Sullivan
Asst. Dir.-Purch.: H. R. Pickering
Purch. Engr.: G. W. Bramhall
Sales Mgr., Polarizer Div.: J. H. Mulhall

JOSEPH POLLAK CORP.
85 Freeport St., Boston 25, Mass. (Tel. AVenue 2-9550)
V. P.-Purch.: Henry Brandt
Purch. Agent: James Burns
Sales Mgr.: H. A. MacDonald R&O

POLYKEN SALES DIV., THE KENDALL CO.
309 W. Jackson Blvd., Chicago, Ill. (Tel. WEbster 9-7100)
Dir.-Purch.: J. F. Karl
Gen. Sales Mgr.: W. J. Hodges MM

POLYMER CORP., THE
2120 Fairmont Ave., Reading, Pa. (Tel. FRanklin 6-7241)
Purch. Agent: Alvin S. Mallatratt
Sales Mgr.: Robert E. Barthold MF, WN, PS, GS, GE, TR, MM

POLYPHASE INSTRUMENT CO.
E. 4th St., Bridgeport, Montgomery Co., Pa. (Tel. BRoadway 9-4660)
Purch. Agent: D. C. Morris
Sales Mgr.: D. J. Seifert GE, CO, TS

POLY-SCIENTIFIC CORP.
College Ave., Blacksburg, Va. (Tel. PR 2-8212)
Purch. Agent: Herbert H. Albert
V. P.-Sales: A. S. Hackley GE, R&O

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.
202 Tillary St., Brooklyn 1, N. Y. (Tel. ULster 2-6800)
Dir.-Purch.: Walter A. Cuskie
Electronic Buyers: Frank H. Roberts & James J. Alfieri
Subcontract Buyers: Alphonse Pristupa & A. C. Heldman
Misc. Buyer: John La Scala
Expediters: Walter Ezoch & Frank Sidoti
Sales Mgr.: Harry C. Nelson TS

POMONA ELECTRONICS CO., INC.
1126 W. 5th Ave., Pomona, Calif. (Tel. NAtional 9-9549)
Purch. & Sales Mgr.: Carl Wm. Musarra GE, R&D

POROLOY EQUIPMENT, INC.
14943 Califa St., Van Nuys, Calif. (Tel. STate 6-2670)
Purch. Agent: D. S. Draves
Dir.-Sales & Engrg.: W. N. Caldwell PS, GS, GH

PORTCHESTER INSTRUMENT CORP.
114 Wilkins Ave., Port Chester, N. Y. (Tel. WEstmore 9-4092)
Buyer: Mrs. Frances B. O'Brien
Pres.: Irving M. Gross GE

H. K. PORTER CO., INC.
74 Foley, Somerville 43, Mass. (Tel. PRospect 6-8200)
Purch. Agent: W. E. Coffey
V. P.-Sales: H. M. Webster MF, WN, PS, GS, TS

H. K. PORTER CO., INC., FORGE & FITTINGS DIV., CLEVELAND FORGE WORKS
3270 E. 79th St., Clevelond 4, Ohio (Tel. MI 1-5200)
Purch. Agent: P. A. Heideman
Sales Mgr.: E. M. Smith GS, GH

H. K. PORTER CO., INC., NATIONAL ELECTRIC DIV.
Porter Bldg., Pittsburgh, Pa. (Tel. EXpress 1-1800)
Purch. Agent: George L. Dovis
Gen. Mgr.: R. C. Bennett, Jr.

H. K. PORTER CO., INC., THERMOID DIV.
Tacony & Comly Sts., Philadelphia 24, Pa. (Tel. JEffersan 3-4800)
Dir.-Purch.: T. J. Gorman
Gen. Sales Mgr.: E. G. Counselman PS, GS

PORTLAND COPPER & TANK WORKS INC.
80 2nd St., S. Portland, Me. (Tel. SPruce 9-3341)
Purch. Agent: Willard Jones
Buyer-Special Prods. Div.: John Curran
Sales Mgr.: Harry Higgins MF, WN, PS, GS, GH, R&D

POSITIVE LOCK WASHER CO., THE
181 Vanderpool St., Newark 5, N. J. (Tel. Bigelow 3-8460)
Gen. Mgr.: Fred J. Goll

L. POTTER, INC.
4040 Hempstead Tpke., Bethpage, N. Y. (Tel. PE 5-7000)
Asst. Treas.: O. P. Dieffenbach
Secy.: John Potter GH

POTTER AERONAUTICAL CORP.
U. S. Rt. 22, Union, N. J. (Tel. MUrdock 6-3010)
Purch. Agent: Harry Carlson
Gen. Sales Mgr.: Irving Hirsch PS, GS, CO, TS

POTTER & BRUMFIELD INC.
Princeton, Ind. (Tel. FUlton 5-5251)
Purch. Agent: Charles Schrader
Asst. Purch. Agent: Everett Cox
Gen. Sales Mgr.: Nelson Havill GE

POTTER CO., THE
1950 Sheridan Rd., N. Chicago, Ill. (Tel. DExter 6-4350)
Dir.-Purch.: Richard Glogovsky
Sales Mgr.: William L. Miller PS, GS, GE, TR

POTTER INSTRUMENTS CO., INC.
Cutter Mill Rd. at Ipswich, Great Neck, N. Y.

HAROLD H. POWELL CO.
2102 Market St., Philadelphia 3, Pa. (Tel. LOcust 7-5285)
Purch. Agent: Joseph Harris
V. P.: J. Lewis Powell PS, GS, GE, CO, TS, TR

POWER DESIGNS INC.
89-25 130th St., Richmond Hill, N. Y. (Tel. VIrginia 9-3675)
Purch. Agent: Irwin Wald
Chief Engr.: Milton Geller
Pres.: Herb Roth TS, TR

POWER SOURCES, INC.
South Ave., Burlington, Mass. (Tel. BRowning 2-3000)
Buyer: Bob Stetson
Sales Mgr.: Jon B. Jolly GS, GE, T

POWER SUPPLIES INC.
Rt. 143, P. O. Box 169, Highland, Ill. (Tel. 2139)
Purch. Agent: Dale Rutz
Sales Mgr.: Dorsey Roejr GS, C

POWERS REGULATOR CO., THE
3400 Oakton St., Skokie 66, Ill. (Tel. OR 3-6700)
Purch. Agent: R. C. Guhr
Asst. Purch. Agents: R. Bennett & V. Wiland

POWER-TRONIC SYSTEMS INC.
10 Pine Ct., New Rochelle, N. Y. (Tel. NE 2-2200)
Purch. Agent: J. Tranos
V. P.-Sales: Edmund D. Holland GE, TR, R&

PRATT & WHITNEY AIRCRAFT DIV., UNITED AIRCRAFT CORP.
400 Main St., East Hartford 8, Conn.

PRECISE DEVELOPMENT CORP.
2 Neil Ct., Oceanside, N. Y. (Tel. Rockville Centre 6-0171)
Dir.-Sales: Melville Byron
Dir.-Purch.: Charles Rollings GS, GE, CO, T

PRECISION APPARATUS CO., INC.
70-31 84th St., Glendale 27, L. I., N. Y. (Tel. DAvenport 6-3982)
Dir.-Purch.: A. S. Weingast
Sales Mgr.: S. S. Sparer

PRECISION CASTINGS, INC.
1550 Superior Ave., Costa Mesa, Calif. (Tel. LIberty 8-2278)
V. P.-Prod.: Charles R. Salmon
Dir.-Sales: John J. Hall MF, GH, MI

PRECISION CASTPARTS CORP.
4600 S. E. Harney Dr., Portland 6, Ore. (Tel. PRospect 5-4391)
Admin. Asst. for Purch.: Miss E. G. Graham
V. P. & Sales Mgr.: K. H. Pierce MM, R&

PRECISION CIRCUITS, INC.
705 S. Fulton Ave., Mt. Vernon, N. Y. (Tel. MOunt Vernon 4-3737)
V. P.-Purch.: Herbert L. Schwartz
Dir.-Sales: Charles Sabel GS, GE, CO, TS, TR, R&I

PRECISION ELECTROPLATING CO.
519 S. Oakley Blvd., Chicago 12, Ill. (Tel. SEeley 3-5855)
Dir.-Purch.: James Zacharias
Dir.-Sales: Richard Zacharias MF, WN, P

PRECISION EQUIPMENT CO., INC.
1740 Crenshaw Blvd., Torrance, Calif. (Tel. NEvada 6-5701)
Production Coordinator: John Pavack
Pres.: Richard Gilman G

PRECISION, INC.
4748 France Ave. N., Minneapolis, Minn. (Tel. JU 8-9441)
Pres.: A. H. Benner
V. P.-Sales: D. G. Benner GE

PRECISION LINE INC.
63 Main St., Maynard, Mass. (Tel. TWin Oaks 7-2451)
Gen. Mgr.: L. M. Burgess
Sales Mgr.: Paul Hokanson MF, GS, GE, TS, TR, R&D

PRECISION METALSMITHS, INC.
1081 E. 200 St., Cleveland 17, Ohio (Tel. IVanhoe 1-8900)
Purch. Agent: E. K. Hutchinson
Sales Mgr.: W. W. Lamb GE

PRECISION METHODS & MACHINES DIV.-TEXTRON INC.
Cumberland Dr., Waterbury 20, Conn. (Tel. PLaza 6-3651)
Dir.-Purch.: Edward Jankowski
Buyers-Proj. Engrg.: Thomas Kepinski & Ross Upton
Sales Engr.: K. T. Starkweather GS, GH

PRECISION PLATING CO., INC., THE
Field Rd., Somers, Conn. (Tel. THompsonville, RI 9-8337)
Pres.: Theodore M. Bauer
Office Mgr.: Richard H. Bauer PS, GE, R&D

PRECISION RESISTOR CO. INC.
109 U. S. Hwy. No. 22, Hillside, N. J. (Tel. Bigelow 3-3809)
L. E. Wright, Jr. GE, TR

PRECISION SHAPES, INC.
15 Washington Ave., Suffern, N. Y. (Tel. SUffern 5-0226)
Procurement Mgr.: Ronald Lockyer
Sales Mgr.: Norman M. Oickson MF, MM

RECISION SHEET METAL, INC.
5235 W. 104th St., Los Angeles 45, Calif. (Tel. SPring 6-2620)
Sales Mgr.: Frank Csupak
Materiel Mgr.: Russ Manning MF, GS, GH, R&D

RECISION THERMOMETER & INSTRUMENT CO.
1434 Brandywine St., Philadelphia 30, Pa. (Tel. RIttenhouse 6-6671)
Purch. Agent: I. H. Shubin
Sales Mgr.: Carl H. Waser

RECISION TUBE CO., INC.
Church Rd. & Wissahickon Ave., North Wales, Pa. (Tel. OXbow 9-4806)
Purch. Agent: Otto Chvoka
V. P.-Sales: Matthew F. Balch, Jr. MF, PS, GS, GH, CO, MM

RE-FLITE INDUSTRIES CORP.-SUB.-AVCO MFG. CORP.
16706 S. Garfield Ave., Paramount, Calif. (Tel. NEvada 6-0292)
Purch. Agent: Bruce Green
V. P.-Engrg. & Sales: A. J. Dillon, Jr. GS, GH, TS

P. PREIS ENGRAVING MACHINE CO.
651 U. S. Highway 22, Hillside 5, N. J. (Tel. MU 6-7736)
Purch.: M. H. Preis
Prod. Mgr.: J. A. Hoffmann GS

REMIER METAL PRODUCTS CO.
337 Manida St., New York 59, N. Y. (Tel. WYandotte 1-6600)
V. P.-Purch.: Mayer Faynberg
Sales Mgr.: E. Kossoy MF, GS, GH, GE, TR

REMIER RESEARCH LABORATORIES, INC.
79-85 7th Ave., New York 11, N. Y. (Tel. ALgonquin 5-0700)
Purch. Agent: W. J. Gutman
Sales Mgr.: M. H. Proelsdorfer GS, GE, TR

REREG MFG. INC.
11 Market St., Stamford, Conn. (Tel. DA 5-1301)
Pres.: John Stambaugh

RESSED STEEL TANK CO.
1445 S. 66th St., Milwaukee 14, Wisc. (Tel. GReenfield 6-0500)
Purch. Agent: R. E. Holmes
Mgr.-Industrial Prods. Div.: T. V. Montgomery MF, WN, PS, GS, R&D

RESSTITE DIV., AMERICAN-MARIETTA
39th & Chouteau, St. Louis 10, Mo. (Tel. MOhawk 4-6000)
Purch. Agent: G. C. Weston
Mgr., Indsl. Sales: R. H. Knight MM

REWITT AIRCRAFT CO.
Holly & Madison Aves., Clifton Heights, Pa. (Tel. MAdison 6-6500)
Purch. Agent: F. Edwin Davis
Engr.-Sales: David F. Thompson WN, GE, R&D

I W. PRICE CORP.
1161 W. Pico Blvd., Los Angeles 64, Calif. (Tel. GRanite 7-6791)
Dir.-Sales: Russ C. Bremmer MF, GS, GH

IICE ELECTRIC CORP.
E. Church & 2nd Sts., Frederick, Md. (Tel. MOnument 3-5141)
Purch. Agent: Robert H. Haines
Sales Mgr.: Don C. Leith GS, GE, CO, TR

IINTED ELECTRONICS CORP.
North Ave., Natick, Mass. (Tel. OLympic 5-0070)
Purch. Agent: Gilman N. Fernald
V. P.-Sales: Richard G. Zens

IINTRONICS CORP.
1127 El Camino Real, Palo Alto, Calif. (Tel. DA 6-7446)
Business Mgr.: Otto J. Feucht, Jr.
V. P.-Sales: Maury Russ GS, GE, CO, TS

JF. PRITCHARD & CO. OF CALIFORNIA, DIV.-J. F. PRITCHARD & CO.
1625 Roanoke Pkwy., Kansas City, Mo.
Gen. Sales Mgr.: W. R. Roeyer

JOBESCOPE CO. INC.
Sagamore Hill Dr., Port Washington, N. Y. (Tel. PO 7-8150) TS, TR, R&D

JOCESS & INSTRUMENTS
5 Stone Ave., Brooklyn 33, N. Y. (Tel. GLenmore 2-8380)
Dir.-Purch.: L. Peimer MF, PS, GS, CO, TS, R&D

JODELIN INC.
107 Bergen Ave., Kearny, N. J. (Tel. WYman 1-8600)
Purch.: G. D. Higgins & R. Munley
Purch. Agent: G. H. Higgins TR

JODUCT & INDUSTRIAL ENGRG. CORP.
1806 S. Four Mile Run Dr., Arlington 6, Va. (Tel. JAckson 4-6565)
V. P., Secy. & Treas.: C. J. Ritchie, Jr. R&D

PRODUCTION SERVICES CORP., THE
81 Market Sq., Newington 11, Conn. (Tel. MOhawk 6-3363)
Pres.: R. H. Whitney MF, WN, GS, GH, R&D

PRODUCTS RESEARCH CO.
3126 Los Feliz Blvd., Los Angeles 39, Calif. (Tel. NOrmandy 5-5951)
Materiel Mgr.: R. Brooks Parker
Sales Mgr., Aircraft, Missile & Allied Electrical Products: W. L. Smith MM, R&D

PROJECT FABRICATION CORP.
112-20 14th Ave., College Point 56, N. Y. (Tel. FLushing 9-2122)
Dir.-Purch.: T. R. Scandura
Dir.-Govt. Cust. Relations: Karl E. Heden GS

PROJECTS UNLIMITED INC.
1926 E. Siebenthaler Ave., Dayton 14, Ohio (Tel. CR 8-4244)
Pres.: D. S. Wyse
Asst.-Purch.: Bus Mason GS, CO, TS

***PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.**
Box 187, Edwardsville, Ill. (Tel. 3400)
Purch. Agent: S. J. Meister
Dir.-Customer Relations: A. M. Zollars MF, PS, R&D
*(See Page 81 for Advertisement)

PROSPECT SCREW MACHINE PRODUCTS
Rek Lane, Prospect, Conn. (Tel. Waterbury, Conn., PLaza 9-9460)
Owner: M. A. Pugliese PS, GE, CO, TR, R&D

PROTAIR CORP.
4086 Del Rey Ave., Venice, Calif. (Tel. EXmont 1-6241; TExas 0-4807)
V. P.-Purch.: John D. Goldson
Sales Mgr.: H. Lacock

PROTECTIVE COATINGS, INC.
Box 3985, Detroit 27, Mich. (Tel. VE 6-4664)
H. Tom Collord

PROTEX-A-COTE, INC.
161 Delancy St., Newark 5, N. J. (Tel. Mitchell 2-8292)
Pres.: Ira Zeitlin
V. P.-Sales: David R. Minkoff MM

PRY WELDING & MFG., INC.
Modena, Pa. (Tel. COatesville 2442)
Secy.-Treas.: Gilbert H. Pry GS, GH

PRYOR MARKING PRODUCTS
434 S. Wabash Ave., Chicago 5, Ill. (Tel. HA 7-0495)
Gen. Mgr.: D. J. Wilken GS

PSYCHOLOGICAL RESEARCH ASSOCIATES, INC.
(West Coast) 15537 Ventura Blvd., Encino, Calif. (Tel. STate 8-2700); (East Coast) 507 18th St., S., Arlington 2, Va. (Tel. OTis 4-6600)
West Coast Repres.: Harold E. Price
East Coast Repres.: James F. Parker R&D

PUBLIC INFORMATION PROGRAMS, INC.
6047 Hollywood Blvd., Hollywood 28, Calif. (Tel. HOllywood 2-7377)
Business Mgr.: James H. Flint
Gen. Mgr.: David R. Showalter

PULSE ENGRG. INC.
2657 Spring St., Redwood City, Calif. (Tel. EMerson 8-3331)
Purch. Agent: John Devine GE, TR

PURE CARBON CO. INC.
441 Hall Ave., St. Marys, Pa. (Tel. TE 4-1578)
Purch. Agent: H. W. McGeehin
V. P.-Sales & Engrg.: M. C. Burr MF, PS, GE, TS

PURITAN COMPRESSED GAS CORP., AVIATION DIV.
2012 Grand Ave., Konsas City 8, Mo. (Tel. HArrison 1-2122)
Aviation Sales Mgr.: F. C. Stebbins MF, PS, GS, GH

PUROLATOR PRODUCTS INC.
970 New Brunswick Ave., Rahway, N. J. (Tel. FUlton 8-4000)
Purch. Agent: John T. Gaffney
Gen. Sales Mgr.: R. T. Karr GS

PYLE-NATIONAL CO., THE
1334 N. Kostner Ave., Chicago 51, Ill. (Tel. DIckens 2-6300)
Purch. Agent: Carl Mackprang
Asst. Purch. Agents: Charles Skobel & William Sheridan
V. P.-Mktg.: E. M. Nesvig
Mgr.-Connector Div. (Missile Prod. Sales): J. Shearer GS

PYLES INDUSTRIES, INC.
20855 Telegraph Rd., Detroit 41, Mich. (Tel. KE 4-3820)
Purch. Agent: H. T. Gerald
V. P.-Sales: C. M. Singleton
Gen. Sales Mgr.: Clifford G. Davis GS

PYRAMID ELECTRIC CO.
507 26th St., Union City, N. J. (Tel. UNion 5-1776)
Distributor Sales Mgr.: J. Poff
Purch. Agent: Joseph Poitras, Orange St., Darlington, S. C. (Tel. Darlington 1983)
Indsl. Sales Mgr.: J. Starr (Tel. Darlington 1983)

PYROFILM RESISTOR CO., INC.
U. S. Highway 46, Parsippany, N. J. (Tel. DEerfield 4-8282)
Pres.: John M. Hinkle GE, TR

PYROMETER INSTRUMENT CO., INC.
92 Portland Ave., Bergenfield, N. J. (Tel. DUmont 4-5140)
Purch. Agent: J. Crystall
Sales: A. Bollerman TS

Q. O. S. CORP.
Bronx Blvd. at 216th St., New York 67, N. Y. (Tel. OLinville 4-3930)
Purch. Agent: Elliott Reiss GE, CO, TS, TR

Q. V. S. INC.
20 N. 15th St., E. Orange, N. J. (Tel. ORange 3-3996)
Pres.: M. E. Fogle

Q-CIRCUITS, DIV.-ETCHING CO. OF CALIF.
1208 Howard St., San Francisco 3, Calif. (Tel. MArket 1-7670)
Gen. Mgr.: Sterling Call
Dir.-Sales: Harry Scott GE, CO, TS, TR

QUAN-TECH LABS.
236 Mt. Kemble Ave., Box 505, Morristown, N. J. (Tel. JEfferson 8-6350)
Bus. Mgr.: Fred R. Stampfli
Sales Mgr.: Ronald C. Pittenger R&D

QUIETROLE CO.
395 St. John St., Spartanburg, S. C. (Tel. 8996)
Gen. Mgr.: Robert O. Monk
Dir.-Sales: Ralph M. Rouse MM

QUINCY COMPRESSOR CO.
217 Maine St., Quincy, Ill. (Tel. BA 2-7700)
Purch. Agent: Richard Busch
Sales Mgr.: Loren Gillhouse GS

QUTRONIC SEMI CONDUCTOR CORP.
525 Broadway, New York 12, N. Y. (Tel. WAlker 5-3424)
Purch. Agent: E. H. Loganoff
Engr.: M. S. Luck
V. P. & Plant Mgr.: Peter Toong MF, WN, PS, GE, TS, TR, R&D

QUTRONIC TRANSFORMER CORP.
525 Broadway, New York, N. Y. (Tel. WOrth 2-3639)
Dir.-Purch.: E. H. Loganoff
Purch. Agent: Angelo Lomascolo
Gen. Mgr.: Louis L. Weintraub MF, WN, PS, GS, GH, GE, CO, TS, TR, R&D

R. C. L. MFG. CO.
New Jersey Ave., Riverside, Burlington Co., N. J. (Tel. HObort 1-1003)
Pres.: Charles T. Gamble

R & R ENGRG. CO.
25 Fernwood Ave., New Castle, Del. (Tel. OLympia 6-0531)
Dir.-Purch.: Richard A. Weber
Dir.-Sales: Robert R. Gulick PS, GS, R&D

RS ELECTRONICS CORP.
435 Portage Ave., P. O. Box 368, Stotion A, Palo Alto, Calif. (Tel. DAvenport 3-1130)
Mgr.-Material: Frank C. Kerr TR, R&D

RACINE HYDRAULICS & MACHINERY INC.
2000 Albert St., Racine, Wisc. (Tel. MElrose 3-3561)
Purch. Agent: G. Fritchen
Sales Mgr. Cont. Sales: Robert Veraar

RADAR DESIGN CORP.
P. O. Box 38, Pickard Dr., Syracuse 11, N. Y. (Tel. GLenview 4-4418)
Pres.: Glyn Bostick

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Graund Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

RADAR RELAY, INC.
2322 Michigan Ave., Santa Monica, Calif. (Tel. EXbrook 4-2230; TExas 0-1S26)
Chief Engr.: Kurt W. Kuhn
Pres. & Gen. Mgr.: Wm. C. Arrasmith GE, CO

RADEX CORP.
2076 Elston Ave., Chicago 14, Ill. (Tel. ARmitage 6-6900)
Purch. Agent: R. R. Cook GE, TS

RADIAL BEARING CORP.
Taylor St., Danbury, Conn. (Tel. Pioneer 8-2S77)
Pres.: Leo Papish
Mgr.: M. Krouots MF, GE

RADIAL CUTTER MFG. CORP.
831 Bond St., Elizabeth, N. J. (Tel. ELizabeth S-9000)
Purch.: Lucien Revol
Sales: George S. Mackrin

RADIANT LAMP CORP.
300 Jelliff Ave., Newark, N. J. (Tel. Bigelow 3-68S0)
Purch.: L. Mocerino
Sales Mgr.: Carl L. Krueger GS, GE

RADIAPHONE CO. INC.
600 E. Evergreen St., Monrovia, Calif. (Tel. Elliott 8-258S)
Purch. Agent: H. E. Adams, Jr.
Mgr.-Contracts Dept.: W. H. Schetter GS, CO, TS, TR, R&O

RADIATION DYNAMICS, INC.
1800 Shames Drive, Westbury, L. I., N. Y. (Tel. EOgewood 4-3990)
V. P.: Marshall R. Cleland
Prod. Mgr.: Don C. Reynolds
Engr.: Howard F. Malone R&O

RADIATION, INC.
Melbourne, Fla. (PArkway 3-1S11)
Purch. Agent: W. R. Pierpont
Sr. Buyer: J. I. Markham
Electronics Buyer: L. R. Helser
Industrial Buyer: O. L. Campbell
Mechanical Buyer: G. S. Vandegrift
V. P.-Contracts: W. W. Dodgson, Jr. GS, GH, GE, CO, TS, TR, R&O

RADIATION INSTRUMENT DEVELOPMENT LAB., INC.
S737 S. Halsted, Chicago 21, Ill. (Tel. TRiangle 3-234S)
Purch. Agent: J. F. Miller
Sales Mgr.: W. J. Buffer

RADIATION RESEARCH CORP.
1114 First Ave., New York, N. Y. (Tel. TEmpleton 8-2S13)
Purch. Agent: Stanley Grand
Sales Mgr.: Maury Ray R&O

RADIATRONICS, INC.
S956 Kester Ave., Van Nuys, Calif. (Tel. State 2-1461; Stanley 3-2736)
Pres.: G. E. Hewitt
V. P.-Sales: E. H. Lockhart GE, CO, TE, TR

RADIO CORES, INC.
9540 Tulley Ave., Oak Lawn, Ill. (Tel. GArden 2-33S3)
V. P.-Sales: Arthur J. Mark TR

RADIO CORPORATION OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Front & Cooper Sts., Camden 2, N. J. (Tel. WOodlawn 3-8000)
V. P.-Mktg.: J. M. Hertzberg GS, GE, CO, TR

RADIO FREQUENCY CO., INC.
Medfield, Mass. (Tel. NOrwood 7-4900)
Pres.: J. G. Manwaring

RADIO INDUSTRIES, INC.
666 Garland Pl., Des Plaines, Ill. (Tel. VAnderbilt 7-4402)
Purch. Agent: Roy Sielisch
V. P.-Sales: Joh T. Driscoll GE, TS, TR

RADIO SPECIALTY MFG. CO.
2023 S. E. 6th Ave., Portland 14, Ore. (Tel. BE 2-8123)
Purch. Agent: Ellis R. Schlosser
Dir.-Sales: Kenneth C. Johnson

RADIONICS, INC.
76 Cambridge St., Burlington, Mass. (Tel. BRowning 2-1233)
Gen. Mgr.: B. S. Cosman R&O

RAE MOTOR CORP.
2009 Kewaunee St., Racine, Wis. (Tel. MElrose 3-7741)
Purch. Agent: J. Costabile
V. P.: E. K. Hansen PS, GS, GH, GE

RAHM INSTRUMENTS, DIV.-AMERICAN MACHINE & METALS, INC.
6S Rushmore St., Westbury, N. Y. (Tel. EOgewood 3-4840)
Purch. Agent: John E. Sullivan
Sales Mgr.: G. Roger Preisick GS, GE, TS, TR

RAILWAY COMMUNICATIONS INC.
93S1 E. 59th St., Raytown 33, Mo. (Tel. FLeming 3-2100)
Sales: E. E. Tuel GS, CO, TS

RAM ELECTRONICS INC.
600 Industrial Ave., Paramus, N. J. (Tel. COlfax 1-6900)
Purch. Agent: R. Rubin
V. P.-Sales: M. Mayersohn GS, GE, TS, TR

RAMO-WOOLORIOGE, DIV.-THOMPSON RAMO WOOLORIOGE INC.
4800 Ramo-Wooldridge Rd., P. O. Box 5037, Terminal Annex Sta., Denver 17, Colo. (Tel. PYramid 4-4311)
Mgr.-Purch.: F. LaRiviere
Admin. Asst.: Les Ortman
Buyers: M. Z. Williams, M. J. Spencer, M. E. Leonetti, L. J. Michels, Larry Mack
Mgr.-Mktg.: Warren Harmon TS, TR, R&D

RAMO-WOOLDRIOGE DIV., THOMPSON RAMO WOOLORIOGE INC. OF CALIF.
SS00 W. El Segundo Blvd., P. O. Box 90S34 Airport Sta., Los Angeles 45, Calif. (Tel. ORegon 8-0S11)
Mgr.-Material: Joseph N. Celello
Purch. Agent: Charles G. Locke R&O

DOUGLAS RANDALL INC.
6 Pawcatuck Ave., Westerly, R. I. (Tel. LYric 5-57S7)
Purch. Agent: R. Stokes
Material Control: K. Walsh
V. P.-Sales: R. Parnigoni CO, TS

RANDALL ENGRG. CORP.
5933 Bowcroft St., Los Angeles 16, Calif. (Tel. TExas 0-8533)
Dir.-Materiel: Bob Banks
V. P.-Sales: Rex Oberbeck

RANDALL GRAPHITE BEARINGS, INC.
Box 839, Greenlawn & Lake Sts., Limo, Ohio (Tel. CApitol 3-1075)
Purch. Agent: Frank O. Burnette
Sales Mgr.: Roy Chaney WN, PS, GH, GE

RANSOHOFF CO.
N. Sth St. & Ford Blvd., Hamilton, Ohio (Tel. TW 3-S813)
Purch. Agent: C. V. Noonan
V. P.: R. C. Wigger GS, MM, R&D

RAPID ELECTRIC CO.
2881 Middletown Road, Bronx 61, N. Y. (Tel. TAlmadge 8-2200)
Dir. Purch.: Paul Puccerelli
Dir.-Sales: Robert Tedeschi GS, TS

RAPIDS-STANDARD CO., INC., THE
Rapistan Bldg., Grand Rapids 2, Mich. (Tel. GL 9-0281)
Dir.-Purch.: W. Pipe
Dir.-Sales: H. M. Rasmussen

RATTAN MFG. CO., THE
P. O. Box 174S, 10 Wall St., New Haven, Conn. (Tel. UNiversity S-2141)
V. P.: G. H. Keith Miller
Sales: George L. Hathewoy MF, WN, PS, GS, GH

GEORGE RATTRAY & CO.
116-08 Myrtle Ave., Richmond Hill 18, N. Y. (Tel. VIrginia 6-82S0)
Purch. Agent: Robert Mandel
Gen. Mgr.: Harold C. Pasini
Sales Mgr.: Irwin Hansen GE, TR

RAULANO CORP., THE
424S North Knox Ave., Chicago 41, Ill. (Tel. MUlberry S-S000)
Dir.-Purch.: J. Loibl
Asst. Purch. Agent: J. Nee
Sales Mgr.: H. Wunderlich
Military Sales: G. M. Snow R&O

RAVENNA METAL PRODUCTS, DIV.-STANDARD SCREW CO.
6S18 Ravenna Ave., Seattle 1S, Wash. (Tel. LAkeview S-55SS)
Purch. Agent: L. O. Johnson
Gen. Mgr.: I. K. Schlamp
Sales Mgr.: G. E. Earsley MF, PS, GS, GH, CO

RAWAY BEARING CO., INC.
4 Forsyth St., New York 2, N. Y. (Tel. WAlker S-81S0)
Purch.: Rubin Yarmush
Sales: Aharon Baskin GE, TS, TR

RAWSON ELECTRICAL INSTRUMENT CO.
128 Potter St., Cambridge 42, Mass. (Tel. KIrkland 7-4041)
Chief Engr.: M. J. Lush
Office Mgr.: G. C. Henderson R

RAY PROOF CORP.
843 Canal St., Stamford, Conn. (Tel. DAvis 5-2201
Pres.: S. A. Bornett
Gen. Mgr.: G. R. Brownridge
Chief Engr.: R. Aronson MM, R

RAYBESTOS-MANHATTAN, INC.
Passaic, N. J. (Tel. GRegory 3-2000) MF, WN, PS, GS, GH,

RAYBESTOS-MANHATTAN INC., PA.
Manheim, Pa. (Tel. MOhawk S-2211)
Purch. Agent: F. R. Bitzer
Adv. Mgr.: S. R. Robinson

RAYMOND ENGRG. LAB., INC.
Smith St., Middletown, Conn. (Tel. Olamond 6-7745
Purch. Agent: Herbert E. Cruickshanks
Subcontr. Rep.: Volmore J. Labbe
Liaison Coord.: Joseph G. Lombardo R

RAY-O-VAC CO., DIV.-ELECTRIC STORAGE BATTERY CO.
212 E. Washington Ave., Madison 10, Wisc. (Tel. ALpine S-7201)
Purch.: O. B. Wynn
V. P.-Mktg.: O. R. Slauson GS,

RAYTHEON MFG. CO.
Waltham, Mass. (Tel. TWinbrook 3-5860)
Dir.-Procurement: Paul Wilson
Act. Dir.-Mktg. (Commercial): C. R. Hammond

RAYTHEON MFG. CO., GOVERNMENT EQUIPMEN DIV.
Wayland, Mass. (Tel. TWinbrook 3-5860)
Gen. Purch. Agent: David M. Nason
Sales Mgr.: Clark C. Rodimon GS, GE, TR, R

RAYTHEON MFG. CO., MISSILE SYSTEMS HEAD-QUARTERS DIV.
S20 Winter St., Waltham, Mass. (Tel. TWinbrook 4-0910)
Gen. Purch. Agent: Bruce T. Brace
Purch. Agent, Andover, Mass.: Frank Samuel
Purch. Agent, Lawell, Mass.: Vincent Sorrentino
Purch. Agent, Bedford, Mass.: Robert H. Pohl
Purch. Agent, Bristol, Tenn.: Theodore Sheldan
Purch. Agent, Oxnard, Calif.: Charles A. Wisenbak
Purch. Agent, White Sands, N. M.: Harry Leiper MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&

REACTION MOTORS DIV., THIOKOL CHEMICAL CORP.
Denville, N. J. (Tel. OAkwood 7-7000)
Purch. Agent: Ernest DeRome
Purch. Supvrs.: Laurance Levy & J. Young
Supvr.-Expediting: C. Birckholtz
Purch. Coordinator: J. Oaley
Dir.-Sales: R. Frazee MF, PS, GS, G

RECTICO, INC.
963 Frelinghuysen Ave., Newark, N. J. (Tel. Bigelow 3-8739)
Purch. Agent: F. Fertell G

RED DEVIL MFG. CO.
1412 N. Ogden Ave., Chicago 10, Ill. (Tel. MIchigan 2-S161)
Pres.: Matthew Kassnel M

RED LION CABINET CO., REDCO TOOL DIV.
Red Lion, Pa. (Tel. 3-3211)
Purch. Agent: O. W. Royston
Buyers: H. Q. Fishel, K. Worley and R. W. Keller
Sales Mgr.: F. A. Bowles PS, GS, G

RED POINT CORP.
1907 Riverside Dr., Glendale 1, Calif. (Tel. THornwall 2-489S)
Gen. Mgr.: Rolph P. Craig GS, G

***REDEL INC.**
220 N. Atchison St., Anaheim, Calif. (Tel. PRospect 4-3624)
Purch. Agent: Edward Carlson
Buyer: Cliff Young
Sales Mgr.: Jay W. DeDapper PS, R&
*(See Page 46 for Advertisement)

REDMAN ELECTRONICS CORP.
92 Prospect St., Thompsonville, Conn. (Tel. RIverview S-8024)
Purch. Agent: David Engleman GS, GE, TS, T

REDMOND CO., INC., SUB.-CONTROLS CO. OF AMERICA
201 Monroe St., Owosso, Mich. (Tel. SAratoga 5-S1S1)
Dir.-Purch.: Glen Baumhardt
Buyers: R. Kircher, B. Wiegel, R. Muehlberger, & M. Carson
Gen. Sales Mgr.: M. J. Koenig G

REDSTONE ARSENAL RESEARCH DIV., ROHM & HAAS CO.
Huntsville, Ala. (Tel. JE 6-4411)
Purch.: Alton H. Belcher
Asst. Purch. Agent: Clarence R. Lumpkin P

EED MFG. CO.
104S Main St., Waltham S4, Mass. (Tel. TW 4-1464)
Pres.: H. F. Stewart MM

EED RESEARCH INC.
1048 Potomac St., N. W., Washington 7, D. C. (Tel. FEderal 3-7000)
Dir.-Purch.: Fred Mozingo
Dir.-Sales: Edward R. Redding
GS, GH, CO, TS, R&D

EEVE ELECTRONICS, INC.
609 W. Loke St., Chicago 6, Ill. (Tel. RAndolph 6-97SS)
Purch. Agent: E. F. Steichmann
Sales Engr.: I. R. Wayne MF, PS, GS

EEVES INSTRUMENT CORP.
Roosevelt Field, Garden City, N. Y. (Tel. Ploneer 6-8100)
Purch. Mgr.: A. J. Rutherford
V. P.-Mktg.: D. B. Nason GS, GE, TR, R&D

EEVES SOUNDCRAFT CORP.
Great Pastures Rd., Danbury, Conn. (Tel. Ploneer 3-7601)
Purch. Agent: Guy Bonham
Sales Mgr., Audio Products: George Bassett
Sales Mgr., Instrumentation Products: William A. Morrison
V. P.-Sales, Film Products: W. H. Deacy
GE, TS, TR

EEVES-HOFFMAN DIV.
14S Cherry St., Carlisle, Pa. (Tel. 2480)
Purch. Agent: Helen Sheaffer
Sales Mgr.: C. M. Rahn GE, TS, TR

FLECTONE CORP., THE
Post Rd. & Myano Lane, Stamford, Conn. (Tel. DAvis S-22S1)
Purch. Agent: Frank G. Hill
Purch. Expediter: Miss SaraLee Swift
Asst. Purch.-Buyer: Merrill Burchard
Sales Mgr.: John B. Thaler GH, R&D

GENT JACK MFG. CO., INC.
1190S Regentview Ave., Downey, Calif. (Tel. SPruce 3-0103)
Purch. Agents: John Keber & Don Norton
V. P.-Sales: O. A. McPeek GH

IICH BROTHERS MFG. CO., INC.
1439 Ash St., Terre Haute, Ind. (Tel. CRawford 9638)
Purch. Agent: Clarence C. Loy
V. P.-Sales: George T. Davis GH

IICHHOLD CHEMICALS, INC.
RCI Bldg., White Plains, N. Y. (Tel. WHite Plains 8-6200)
V. P.-Purch.: G. C. Sweet
V. P.-Sales: R. T. Urich MF, WN, MM

IID METAL PRODUCTS, INC.
1021 N. Lincoln St., Burbank, Colif. (Tel. VIctoria 9-1284)
Supt.-Purch.: Steve Radick
V. P.-Gen. Mgr.: John Bogue
V. P.-Sales: George G. Gaulk
MF, PS, GS, GH, GE

IINHOLD ENGRG. AND PLASTICS CO.
12827 E. Imperial Hwy., Norwalk, Calif. (Tel. OXbow 3-3781)
Purch. Agent: Paul Hendrix
Buyer: Harmon Price
Pres. & Gen. Mgr.: J. P. Gruettner WN, PS, MM

FLAY SALES INC.
Box 186 MM, W. Chicago, Ill. (Tel. West Chicago 1100)
V. P.-Sales: A. Scandora
Sales Mgr.: R. O. Welch
Pres: E. E. Rullman, Jr.
GS, GH, GE, CO, TS, TR, R&D

FLAYS, INC.
162 W. 83rd St., New York 24, N. Y. (Tel. TRafalgar 3-4S00)
Chief Engr.: S. H. Hartley GS

FLIABLE SPRING & WIRE FORMS CO., THE
1167 Fulton Rd., Cleveland 9, O. (Tel. MElrose 1-2800)
Purch. Agent: Gilbert Gnewotta
V. P.-Sales: Ronald F. Pond
MF, WN, PS, TS, TR, MM

FLIANCE MFG. CO. — INDUSTRIAL PRODUCTS & PARACHUTE DIV.
SO Fifth Ave., New York 1, N. Y. (Tel. DX 5-4900)
V. P.: Michael Kagan
Chief Engr.: William Bell

FMINGTON RAND UNIVAC DIV.-SPERRY RAND CORP.
1S Fourth Ave., New York, N. Y. (Tel. SPring 7-8000)
Mgr.-Procurement: W. R. Gerhardt
V. P.-Univac Sales: H. V. Widdoes GE, TR, R&D

RENBRANDT, INC.
6 Parmelee St., Boston 18, Mass. (Tel. HIghlands S-8910)
Sales: M. Rogers PS, GS, GH

EDW. RENNEBURG & SONS CO.
2639 Boston St., Baltimore 24, Md. (Tel. PE 2-166S)
V. P.: Paul E. Kiefer
Dir.-Sales: E. J. Leister MF, GS

RENWELL CORP.
1 W. Main St., South Hadley Falls, Mass. (Tel. JEfferson 4-3S77)
Dir.-Purch. & Sales: F. T. Renkowicz

REON RESISTOR CORP.
117 Stanley Ave., Yonkers, N. Y. (Tel. YOnkers S-98S0)
Sales Mgr.: J. J. McCann
Purch. Agent: J. Schuldenfrei
GS, GE, TS, TR, R&D

REPUBLIC AVIATION CORP.
Farmingdale, L. I., N. Y. (Tel. CH 9-1100)
Dir.-Materiel: E. I. Little
V. P.: J. Murray MF, WN, GS, CO, TS, TR, R&D

REPUBLIC AVIATION CORP., GUIDED MISSILES DIV.
Jericho Turnpike, Mineola, L. I., N. Y. (Tel. Ploneer 2-4013)
Purch. Mgr.: R. Moore
Mil. Contracts: J. Shea
MF, WN, PS, GS, GH, GE, TS, TR

REPUBLIC LENS CO., INC.
31 E. 169th St., New York S2, N. Y. (Tel. CYpress 3-2790)
Purch. Agent: M. Matthewson
Sales Mgr.: Jack Lurie R&D

REPUBLIC MFG. CO.
1S6SS Brookpark Rd., Cleveland 3S, O. (Tel. CLearwater 2-1800)
Purch. Agent: R. Riley
V. P.-Sales: L. J. Henderson MF, PS, GS, TS

REPUBLIC STEEL CORP.
Republic Bldg., Cleveland 1, O. (Tel. PRospect 1-1400)
Mgr.-Purch. & Raw Materials: W. T. Adams
Asst. Mgr.-Purch.: L. H. Ransom
V. P.-Chg. Sales: Norman W. Foy MM

RESDEL CORP.
Cape May Co. Airport, Wildwood, N. J. Mailing Add.: P. O. Box 217, Rio Grande, N. J. (Tel. WIldwood 2-S643)
Office Mgr./Secy.-Treas.: John F. Dieffenderfer
MF, PS, GS, GH, GE, TS

RESDEL ENGRG. CORP.
330 S. Fair Oaks Ave., Pasadeno, Colif. (Tel. MUrray 1-7689)
Purch. Agent: J. Demarest
V. P.-Mfg. & Sales: Alfred J. Siegmeth
PS, GS, GH, GE, CO, TS, TR, R&D

RESE ENGRG., INC.
731 Arch St., Philadelphia 6, Pa. (Tel. WAlnut 2-S841)
Chief Purch. Agent: John Newton GS, CO, TS, TR

*RESEARCH & ADVANCED DEVELOPMENT DIV., AVCO MFG. CORP.
20 S. Union St., Lawrence, Moss. (Tel. MUrdock 8-6011)
Mgr.: Glenn W. Inman
Mgr.-Mktg.: R. D. Davis
MF, WN, PS, GS, GH, GE, CO, TS, TR
*(See 3rd Cover for Advertisement)

RESEARCH APPLIANCE CO.
Rt. 8 & Craighead Rd., Allison Park, Pa. (Tel. STerling 2-2262)
Purch. Agent: C. W. Thomas
PS, GS, GH, GE, CO, TS, TR

RESEARCH CONTROLS
7902 E. 11th St., Tulsa, Okla. (Tel. TEmple S-7163)
Sales: Roy Horton MF, PS, GS, GH, GE, TS

RESEARCH DEVELOPMENT MFG. INC.
429 E. Collom St., Philodelphia, Pa. (Tel. GLadstone S-9700)
Purch. Agent: A. G. Kamm
Asst. Purch. Agent: Frank Wm. Doll
Treas.: L. Kassvan MF, WN, PS, GS

RESEARCH, INC.
11S N. Buchanan Ave., Hopkins, Minn. (Tel. Minneapolis WEst S-21S6)
Purch. Agent: G. N. Butzow CO, TS

RESEARCH PRODUCTS CORP.
101S E. Washington Ave., Madison 1, Wisc. (Tel. ALpine 6-0621)
V. P.-Sales: A. W. Brown
V. P.-Purch.: E. B. Schlatter, Jr.
Asst. Purch. Agent: Howard E. Hoveland
PS, GS, R&D

RESEARCH WELDING & ENGRG. CO., INC.
18201 S. Santa Fe, Compton, Calif. (Tel. NE 6-9761)

RESISTOFLEX CORP.
Roseland, N. J. (Tel. CApital 6-7700)
Mgr.-Purch.: R. Atkins
Sr. V. P.-Sales: H. E. Krebs
TS, MF, WN, PS, GS, GH, CO

RESISTORS, INC.
S226 W. 26th St., Chicago S0, Ill. (Tel. OL 2-7SSS)
Purch. Agent: Marian Kliemer
Sales Mgr.: Myrtle J. Bryans R&D

REVERE COPPER & BRASS INC.
230 Park Ave., New York 17, N. Y. (Tel. MU 9-6800)
V. P.-Gen. Sales Mgr.: R. P. Winberg
MF, PS, GS, GH

REVERE CORP. OF AMERICA
North Colony Rd., Wallingford, Conn. (Tel. COlony 9-7701)
Buyers: K. Barse & L. Bradford
Sales Mgrs.: C. W. Silver & G. W. Grace
PS, GS, GE, CO

REVOLVATOR CO.
2000 86th St., North Bergen, N. J. (Tel. UNion 9-1220)
Purch. Agent: J. F. Taylor
Sales: H. S. Germond III

REX CORP., THE, SUB.-AMERICAN ENKA
Hoyward Rd., West Acton, Mass. (Tel. COlonial 3-7721)
Buyer: S. M. Coyne GS, MM

REYNOLDS METALS CO.
Reynolds Metals Bldg., Richmond, Va. (Tel. AT 2-2311)
V. P.-Purch.: M. W. Henry
Exec. V. P.-Sales: D. P. Reynolds MM

REZ-COAT OF CALIFORNIA
690 N. Lemon St., Drange, Calif. (Tel. KEllogg 8-1197)
Prod. Mgr.: F. P. McGowan
Sales: Bruce Brown MF, WN, PS, MM

*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
11711 Woodruff Ave., Downey, Calif. (Tel. TOpaz 1-9711)
Mgr.-Materiel: Robert W. Lassman
Sales Mgr.: John H. Titley
V. P.-Sales: Alexander Black
MF, WN, PS, GS, GH, CO, TR, R&D
*(See 2nd Cover for Advertisement)

RHEEM MFG. CO., ELECTRONICS DIV.
7777 Industry Ave., Rivera, Calif. (Tel. TOpaz 1-9271)
Dir.-Purch.: Roy Smith
Div. Sales Mgr.: Hugh C. Bream
GS, GH, GE, CO, TS, TR

M. H. RHODES, INC.
30 Batholomew Ave., Hartford 6, Conn. (Tel. JAckson 2-426S)
Dir.-Purch.: Miss E. M. Sonderson
V. P.-Sales: E. J. Doyle GE, R&D

RICHARDSON SCALE CO.
668 Van Houten Ave., Clifton, N. J. (Tel. GRegory 1-3400)
Purch. Agent: Andrew A. Fisher
Dir.-Sales: Walter M. Young GH

RICHARDS-WILCOX MFG. CO.
Aurora, Ill.
Mgr.-Advertising: C. A. Rasey

RIGGS NUCLEONICS CORP.
177 W. Magnolia Blvd., Burbank, Colif. (Tel. VIctoria 9-2481)
Purch. Agent: Philip Solomon
Sales Mgr.: John R. Foster
Pres.: Harvey Riggs PS, GE, TS

RIMAK, INC.
10929 Vanowen St., North Hollywood, Calif. (Tel. TRiangle 7-SS26)
Purch. Agent: Richard H. Flint (Tel. PDpular 1-2377)
Sales Mgr.: William S. Bawers GS, GE, TR, R&D

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

RINCO, INC.
7962 S. E. Powell Blvd., Portland 6, Ore. (Tel. PRospect 4-3259)
Purch. Agent: Jesse L. Brown
Buyer: Lee Patterson
Sales Mgr.: Franklin M. Brown — CO, TS, TR

RIPLEY CO., INC.
Flactory St., Middletown, Conn. (Tel. Olamond 6-6679)
Purch. Agent: H. I. Thayer
Sales Mgr.: P. J. Riniacdi — GS, GH, TS

RIVERBANK LABS., DEPT.-ENGRG.
P. O. Box 65, Geneva, Ill. (Tel. Geneva 2207)
Buyer: R. J. Eisenhour
Chief Engr.: B. E. Eisenhour, Jr. — GE, TS, TR

RIVETT LATHE & GRINDER INC.
P. O. Box 7, Brighton 35, Mass. (Tel. STadium 2-4530)
Purch. Agent: W. C. Woodworth
Sales Mgr.-Hydraulic Div.: J. A. Marsh MF, PS, GS

RIXON ELECTRONICS, INC.
2414 Reedie Dr., Silver Spring, Md. (Tel. LOckwood 5-4578)
Purch. Agent: Nevin Price
Dir.-Sales: Oean Perry — GS, GE, TR, R&D

ROANWELL CORP.
180 Varick St., New York, N. Y. (Tel. YUkon 9-1090)
Dir.-Purch.: H. Schmidt
Asst. Sales Mgr.: J. I. Nevins, Jr. — GS, TR

C. F. ROARK WELDING & ENGRG. CO., INC.
Brownsburg, Ind. (Tel. ULrick 2-2224)
Purch. Agent: Glenn Seeds
Asst. Purch. Agent: W. S. Schenck
Sales Mgr.: M. E. Mann — PS, MM

ROBBINS AVIATION, INC.
2350 E. 38th St., Los Angeles 58, Calif. (Tel. LUdlow 9-5221)
Dir.-Materiel: R. E. Bixler
V. P.-Sales: H. N. Mabery — GS, GH

ROBBINS & MEYERS, INC., HOIST & CRANE DIV.
Springfield, Ohio

FRED T. ROBERTS & CO.
Oanbury Rd., Wilton, Conn. (Tel. POrter 2-7002)
V. P.: R. E. Roberts
Pres.: Fred T. Roberts — MF, GS, GH, MM, R&D

ROBERTS INDUSTRIES, INC.
Box 71, Branford, Conn. (Tel. HU 8-1671)
Pres.: H. W. Wallace
V. P.: B. V. Harrison, III — MM

ROBERTS TOLEDO RUBBER CO., THE
4143 Monroe St., Toledo 13, O. (Tel. GReenwood 9-4466)
Pres.: Robert Roberts — MF, PS, GS, GE

ROBINS INDUSTRIES CORP.
36-27 Prince St., Flushing 54, N. Y. (Tel. HIckory 5-7200)
Purch. Agent: E. OiCarlo — TR

ROBINSON TECHNICAL PRODUCTS, INC.
Teterboro Air Terminal, Teterboro, N. J. (Tel. ATlas 8-2500)
Sr. Buyer: Harold Adler
Buyers: Merle Oarragh, James Eames, Charles Preuss
V. P.-Proj. Dev.: H. Erich Nietsch — GH, GE, TR, R&D

ROBOT INDUSTRIES INC.
7041 Orchard St., Dearborn, Mich. (Tel. TIffany 6-2623)
Purch. Agent: K. Krake — MF, PS, GS, GH, GE, TR

ROCHESTER MFG. CO. INC.
113 Rockwood St., Rochester 10, N. Y. (Tel. BRowning 1-2020)
Purch. Agent: L. A. Mumford
Sales Mgr.: David McEwen — MF, GS, GH, CO, R&D

ROCKBESTOS PRODUCTS CORP.
Nicoll & Canner Sts., New Haven 4, Conn. (Tel. STate 7-1141)
Dir.-Purch.: C. A. Berlepsch
Purch. Agent: R. B. Miniter
Buyer: C. F. Connerton
V. P.-Sales: H. O. Anderson — PS, GS, GH, TS, TR, MM

ROCKETDYNE DIV., NORTH AMERICAN AVIATION, INC.
6633 Canoga Ave., Canoga Park, Calif. (Tel. Olamond 7-5651)
Gen. Purch. Agent: M. J. Dubuc
Purch. Agents: V. L. Butterbaugh, S. C. Schultz, G. J. Cheek
Dir.-Plans & Programs: E. F. Brown — PS, R&D

ROCKWELL-STANDARD CORP.
843 Fourth Ave., Coraopolis, Pa. (Tel. SPalding 1-1800)
V. P. & Dir.-Purch.: V. E. Gumbleton
Exec. V. P.-Sales, Mktg.: C. B. Black — GS, GH

ROCKWELL-STANDARD CORP.
Ashtabula, Ohio
Gen. Sales Mgr.: O. M. Heath — GS

RODNEY METALS INC.
1357 Rodney French Blvd., New Bedford, Mass. (Tel. WY 6-5691)
V. P.: C. W. Smith
Purch. Agent: L. A. Oobson — MF, PS, GS, GH

JOHN A. ROEBLING'S SONS CORP.
640 S. Broad St., Trenton, N. J. (Tel. EXport 6-6511)
Dir.-Purch.: R. K. Spofford
Asst. Dir.-Purch.: K. S. Dickel
Buyers: J. G. Hottinger, C. G. Bennighoff, J. R. Nemeth, W. P. Strohauer & P. S. Toth
V. P.-Sales: E. George Hartmann — MF, PS, GS, GH, MM

ROGERS CORP.
Rogers, Conn. (Tel. PRescott 4-9605)
Purch. Agent: Austin R. Schillinger
Dir.-Mktg.: N. L. Greenman — MF, WN, PS, GE, TR, MM

ROHM & HAAS CO. — REDSTONE ARSENAL RESEARCH DIV.
Huntsville, Ala. (Tel. JEfferson 6-4411)
Supvr.-Purch.: A. H. Belcher
Asst. Supvr.-Purch.: C. R. Lumpkin
Gen. Mgr.: A. R. Deschere — R&D

ROHR AIRCRAFT CORP.
Foot of H St., Chula Vista, Calif. (Tel. GArfield 2-7111)
Materiel Mgr.: C. R. Campbell
Mgr.-Purch.: R. J. Rucci
Purch. Agents: J. W. O'Reilly, E. T. Elvin
Contracts Mgr.: A. R. Campbell — MF, PS, R&D

ROLL FORMED PRODUCTS CO.
3760 Oakwood Ave., Youngstown, O. (Tel. SWeetbriar 9-3223)
Purch. Agent: S. Kakish
Sales Mgr.: L. C. Colleran — MF, WN, PS, GS, TS, TR

ROLLAN ELECTRIC CO.
8233 S. Princeton Ave., Chicago 20, Ill. (Tel. RAdcliffe 3-4000)
Purch. Agent: William Pierucci
Sales Mgr.: C. E. Schneider

ROLLE MFG. CO.
3rd & Cannon Ave., Lansdale, Pa. (Tel. UL 5-1171)
Purch. Agent: H. Wardle
Sales Mgr.: W. F. Trakat — MF, GS

ROLLER BEARING CO. OF AMERICA
Sullivan Way, W. Trenton, N. J. (Tel. EX 3-7191)
Purch. Agent: R. J. McCoy
Sales Mgr.: Robert R. Voorhees — PS, GH, GE

ROLLWAY BEARING CO., INC.
541 Seymour St., Syracuse 4, N. Y. (Tel. GR 5-2121)
Purch. Agent: William R. Bowes
Gen. Sales Mgr.: Alfons Alven — GE

ROLOCK INC.
1350 Kings Hwy., Fairfield, Conn. (Tel. FO 7-8611)
Purch. Agent: Robert L. Larkin
V. P.-Sales: Robert Platt — MM

ROME CABLE CORP., SUB.-ALUMINUM CO. OF AMERICA
421 Ridge St., Rome, N. Y. (Tel. Rome 3000)
Purch. Agent: S. O. Williams
Asst. Purch. Agent: J. H. McCann
V. P. & Dir.-Mktg.: G. E. Rolston — TR, MM

ROME-TURNEY RADIATOR CO., THE
109 Canal St., Rome, N. Y. (Tel. 2200 and 2201) — MM

RONAN & KUNZL, INC.
502 S. Kalamazoo Ave., Marshall, Mich. (Tel. STory 1-2861)
Purch. Agent: Jack Lawler
Cryogenic Sales Engr.: Herbert A. Eichstaedt — MF, PS, GS, GH

RONAN & KUNZL, INC., CRYOGENIC DIV.
Marshall, Mich. (Tel. STory 1-2861)
Purch. Agent: Jack Lawler
Sales: H. E. Eischstaedt — WN, PS, GS

RONSON HYDRAULIC UNITS CORP.
1313 Lincoln Ave., Pasadena, Calif. (Tel. RYan 1-0221)
Purch. Agent: M. E. Boltz
Dir.-Sales: R. K. Boltz — GS, GH, GE

ROOVERS-LOTSCH CORP.
3611 14th Ave., Brooklyn 18, N. Y. (Tel. GEdney 5-0004)
Chief Engr. & Gen. Mgr.: Charles F. Lotsch
Plant Supt.: Paul O. Payne — MF, PS, G

ROSAN, INC.
2901 W. Coast Hwy., Newport Beach, Calif. (Tel. LIberty 8-5533)
Purch. Agent: Robert A. Carr
Mfg. Mgr.: L. F. Barth
Gen. Sales Mgr.: E. G. Miller — MF, WN, P

ROSE MFG. CO.
2700 W. Barberry Place, Oenver 4, Colo. (Tel. AC 2-7847)
V. P.: J. E. Sharp — GS, G

ROSEMOUNT ENGRG. CO.
4900 W. 78th St., Minneapolis 24, Minn. (Tel. WAlnut 7-7711)
Secy.-Treas.: Vernon H. Heath
Buyer: Harry Baquist
Sales Mgr.: B. L. Sadler — TS, TR, R&D

CHARLES ROSS & SON CO., INC.
148-156 Classon Ave., Brooklyn 5, N. Y. (Tel. MAin 2-8400)
Purch. Agent: Richard M. Ross
Asst. to Pres.: Charles K. Ross — PS, R&D

MILTON ROSS METALS CO., THE
237 Jacksonville Rd., Hatboro, Pa. (Tel. OSborne 2-0550)
V. P.: E. D. Ross
Pres.: M. I. Ross — MF, WN, PS, GS, GH, GE, CO, TS, TR

ROTARY LIFT CO., DIV.-DOVER CORP.
1054 Kansas St., Memphis 2, Tenn. (Tel. WHitehall 8-8561)
V. P.-Purch.: W. E. Rier
Sales Mgr.-Elevator Div.: H. G. Sanders
Sales Mgr.-Indsl. Div.: H. T. Hamm

ROTEX PUNCH CO., INC.
2350 Alvarado St., San Leandro, Calif. (Tel. LOckhaven 9-8180)
Prod. Mgr.: Mark Hamlin
Sales Mgr.: John B. Sweeney — GS

ROTO-FINISH CO.
3700 Milham Rd., Kalamazoo, Mich. (Tel. FIreside 3-5578)
V. P. & Secy.: John W. Sercaas
Sales Mgr.: Wm. J. Walther

ROTOTEST LABS., INC.
2803 Los Flores Blvd., Lynwood, Calif. (Tel. NEvada 6-9238)
Purch. Agent: Mrs. Tim Taylor
V. P.-Sales: J. R. Duncan — TS

ROTRON MFG. CO.
Schoonmaker Lane, Woodstock, N. Y. (Tel. ORiole 9-2401)
Purch. Agent: A. J. Gibson, Jr.
Dir.-Sales: Paul M. Beard
Asst. Sales Mgr.: W. W. Blelock, Jr. — WN, GS, GE, CO, TS, TR

ROWE INDUSTRIES
1702 Wayne St., Toledo 9, Ohio (Tel. EVergreen 2-5666)
Asst. Purch. Agent: Howard B. Lang
Gen. Mgr.: Harold M. Klopping — GS

MILTON ROY CO.
1300 E. Mermaid Lane, Philadelphia 18, Pa. (Tel. CHestnut Hill 7-8000)
Purch. Agent: E. W. Brook
Sales Mgr.: John Procopi — PS, GS, GH, CO, TS

ROYAL ELECTRIC CORP.
95 Grand Ave., Pawtucket, R. I. (Tel. PAwtucket 2-8600)
Purch. Agent: H. Spanglet
Asst. Purch. Agent: W. Slack
V. P.-Sales Operations: S. B. Alperin — MF, WN, PS, GS, GH, CO, TS, TR

ROYAL INDUSTRIES, INC.
1035 Westminster Ave., Alhambra, Calif. (Tel. ATlantic 9-5101)
Purch. Agent: Victor Kail
V. P.-Sales: R. T. Lowrie — MF, GS, GH, CO, TS, TR, R&D

ROYCO INSTRUMENTS, INC.
123 Santa Maria Ave., Portola Valley, Calif. (Tel. ULmar 1-7263)
Dir.-Purch.: F. Roy Gustavson
Sales Mgr.: Emil Wachtel — PS, CO, TS

ROYLYN INC.
620 Paula Ave., Glendale 1, Calif. (Tel. CHapman 5-8521)
Purch. Agent: Jack Schroeder
Asst. Purch. Agent: Harold Conley
Buyer: Alice Coty
V. P.-Sales: Oonald E. Butler — GS, GH, TS, R&D

UBATEX DIV., GREAT AMERICAN INDUSTRIES INC.
Bedford, Va. (Tel. JUstice 6-2611)
Purch. Agent: Mary B. Dean
Sales Mgr.: W. C. Walters MF, PS, GE, TR

UBBER & ASBESTOS CORP.
225 Belleville Ave., Blaamfield, N. J. (Tel. PIlgrim 8-1300)
Purch. Agent: Mrs. A. Galden
Gen. Sales Mgr.: Harald Greene MF, WN, PS, GE

UBBER TECK INC.
19115 S. Hamilton St., Gardena, Calif. (Tel. FAculty 11669)
Purch. Agent: E. D. Rogers
Dir.-Sales: Nat Feldman MM

UBBERCRAFT CORP. OF CALIFORNIA
1800 W. 220th St., Tarrance, Calif. (Tel. FAirfax 8-5402)
V. P.-Sales: Robert N. Merralls
MF, WN, PS, GS, GH, GE, CO, TS, TR

JCKER CO., THE
4700 San Pablo Ave., Oakland 8, Calif. (Tel. OLympic 3-5221)
V. P.-Gen. Mgr.: Clarence J. Waodard
GS, GH, CO, TS, R&D

RTHUR C. RUGE ASSOCIATES, INC.
Hudsan, N. H. (Tel. TUxeda 2-5195)
Pres.: Paul W. Kach
Chief Engr.: Warren E. Jacksan
Prod. Mgr.: Hugh R. Rainge
Dir.-Sales: W. E. Jacksan & H. R. Rainge TR

JSSELL MFG. CO., THE
Middletawn, Conn. (Tel. DIamand 6-7721)
Purch. Agent: Henry Fischer, Jr.
Dir.-Automotive Research & Mfg.: H. C. Martan
Dir.-Research, Textile Div.: T. I. Read
V. P.-Sales: L. S. Sullivan

JSSELL REINFORCED PLASTICS CORP.
521 W. Haffman Ave., Lindenhurst, N. Y. (Tel. LIndenhurst 5-1700)
Gen. Mgr.: Warren R. Amendala
Exec. V. P.: Ernest C. Schultz

JTHERFORD ELECTRONICS CO.
8944 Lindblade St., Culver City, Calif. (Tel. TExas 0-7393)
Purch. Agent: S. Cooper
Sales: N. T. Halzer CO, TS

JTHMAN MACHINERY CO., THE
1813 Reading Rd., Cincinnati 2, O. (Tel. MA 1-5462)
V. P.-Purch.: A. H. Ruthman

'AN AERONAUTICAL CO.
2701 Harbar Dr., San Diega 12, Calif. (Tel. CYpress 6-6681)
Dir.-Materiel: M. K. Smith
Gen. Supvr.-Purch.: J. H. Stramberg
Gen. Supvr.-Outside Prod.: R. W. Carr
MF, WN, P5, GE, TS, MM, R&O

'AN INDUSTRIES, INC.
888 E. 70th St., Cleveland 3, Ohia (Tel. UT 1-6878)
Purch. Agent: C. P. Breitmayer
V. P.-Engrg. & Sales: R. M. Haas

SEPH T. RYERSON & SON, INC.
16th & Rackwell Sts., Chicaga 8, Ill. (Tel. ROckwell 2-2121)
V. P.-Proc.: J. M. Mead
V. P.-Sales: T. Z. Hayward MM

TRON CO., INC.
7303 Lankershim Blvd., N. Hallywaad, Calif. (Tel. POplar 5-0756)
Purch. Agent: Jack Kennedy
Dir.-Engrg.: Rabert E. Schlegel
Chief Engr., Filters: Carl Nelsan
Chief Engr., Mag. Amplifier: Ralph Halanay
Sales Mgr.: Maurice Faster PS, GE, CO, TS, TR

S INDUSTRIES, INC.
rant St. & Erie Ave., Philadelphia 32, Pa. (Tel. GArfield 6-6400)
en. Purch. Agent: F. E. Whyte
urch. Agent: J. R. Bremer
upvrs.: W. R. Sine
uyers: B. F. Maurer, J. A. McCarran, W. R. Canlague, & J. A. Chaman
xpediter.: O. P. Haggerty PS, GE

S MFG. CORP., THE
0201 Aurara Rd., Salan, Ohia (Tel. CHurchill 8-6141)
urch. Agent: A. W. Fisher
ales Mgr.: R. E. Sutherland MM

S ETY ELECTRICAL EQUIPMENT CORP.
87 Dixwell Ave., New Haven 14, Cann. (Tel. UN 5-3171)
urch. Agent: Joseph Prestianni
dsl. Sales Mgr.: Charles Pierce
P.-Sales: J. J. Kennedy GS, TS

SAFEWAY HEAT ELEMENTS, INC.
680 Newfield St., Middletawn, Cann. (Tel. DIamand 6-6601)
Secy.-Asst. Treas.: Joseph F. O'Raurke
Dir.-Sales: T. A. Dissel PS, GS, R&D

SAGE ELECTRONICS CORP.
Cauntry Club Raad, East Rachester, N. Y. (Tel. LU 6-8010)
Treas.: A. B. Mills
Pres.: F. D. Sage GE, TR

SAGE EQUIPMENT CO. INC.
30 Essex St., Buffala, N. Y. (Tel. ELmwaad 5242)
Purch.: A. Sperduti
Dir.-Sales: Jahn Haynes GH

SAGE LABS., INC.
159 Linden St., Wellesley 81, Mass. (Tel. CEdar 5-4760)
Admin. Supvr.: William S. Patsas
GS, GH, GE, CO, TS, TR, R&D

SAGE-CRAFT, INC.
Narwich, N. Y. (Tel. 4-6118)
Pres.: Earle R. Sage GS, GE, R&D

SAGINAW BEARING CO.
967 S. Water St., Saginaw, Mich. (Tel. PLeasant 2-3169)
Dir.-Purch.: Robert L. Pieschke
Dir.-Sales: Jahn Truer MM

ST. JOHN X-RAY LABORATORY
Califan, N. J. (Tel. Califan 49)
Pres.: Herbert R. Isenburger

5T. MARYS CARBON CO.
W. State St., St. Marys, Pa. (Tel. TErminal 4-2844)
Dir.-Purch.: C. J. Ehrensberger
V. P.-Sales: L. W. Eberl MM

ST. REGIS PAPER CO., PANELYTE DIV.
Enterprise Ave., Trentan, N. J. (Tel. EXport 2-2181)
Purch. Agent: Frank P. Yaccarina, Sr.
Indsl. Sales Mgr.: Jahn M. Zeier

SAN FERNANDO ELECTRIC MFG. CO.
1509 1st St., San Fernanda, Calif. (Tel. EMpire 1-8681)
Purch. Agent: Richard A. Griffis
Gen. Sales Mgr.: Lyle R. Smith

SANBORN CO.
175 Wyman St., Waltham 54, Mass. (Tel. TW 4-6300)
Purch. Dir.: E. A. Craddock
V. P.-Sales: A. E. Lannberg T5

SANCOR CORP.
1661 Franklin Ave., El Segunda, Calif. (Tel. OREgan 8-5069)
Purch. Agent: A. H. Knight
V. P.-Sales: L. H. Sanderfer GS, GH

SANDBERG-SERRELL CORP.
2550 E. Faothill Blvd., Pasadena, Calif. (Tel. SYcamare 6-0281)
V. P.-Sales: Peter V. H. Serrell GH, TS, R&O

SANDERS ASSOCIATES, INC.
95 Canal St., Nashua, N. H. (Tel. TUxeda 3-3321)
Purch. Agent: Chandler Galdswaite
Sales Mgr.: W. B. Wilkens G5, GE, TR, MM, R&O

SANFORD PLASTICS CORP.
New Brunswick Ave. & Charles St., Matawan, N. J. (Tel. LOwell 6-1923)
V. P.-Purch.: Jahn B. Andersan
Pres.: Warren L. Schnur MM

SANGAMO ELECTRIC CO.
11th & Canverse, Springfield, Ill. (Tel. 4-6411)
Purch. Agent-Springfield, Ill.: H. C. Chambers
Purch. Agent-Pickens Div., Pickens, S. C.: R. W. Kreppert (Tel. 6311)
Purch. Agent-Ordill Div., Marion, Ill.: Rex McCluskey (Tel. 231)
V. P.-Sales: R. C. Lanphier, Jr. MM

SANTA ANITA ENGRG. CO.
2451 E. Calarada St., Pasadena 8, Calif. (Tel. RYan 1-7441)
Prod. Mgr.: Rabert Blyth
Purch. Agent: Kent Felker
V. P.-Sales: L. O. Banham MF

SANTA BARBARA RESEARCH CENTER
Bldg. 316, Santa Barbara Airport, Galeta, Calif. (Tel. WOadland 7-2331)
Purch. Agent: William J. Cartledge
Asst. Chief-Admin.: O. T. Shiffman GE, R&D

SARGEANT & WILBUR HEAT TREATING CORP.
170 York Ave., Pawtucket, R. I. (Tel. PA 3-5900)
Pres.: Irvin M. Sargeant
Asst. to Pres.: Jaseph T. McDevitt MM, R&D

SARGENT ENGRG. CORP.
2533 E. 56th St., Huntingtan Park, Calif. (Tel. LUdlaw 3-4161)
Purch. Agent: C. A. Brack
Dir.-Sales, Aircraft Div.: S. B. Sargent, Sr.
G5, GH, GE, CO, R&D

SARKES TARZIAN, INC., RECTIFIER DIV.
415 N. College Ave., Bloamingtan, Ind. (Tel. EDisan 2-1435)
Purch. Agent: Max Rabertsan GS, GE, TS, TR

SATELLITE-KENNEDY, INC. OF CALIFORNIA
P. O. Box 1711, Monterey, Calif. (Tel. FRantier 3-2461)
Controller: M. E. Mawer
Engrg. Mgr.: C. M. Brawn R&D

SAUEREISEN CEMENTS CO.
1045 N. Canal St., Pittsburgh 15, Pa. (Tel. STerling 1-2323)
Purch. Agent: G. W. Read
V. P.-Sales: P. F. Sauereisen MM

SAVAGE-ROWE PLATING CO., INC.
2152 Partage St., Kalamazaa, Mich. (Tel. FIreside 5-0532)
Pres.: Frank K. Savage
V. P.-Sales: A. K. Graham MM

SAYLOR ELECTRIC PRODUCTS CORP.
277 Pierce, Birmingham, Mich. (Tel. JOrdan 6-7122)
Purch.: W. R. Saylar
Sales: B. F. Stiles MF, PS

SCAICO CONTROLS, INC.
P. O. Box 41, Caaper St., Delanca, N. J. (Tel. HObart 1-4717)
Secy.: J. S. Caaper GS, TS, R&D

SCAIFE CO., DIV.-WILSON BROTHERS
26 Ann St., Oakmant, Pittsburgh, Pa. (Tel. EMerson 2-2100)
Purch. Agent: J. M. McClure
Mgr.-Defense Sales: R. S. Townend MF, GH, R&D

SCALA RADIO CO.
2814 19th St., San Francisco 10, Calif. (Tel. VA 6-2898)
Purch. Agent: E. M. O'Neill
Owner: Bruna Zuccani

SCAM INSTRUMENT CORP., THE
1811 Irving Park Rd., Chicaga 13, Ill. (Tel. GRaceland 7-7850)
Purch. Agent: Wayne Miller
Sales Mgr.: Rascae Garrett GS, CO, TS

SCHAEVITZ ENGRG.
U. S. Rt. 130 & Schaevitz Blvd., Pennsauken, N. J. (Tel. NOrmandy 2-8000)
Purch. Agent: Helen Tarr
Coordinator-Sales: Russell C. Spera GE, CO, R&D

SCHAFFER AIR INDUSTRIES, INC.
290 N. Henry St., Braaklyn 22, N. Y. (Tel. EVergreen 3-5300)
Purch.: Bernard Schaffer GS, GH, CO, TS

RAY A. SCHARER & CO.
17411 E. Warren, Detroit 2, Mich. (Tel. TUxeda 2-7172)
Purch.: M. A. Davis
Sales: R. A. Scharer

SCHAUER MFG. CORP.
4500 Alpine Ave., Cincinnati 42, O. (Tel. SYcamare 1-3030)
Purch. Agent: David T. Face
V. P.-Sales: S. E. Wright GS, GH, GE, TR

SCHELLENS-TRUE CORP.
Pandmeadaw Rd., Ivorytan, Cann. (Tel. Essex-Sauth 7-8248)
V. P.: E. Peter Schellens
Pres.: E. L. Schellens PS

SCHLEGEL MFG. CO.
1555 Jeffersan Rd., P. O. Box 197, Rachester 1, N. Y. (Tel. HIllside 5-5110)
Dir.-Purch.: James Doris
Asst. Purch. Agent: Oanald Nesbitt
Sales Mgr.: William K. Sittig MF, MM

D. A. SCHULTZ CO.
801 S. E. 8th St., Minneapalis 14, Minn. (Tel. FEderal 9-7701)

CODING
Missile Frame MF
Warhead & Nose Cane WN
Prapulsian System PS
Graund Support GS
Graund Handling GH
Guidance Equipment GE
Checkaut Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Develapment R&D
Materials & Metals MM

Purch. Agent: Morge Knight
Sales Engr.: Burton Dahlsten MF, TS

SCHUTTE & KDERTING CD.
Cornwells Hts., Bucks Co., Pa. (Tel. MErcury 9-0900)
Purch. Agent: C. Alsentzer
V. P.-Sales: F. L. Seibold GH

SCHWEBER ELECTRONICS
60 Herricks Rd., Mineola, L. I., N. Y. (Tel. Pioneer 6-6520)
Buyer: George P. Heller
Sales: Jack Laskin GE

PETER J. SCHWEITZER DIV.
261 Madison Ave., New York 16, N. Y. (Tel. MUrray Hill 2-8400)
Dir.-Purch.: J. B. Tropp
Sales Mgr.: Duke Kahl (Lee, Moss.) MM

SCIAKY BRDTHERS, INC.
4915 W. 67th St., Chicago 38, Ill. (Tel POrtsmouth 7-5600)
Purch. Agent: John Bilik
V. P.-Sales: Maurice Sciaky MF, PS, GH, MM

SCIENTIFIC ENGRG. CO.
653 11th Ave., New York 36, N. Y. (Tel. COlumbus 5-7286)
Purch. Agent: Gilbert Goodgion
Owner: F. Feinfrank TS, R&D

SCIENTIFIC ENGRG. LABS., INC.
1510 Sixth St., Berkeley 10, Calif. (Tel. LA 6-2772)
Purch. Agent: Mrs. Alberta Proteau
S. W. Mgr.: J. R. Hafstrom, La Jolla, Calif. (Tel. GL 4-1185)
Pres.: G. C. McFarland GS, TS, R&D

SCIENTIFIC INSTRUMENT CD.
1041 2nd Ave., Detroit 26, Mich. (Tel. WOodward 2-9060)
Pres.: Harold Warr
V. P.-Sales: John E. Peterson GS, GH, CO, TS, R&D

SCIENTIFIC RADID PRODUCTS, INC.
2303 W. 8th St., Loveland, Colo. (Tel. NDrmandy 7-2261)
Treas. & Purch. Agent: G. E. Ulfers
V. P. & Sales Mgr.: G. C. Follmer

SCIENTIFIC-ATLANTA, INC.
2162 Piedmont Rd., N. E., Atlanta 9, Ga. (Tel. TRinity 5-7291)
Buyer: George Ray
Chief Mechan. Engr.: S. F. Hutchins
Chief Elect. Engr.: C. H. Currie
Sales Mgr.: William H. Bradley TS, R&D

SCIDTD SIGN CD.
370 Vine St., Kenton, O. (Tel. 2-1146)
Pres.: Collins M. Shaw
Purch. Agent: K. Buck
Sales Mgr.: B. Deardorff

SCDPES CD., INC., THE
P. O. Box 56, Monsey, N. Y. (Tel. ELmwood 6-6339)
Dir.-Purch.: M. Silver (Dlamond 3-3070)
Pres.: M. Rickard TS

H. H. SCDTT, INC.
111 Powder Mill Rd., Maynard, Mass. (Tel. TWin Oaks 7-8801)
Sales Mgr.-Instr. Div.: E. G. Dyett, Jr. CO, TS, TR

SCDTT AVIATIDN CORP.
Erie St., Lancaster, N. Y. (Tel. REgent 5100)
Purch. Agent: K. J. Albrecht
V. P.-Sales & Finance: R. D. Pollock GS, GH, R&D

SCOVILL MFG. CO.
99 Mill St., Waterbury, Conn. (Tel. PLaza 4-1171)
V. P. & Gen. Mgr.: P. E. Fenton
Sales: R. Woodacre MM

SCREW CDRP.
157 N. Rivergrade Rd., City of Industry, Calif. (Tel. EDgewood 8-5501)
Treas.: H. Wechsler
Secy.: K. R. Brooks

SCREW PRODUCTS CORP. OF AMERICA
5211 Southern Ave., South Gate, Calif. (Tel. LDrain 6-5141)
Purch. Agent: Albert Jenkins
Sales Mgr.: Walter Cleary MF, WN, PS

SEALECTRIC SWITCH & RELAY CDRP.
6025 N. Keystone Ave., Chicago 46, Ill. (Tel. KEystone 9-7502)
Purch. Agent: J. C. Miller
Sales Mgr.: E. M. Paradise PS, GS, GH, GE, TS, TR

SEALMASTER BEARING DIV., STEPHENS-ADAMSON MFG. CO.
Ridgeway Ave., Aurora, Ill. (Tel. AUrora 2-4311)
Purch. Agent: K. L. Johnson
V. P.: C. B. Hurd, Bearing Div.
Sales Mgr.: J. W. Todd, Engrg. Div. GH, GE

SEALOL CORP.
460 Post Rd., Providence 5, R. I. (Tel. STuart 1-4700)
Purch. Agent: Nathaniel Burnham
Pres.: Clement W. Williamson PS, GS, GH, R&D

SEAL-PEEL, INC.
775 Stephenson Hwy., Royal Oak 3, Mich. (Tel: JUniper 8-1055)
V. P. & Purch. Agent: Frank Evans
Pres.: Arthur Aaron

SEAMLESS PRDDUCTS CO., INC.
126 11th Ave., New York 11, N. Y. (Tel. ALgonquin 5-2152) MF, WN, PS, GS, GH, GE

SECO MFG. CO.
5015 Penn Ave., S., Minneapolis 19, Minn. (Tel. WAlnut 6-4545)
Pres. & Chief Engr.: E. A. Bramsen
Sales Mgr.: L. P. Henaman TS

SECON METALS CORP.
7 Intervale St., White Plains, N. Y. (Tel. WHiteplains 9-4757)
Pres.: Eugene Cohn MF, PS, GS, TR

SEEBURG CORP., THE
1500-38 N. Dayton St., Chicago 22, Ill. (Tel. MIchigan 2-0800)
Purch. Agents: Walter Metcalf & Ritchie Tredwell
Buyers: Walter Korzun, Daniel Dolce & George Keller
Contract Adm.: W. Cummins GS, GE, TR

SEELEY ELECTRONICS
1060 S. La Brea Ave., Los Angeles 19, Calif. (Tel. WEbster 3-1183)
Warren M. Seeley TR

EDWARD SEGAL
132 Lafayette St., New York 13, N. Y. (Tel. WOrth 6-3935)
Dir.-Purch.: I. Pollevoy
Sales Mgr.: E. Segal MM

SEISCOR MFG. CORP.
P. O. Box 1590, 6200 E. 41st St., Tulsa, Okla. (Tel. RIverside 3-1381)
Purch. Agent: M. G. Steil
Sales Mgr.: Clyde V. Hussey GS, GE, CO, TS, R&D

SELAS CORP. DF AMERICA
Dresher, Pa. (Tel. MItchell 6-6600)
Pres.: F. O. Hess
Purch. Agent: J. E. Kerns R&D

SEL-REX CDRP.
75 River Rd., Nutley 10, N. J. (Tel. NUtley 2-5200)
Branch Dffices: 5875 N. Lincoln, Chicago, Ill. (Tel. Long Beach '-3183); 1168 Santa Monica Blvd., Los Angeles 25, Calif. (Tel. GRanite 7-4206)
Purch. Agent: J. R. Ezzo
V. P.-Sales: S. S. Wilson MM, R&D

SEQUDIA WIRE & CABLE CD., DIV.-MANDREL INDUSTRIES, INC.
2950 N. Dntario St., Burbank, Calif. (Tel. VIctoria 9-2341)
Purch. Agent: John W. De Brenan
Gen. Sales Mgr.: Edward J. Stephens MF, PS, GS, GE, CO, TS, TR, R&D

SEQUOIA WIRE CO.
2201 Bay Rd., Redwood City, Calif. (Tel. EMerson 9-0331)
Buyer: Ruth Pasco
Gen. Sales Mgr.: M. C. Jafferies MF, PS, GS, GH, CO, TS, TR

SERVD CDRP. OF AMERICA
2020 Jericho Turnpike, New Hyde Park, L. I., N. Y. (Tel. Fieldstone 3-4100)
Purch. Agent: R. Montag
Mktg. Mgr.: A. Freed
Govt. Sales Mgr.: S. S. Levine
Systems Sales Mgr.: Jules Cardon GS, GE, CO, TS, TR

SERVOMECHANISMS, INC.
12500 Aviation Blvd., Hawthorne, Calif. (Tel. ORegon 8-7841)
Purch. Agent: H. Muller
Sr. Buyer: E. Mason
Buying Supvr.: R. Womack
Buyers: L. Meyer, T. Butler & S. Jordan
Dir.-Customer Liaisan: G. S. Robinson GS, GH, GE, CO, TS, R&D

SERVDMECHANISMS, INC., MECHATRDL DIV.
1200 Prospect Ave., Westbury, L. I., N. Y. (Tel. EDgewood 3-6000)
Purch. Agent: James Dwens
Buyer: Louis Addazio
Sales Mgr.: T. Cataldo PS, GS, GH, GE, TS, TR

SERVWELL PRODUCTS CO.
6541 Euclid Ave., Cleveland 3, Dhio (Tel. EXpress 1-0497)
Dir.-Purch.: I. W. McCulley
Sales Mgr.: R. McCulley GH

SESCO MFG., INC.
4th & Prospect St., Bridgeport, Pa. (Tel. BRoadway 9-4350)
Pres.: S. E. Slaymaker, 3rd MF, WN, PS, GS, GE, TS

J. H. SESSIONS & SON
Riverside Ave., Bristol, Conn. (Tel. LUdlow 2-3127)
Pres.: Paul B. Sessions
Dir.-Sales: Ray Alcott MM

SETCHELL-CARLSON INC.
New Brighton, St. Paul 12, Minn. (Tel. MElrose 3-3131)
Pres. & Gen. Mgr.: B. T. Setchell
Secy.-Treas.: C. Donald Carlson
V. P.: Alice Chermak
Natl. Sales Dir.: Cal Karnstedt

SHAFER BEARINGS, CHAIN BELT CO.
Belmont at Curtiss St., Downers Grove, Ill. (Tel. WOodland 9-1770)
Purch. Agent: Robert L. Kaiser GS, GH, GE

SHALLCROSS MFG. CO.
Preston St., Selma, N. C. (Tel. WOodlawn 5-2341)
Purch. Agent: J. C. Scanlon
V. P.-Sales: D. M. O'Halloran WN, CH, GH

SHALLITE, INC.
128 W. First Ave., Roselle, N. J. (Tel. CHestnut 5-9800)
Purch. Agent: S. H. Dlszewski
Pres. & Sales Mgr.: C. K. Krouse TH

W. S. SHAMBAN & CO.
11617 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-6877); also Box 176, Meyer Rd., Ft. Wayne, Ind. (Tel. ANthony 6491)
Purch. Agent: Howard Drake
Sales Mgr.: Carl Wolff WN, MM, R&D

SHANNON LUMINOUS MATERIALS CO.
7356 Santa Monica Blvd., Hollywood 46, Calif. (Tel. HDllywood 7-5509)
Owner: James R. Alburger
Purch. (Gen.): Iris M. Guider MF, GS, GE, CO, TH

SHARON STEEL CORP.
Sharon, Pa. (Tel. DI 6-4141)
V. P.-Purch.: J. D. Neuman
Purch. Agent: G. R. McQuiston
V. P.-Comm.: W. J. McCune MM

SHARPLES CORP., THE
2300 Westmoreland St., Philadelphia 40, Pa. (Tel. BAldwin 8-9100)
Dir.-Purch.: William Neill
Sales Mgr.: Allen R. Greenlaw MM, R&D

SHAW BELTING CO., THE
150 William St., Middletown, Conn. (Tel. DI 6-8793)
Pres.: Ralph H. Shaw
Gen. Mgr.: Ralph H. Shaw, II GH

SHAW METAL PRODUCTS CORP.
101 Third Ave., Garden City Park, L. I., N. Y. (Tel. Pioneer 6-6650)
Purch. Agent: E. Morton MF, PS, GS, GH, GE, CO, TS

SHEFFIELD CORP., THE, SUB.-BENDIX AVIATION CORP.
Box 893, 721 Springfield St., Dayton 1, D. (Tel. CLearwater 4-5377)
Purch. Agent: Joseph Geyer MF, PS, GS, GH, GE, CO, TS, TH

SHELL CHEMICAL CORP., INDUSTRIAL CHEMICAL DIV.
380 Madison Ave., New York 17, N. Y. (Tel. OXford 7-3311)
Sales Mgr.: W. Q. Mooney
Gen. Mgr.-Purch.: W. H. Bratches MF, PS, MM

SHELL CHEMICAL CORP., PLASTICS & RESINS DIV.
50 W. 50th St., New York 20, N. Y. (Tel. JUdson 6-5000)
Gen. Mgr.-Purch.: W. H. Bratches
Sales Mgr.: D. P. Jones

SHELTERED WORKSHOPS
2521 5th St., Santa Monica, Calif. (Tel. EXbrook 9-7741)
Factories: Plant #1, 2521 5th St., Santa Monica, Calif.; Plant #2, 10835 Hawthorne Blvd., Inglewood 2, Calif.
Gen. Mgr.: J. E. Anthony MF, PS, GS, GH, T

ENANGO FURNANCE CO., THE, CENTRIFUGALLY CAST PRODUCTS DIV.
Third St., Daver, O. (Tel. 4-2114)
Purch. Agent: William Hague
Sales Mgr.: K. L. Jansen

EPARD LABORATORIES, INC.
Broad St. at Park Ave., Summit, N. J. (Tel. CRestview 3-5255)
Purch. Agent: Enoch Jones
Product Mgr.: E. J. Quinby GS, R&D

W. & C. B. SHERIDAN CO.
4701 Crenshaw Blvd., Tarrance, Colif. (Tel. DA 6-6702)
V. P.-Gen. Mgr.-West Coast Div.: Landon R. Gray
V. P.-Sales Mgr.: Wm. E. Seaman, Sr. (Tel. DIgby 9-4090)
Dir.-Sales, Aircraft: Charles Frazee MF, GS

ERMAN INDUSTRIAL ELECTRONICS, DIV.-ENGRG. DESIGN INC.
01 W. College Ave., Box 813, State College, Pa. (Tel. ADams 8-0061)
Office Mgr.: A. Lynn McIlaaine
Gen. Mgr.: A. R. Farrell R&D

ELDING INC.
ox 59, Riverton, N. J. (Tel. TAlmadge 9-1433)
en. Mgr.-Purch.: W. J. Ryan
hief Engr.: A. J. Dicciani
. P.-Sales: T. P. Reath GS, TS

OCKLEY TRANSISTOR CORP.
117 California Ave., Pola Alto, Calif. (Tel. DAvenport 1-2121)
ktg. Mgr.: Frank Newman
urch. Agent: Jack Carlson, 391 S. San Antanio Rd., Mountain View, Calif. (Tel. DAvenpart 6-1300) MM, R&D

SURE BROTHERS, INC.
22 Hartrey Ave., Evonstan, Ill. (Tel. DAvis 8-9000)
. P.-Purch.: M. A. Cape
uyers: L. Elkin & B. Farber
. P.-Sales: V. Machin GS, GE, TS, TR

SIR-LOK CORP.
79 S. East St., Anaheim, Calif. (Tel. PRaspect 4-2773)
res.: F. W. Rahe
urch. Agent: W. A. Livingstone
hief Engr.: D. B. Kreider MF, PS

SLEY MACHINE & FOUNDRY CORP.
06 E. Tutt St., Sauth Bend 23, Ind. (Tel. AT 8-4611)
urch. Agent: E. A. Evans
ales Mgr.: William H. Voll WN

SIR-BATH GEAR & PUMP CO., INC.
52 Hudson Blvd., N. Bergen, N. J. (Tel. UNion 9-3000)
urch. Agent: Martin Nocleria
les Mgr.: J. A. Glaser PS, GS, GH, TS

SIERRA ENGRG. CO.
3 E. Mantecita Ave., Sierro Madre, Calif. (Tel. ELgin 5-3318)
urch. Agent: Eugene Toms
r.-Sales: F. A. Ritterrath

SIERACIN CORP., THE
3 N. Victary Blvd., Burbank, Calif. (Tel. VIctario 9-2421)
urch. Agent: Miss Helen Tyle
. P.-Sales: J. E. Slatky MM

SIFTMASTER CORP.
Aleppo St., Providence, R. I. (Tel. TEmple 1-6200)
urch. Agent: Lawrence Arnott
les Mgr.: Gilbert Glass WN, PS, GE, CO, TR

SIGMA INSTRUMENTS, INC.
0 Pearl St., S. Braintree, Mass. (Tel. VIctor 3-5000)
rch. Mgr.: Alfred E. Faley
rch.: Kjell Pehrson
es Mgr.: R. B. Wolf GE

SIGMAMOTOR, INC.
N. Main St., Middlepart, N. Y. (Tel. RE 5-3611)
es.: Van G. Hungerford
n. Mgr.: Phillip J. Slattery R&D

SIGNAL TRANSFORMER CO.
51 McDonald Ave., Braaklyn 30, N. Y. (Tel. ESplanade 6-0615)
rch. Agent: E. Hirsch
yer: H. Apatheka
es Mgr.: Wm. J. Brinkley, Jr. GS, GH, GE

SILICALITE INC.
41 Neptune Hwy., Neptune, N. J. (Tel. PRospect 5-2490)
P.-Sales: Alvin W. Gershan GS, GE, TS, TR

SILENT HOIST & CRANE CO.
63rd St., Brooklyn 20, N. Y. (Tel. BEachview 2-2525)
Purch. Agent: Anthony Yuzzolino
Sales: M. M. Botnick

SILICON TRANSISTOR CORP.
150 Glen Cove Rd., Carle Pl., Lang Island, N. Y. (Tel. Ploneer 2-4101)
Purch. Agent: Joseph Zack
Sales Mgr.: Robert L. Ashley

SILICONE INSULATION, INC.
1383 Seabury Ave., Branx 61, N. Y. (Tel. SYcamore 2-4400)
Dir.-Purch.: G. Greck
Dir.-Sales: W. Elsfelder WN

SILICONE PRDDUCTS DEPT., GENERAL ELECTRIC CO.
Waterford, N. Y. (Tel. ADams 8-3330)
Purch. Agent: Paul Megan
Mgr.-Mktg.: Jerome T. Cae MF, PS, WN

SILICONE SEALS, INC.
3694 Milwaukee Ave., Chicaga 41, Ill. (Tel. AVenue 2-3787)
Secy.: Robert Shattaw
Sales: Leanard E. Brown MF, GS, GE

SILICONES DIV.-UNION CARBIDE CORP.
30 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 6-1700)
Purch. Agent: J. W. Gordon, Long Reach Silicanes Plant, P. O. Bax 180, Sistersville, W. Va. (Tel. OLdfield 2-3211)
Asst. Purch. Agent: R. Ankram, Sistersville
Gen. Sales Mgr.: L. J. Sinnatt MM

SIMMONDS AEROCESSORIES, INC.
105 White Plains Rd., Tarrytawn, N. Y. (Tel. MEdford 1-7500)
Purch. Agent: T. McAdams
Gen. Contracts Mgr.: H. C. Pringle MF, PS, TR, MM, R&D

SIMMONS FASTENER CORP.
N. Broadway, Albany 1, N. Y. (Tel. 62-5431)
V. P.-Gen. Mgr.: Harry H. Rase MF, GS, GH, GE, CO, TS, TR, R&D

SIMONDS SAW & STEEL CO.
470 Main St., Fitchburg, Mass. (Tel. Dlamand 3-3731)
Purch. Agent: Lauis A. Little, Intervale Rd., Fitchburg, Mass.
Gen. Sales Mgr.: Clyde N. Mansur MM

SIMPLEX PISTON RING MFG. CO.
12301 Benningtan Ave., Cleveland 11, O. (Tel. CLearwater 2-2205) MF, PS

SIMPLEX WIRE & CABLE CO.
79 Sidney St., Cambridge 39, Mass. (Tel. KIrkland 7-9000)
Adv. Mgr.: T. H. Marsh

SIMPSON ELECTRIC CO.
5200-18 W. Kinzie St., Chicaga 44, Ill. (Tel. EStebraok 9-1121)
Purch. Agent: James Werner
Sales Mgr.: M. O. Buehring TS

SINCLAIR MFG. CO.
S. Warcester St., P. O. Box 398, Chartley, Mass. (Tel. ATtleboro 1-2627)
Pres. & Treas.: John C. Sinclair
Sales Mgr.: Haward C. Brawnell MF, WN, PS, GS

SINCLAIR-COLLINS VALVE CO., DIV.-IBEC
454 Margon Ave., Akron, Ohia (Tel. PR 3-6623)
Dir.-Purch.: R. R. Stull
Sales Mgr.: D. R. Branaka GH, TS

SINGER MFG. CO., THE, MILITARY PRODUCTS DIV.
149 Braadway, New Yark 6, N. Y. (Tel. 9-1200)
Mgr., Military Praducts Div.: F. W. Hawells GS, GE, CO, TR, MM, R&D

SIOUX OIL CO.
P. O. Bax 811, Newcastle, Wya. (Tel. SHerwaad 6-4445)
Purch. Agent: G. R. Kaul
Sales Mgr.: Lea Nelson

BERNARD SIROTTA CO.
624 Smith St., Braaklyn 31, N. Y. (Tel. TRiangle 5-3897) MM

SIRVALCD SYSTEMS CORP.
43 Kendrick St., Wrentham, Mass. (Tel. EVergreen 4-3121)
Dir.-Purch.: James Mahaney
Dir.-Sales: E. Richard Bagarazy, New Yark, N. Y. (Tel. PLaza 3-3855)
V. P.: Vincent F. Siravo PS, GH

SITTLER CORP.
18 N. Ada St., Chicaga 7, Ill. (Tel. SEeley 3-4616)
V. P.-Purch.: S. J. Lanasa MF, GS, GH, TS, TR

SIZE CDNTRDL CO., DIV.-AMERICAN GAGE & MACHINE CD.
2500 W. Washingtan Blvd., Chicaga 12, Ill. (Tel. MO 6-6710)
Sales Mgr.: E. E. Olds WN, TS, MM, R&D

C. SJOBERG & SON
415 Statian St., Cranstan 10, R. I. (Tel. HO 1-8220)
Owner: C. Sjaberg, Sr.

SKIATRON ELECTRDNICS & TELEVISION CORP.
180 Varick St., New Yark, N. Y. (Tel. WAtkins 4-7060)
Purch. Agent: N. J. Ackerman
Prod. Mgr.: Albert Caputo
Sales: Frank V. Quigley GS, GE, CO, TR, R&D

SKIDMORE-WILHELM MFG. CO.
442 Green Rd., Cleveland, Ohia (Tel. IVanhae 1-4774)
Pres.: J. W. Wilhelm

SKINNER ELECTRIC VALVE DIV.
95 Edgewaad Ave., New Britain, Cann. (Tel. BAldwin 9-4826)
Purch. Agent: Cliffard Nelsan
V. P.-Sales: D. M. Stevenson PS, GS, GH, GE, TS

SKINNER PRECISION PRODUCTS
600 San Christapher St., Dunedin, Fla. (Tel. 81-5311)
Partners: Ben Skinner & B. C. Skinner MF, PS, GS, GH

SKINNER SEAL CO.
3001 Sutter St., Sonta Ana, Calif. (Tel. KI 5-5571)
Purch. Agent: Bill Philipson
Gen. Mgr.: Rabert T. Skinner MF, PS, GS, GE

SKYCRAFT TOOL ENGRG. CO.
11940 Bray St., Culver City, Calif. (Tel. LI 8-3265)
Purch. Agent: D. Harrisan
Pres.: R. M. Harrisan

SKYDYNE, INC.
River Rd., Part Jervis, N. Y. (Tel. 3-2241)
Dir.-Purch.: W. F. Maccallum
Buyer: B. E. Marchant
V. P. & Sales Mgr.: Robert L. Weill MM, R&D

SKYLINE ELECTRIC & MFG. CO.
203 W. Thamas St., Seattle 99, Wash. (Tel. ATwater 4-8420)
Project Engr.: Benna Persitz (Tel. ATwater 3-6941) GS, GH, GE, TR, R&D

SKYLINE PRODUCTS, INC.
819 Grand Blvd., Deer Park, N. Y. (Tel. DEer Park 2-8644)
V. P.-Sales: Thamas A. Perry
Buyer: Jahn Canning
Pres.: Marris Herberg MF, GS, GH

SKYVALVE INC.
2308 Washingtan Blvd., Venice, Calif. (Tel. EXbraak 6-3733); alsa 831 W. Fayette St., Syracuse 4, N. Y.
Purch. Agent: Anthany Vespa
Gen. Mgr.: Rabert Schaller PS, GS

SLAUGHTER CO., INC.
Piqua 18, O. (Tel. PRaspect 3-5936) TS

SLIP RING CO. OF AMERICA
(Plant) 3612 W. Jefferson Blvd., Las Angeles 16, Calif. (Tel. Republic 5-0253)
Purch. Agent: Larry Jacobsan
Sales Mgr.: Rabert A. Felburg (Engrg. & Sales) 5456 W. Washingtan Blvd., Las Angeles 16, Calif. (Tel. WEbster 1-8156) GS, GE, CD, TS, TR

SLOAN CO., THE
4029 W. Burbank Blvd., Burbank, Calif. (Tel. VIctaria 9-4667)
Purch. Agent: B. K. Pancher
Gen. Mgr.: Paul N. Zazanis GS, GH, GE, CO, TS, TR

SMALL MOTORS INC.
2076 Elstan Ave., Chicaga 14, Ill. (Tel. ARmitage 6-6900)
Pres.: R. R. Cook PS, GS, GE, TS

A. O. SMITH CORP.
P. O. Bax 584, 3533 N. 27th St., Milwaukee, Wisc. (Tel. UPtawn 3-3000)
V. P.-Purch.: M. E. Margan
Purch. Dept.: J. E. Borchert, A. J. Riedel, T. J.

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

Pas & L. H. Lennort
Dir.-Defense Products: H. D. Bornes MF, PS, R&D

A. O. SMITH CORP., SMITH-ERIE DIV.
250 Pork Ave., New York 17, N. Y. (Tel. YUkon 6-7400)
Purch. Agent: A. B. Madjeski, 5715 Smithway St., Los Angeles 22, Colif. (Tel. RAymond 3-3361)
Gen. Sales Mgr.: H. D. Leisenring

E. C. SMITH MFG. CO.
Forrest & Hector Sts., Conshohocken, Po. (Tel. TAylor 8-4790)
Dir.-Sales: Earl C. Smith

G. W. SMITH & SONS, INC.
1700 Spaulding Rd., Dayton, Ohio

L. B. SMITH AIRCRAFT CORP.
P. O. Box 456, International Airport Br., Miami 48, Flo. (Tel. TUxedo 8-8481)
Mgr.-Materials: Lloyd G. Culbertson
Purch. Agent: George Ceglor
V. P.-Aerosmith Prod: W. Peckham
V. P.-Aircraft Sales & Serv.: George R. Dutton

SMITH-MORRIS CORP.
825 Myrtle St., Ferndale, Mich. (Tel. JOrdon 6-3124)
Purch. Agent: L. Gnich
Sales Mgr.: G. W. Smith MF, WN, PS, GS, GH, GE

SMOOTH-ON MFG. CO.
572 Communipaw Ave., Jersey City 4, N. J. (Tel. HEnderson 3-0076)
Gen. Mgr.: H. M. Silver
Sales Mgr.: G. T. Morse MM

SNAP-ON-TOOLS CORP.
8154 28th Ave., Kenosha, Wisc. (Tel. OL 4-8681)
Dir.-Purch.: Fronk A. Tetzloff
Dir.-Sales: Rogers Polmer

SNAP-TITE, INC.
201 Titusville Rd., Union City, Po. (Tel. 497)
V. P.-Purch.: Myron W. Shafer
V. P.-Sales: Leonard M. Clark PS, GS, GH

SODERBERG MFG. CO., INC.
628 S. Polm Ave., Alhambra, Colif. (Tel. CUmberland 3-3382)
Purch. Agent: W. G. Lee
Sales Mgr.: W. W. Hulke MF, GS, GH, TS, TR

SOLAR AIRCRAFT CO.
2200 Pacific Hwy., San Diego 17, Calif. (Tel. BElmont 3-8241)
Mgr.-Purch.: William L. Vaughan
Supvr.-Buying: C. E. Powers
V. P.-Sales: Lynn D. Richardson MF, WN, GS, GE, MM, R&D

SOLARTRON INC.
10761 Burbank Blvd., N. Hollywood, Colif. (Tel. ST 7-5081)
Office Mgr.: J. A. Hughes
Sales Mgr.: F. J. Steward GS, GE, CO, TS

SOLON FOUNDRY, INC.
6370 SOM Ctr. Rd., Solon, O. (Tel. CHurchill 8-5304)
Purch. Agent: H. A. Lucos
Dir.-Sales: George N. Wright MF, WN

SOMERS BRASS CO. INC.
94 Baldwin Ave., Waterbury, Conn. (Tel. PLaza 6-8321)
Purch. Agent: William Jay
Sales Mgr.: Claude S. Speicher MM

SONOTONE CORP.
Elmsford, N. Y. (Tel. LY 2-6400)
Dir.-Purch.: John J. Downs
Battery Sales Mgr.: Eugene F. Murphy PS, R&D

SORENSEN & CO., INC.
Richards Ave., S. Norwalk, Conn. (Tel. TE 8-6571)
Purch. Mgr.: C. Boylan
Chief Purch. Agent: N. Grosso
Buyers: M. J. Ruddock, J. Horwood & R. Kassnoff
Mgr.-Mktg.: P. J. Deery GS, CO, R&D

SOROBAN ENGRG., INC.
Box 1717, Melbourne, Flo. (Tel. PA 3-7221)
Purch. Agent: Albert George
Pres.: C. F. West GE, CO, TS, TR

SOUND APPARATUS CO.
Morris St., Stirling, N. J. (Tel. MIllington 7-0600)
Purch.: H. Niemonn TS

SOUTH RIVER METAL PRODUCTS CO., INC.
377 Turnpike, S. River, N. J. (Tel. CLifford 4-5253)
Gen. Mgr.: J. Cohn
Sales Mgr.: Martin L. Roth MF, WN, PS, GH

SOUTH WIND DIV., STEWART WARNER CORP.
1514 Drover St., Indianopolis, Ind. (Tel. MElrose 2-8411)
Dir.-Purch.: Poul Ostler
Purch. Agent: George Leiendecker
Buyer: Som Salatich
Prod. Mgr.: L. E. Boss
Mgr.-Field Repres.: J. O. Coffey MF, PS, GS, TR, R&D

SOUTHCO DIV., SOUTH CHESTER CORP.
Lester, Po. (Tel. LEhigh 4-1800)
Purch. Agent: C. R. Hirzel
Gen. Mgr.-Sales: T. R. Ounlevy MF

SOUTHERN CALIF. COOPERATIVE WIND TUNNEL-CALIF. INST. OF TECH.
950 S. Raymond Ave., Pasadena, Calif. (Tel. SYcomore 9-4117)
Associate Dir.: Fred H. Felberg
Chief-Operations Dept.: Paul F. Keller TS

SOUTHERN ELECTRONICS CORP.
150 W. Cypress Ave., Burbank, Colif. (Tel. VIctoria 9-3193)
Purch. Agent: R. D. Hirst
Sales Mgr.: George E. Gansell GE, TS, TR

SOUTHWEST PRODUCTS CO.
1705 S. Mountoin Ave., Monrovio, Calif. (Tel. ELliott 8-0181)
Pres. & Gen. Mgr.: K. V. Hackman MF, WN, PS, GS, GH, GE

SOUTHWEST PRODUCTS, INC.
Rt. 4, Box 90, San Antonio, Tex. (Tel. GEneral 2-5266)
Purch. Agent: Robert Collsen CO, TS

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.
10201 Westheimer Rd., P. O. Box 13058, Houston 19, Tex. (Tel. HOmestead 5-3471)
Purch. Agent: W. T. Wooddell
Buyer-Electranic: G. Knower
Buyer-Mechanical & Misc.: C. Brock
V. P.-Sales: R. H. Parker
Gen. Sales Mgr.: W. C. Dunn GS, GH, GE, CO, TS, TR, R&D

SOUTHWESTERN INDUSTRIES, INC.
5880 Centinelo Ave., Los Angeles 45, Colif. (Tel. ORegon 8-8915)
Purch. Agent: Deon F. Oirkson
Pres.: F. P. Jenks PS, GS, GE, CO

SOUTHWIRE CO.
14 Fertilla St., Carrollton, Go. (Tel. TErrace 2-6311)
Purch. Agent: Jomes A. Hatley
Sales Mgr.: J. H. Griffin MM

SPACE CORP.
P. O. Box 5172, Dallas 22, Tex. (Tel. BR 6-5121)
Dir.-Purch.: James J. Nelsen
Asst. Dir.-Purch.: Jay Horne
Buyers: Earl Grunewald, Gene Grubbs, Ken Gracy & George Beardsley
V. P.-Sales: Ellie Jones GS, GH, CO, TS, TR, R&D

SPACE TECHNOLOGY LAB.
5740 Arbor Vitae, Inglewood, Colif.

SPACEFLIGHT FILMS
9 W. 19th St., New York 11, N. Y. (Tel. AL 5-1827)
Dir.-Purch.: Alex Haberstroh

SPARKLER-FILTRION CORP.
24th & Commonwealth, North Chicago, Ill. (Tel. DExter 6-4050)
V. P.-Res. & Dev.: Robert Blevitzky
Pres.: Fred H. Horne

SPARTA MFG. CO., DIV.-U. S. CERAMIC TILE CO.
Dover, O. (Tel. DOver 4-2380)
Plant Mgr.: C. M. Storkey
Sales Mgr.: Myron L. Bailey MF, WN, PS, GE, TR

SPARTAN MARKING CORP.
222 W. Huron St., Chicago 10, Ill. (Tel. SUperior 7-6630)
Sales Mgr.: J. V. Galloway MF, WN, PS, GS, GE, CO, TS, TR

SPAULDING FIBRE CO., INC.
310 Wheeler St., Tonowondo, N. Y. (Tel. JAckson 2000)
Purch. Agent: W. L. Grieser
Gen. Sales Mgr.: W. R. Gilsdorf MM

SPEC TOOL CO.
9626 E. Beverly Rd., Pico Rivera, Calif. (Tel. OX 5-9117)
Purch. Agent: R. J. Snider
Sales Mgr.: J. M. Caulfield GS, GH

SPECIAL INSTRUMENTS DIV., BRITISH INDUSTRIES CORP.
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Dir.-Sales: S. Bosworth

SPECIAL PROJECTS LAB., FOOD MACHINERY & CHEMICAL CORP.
Box 58, Station G, Buffalo 13, N. Y. (Tel. GArfield 6320)
Purch. Agent: Edwin Folts
Operating Mgr.: John Keefe PS, GH, TS, R&

SPECIALTIES, INC.
Skunks Misery Rd., Syosset, N. Y. (Tel. WAlnut 1-2345)
Purch. Agent: George Chadwick
V. P.-Sales: John C. Slocum GS, GE, R&

SPECIALTIES MFG. CO., INC.
125 Bruce Ave., Stratford, Conn. (Tel. EDison 7-4429)
Purch. Agent: J. J. Zimmer
Sales Mgr.: A. I. Zimmer

SPECIALTY ENGRG. & ELECTRONICS CO.
79 Clifton Pl., Brooklyn 38, N. Y. (Tel. ULster 7-4760)
Chief Purch. Agent: J. Ross
Purch. Agent, Electranic: D. Alster
Purch. Agent, Factary Supply: W. Prichep
Purch. Agent, Mech. Parts: M. Friedlonder
Sales Mgr.: H. R. Cammer G

SPECIALTY PLUG & CAP CO.
5422 Fairlawn Ave., Baltimore 15, Md.
Dir.-Sales: H. E. Foxman GH, T

SPECIALTY PRODUCTS CORP.
29980 Lakeland Blvd., Wickliffe, O. (Tel. WHitney 3-3040)
Purch. Agent: Howord Seobeck
Dir.-Sales: J. J. Skelly MF, GS, GH, GE, CO, T

SPECTRA-STRIP WIRE & CABLE CORP.
P. O. Box 415, 10052 Larson Ave., Gorden Grove, Colif. (Tel. JEfferson 7-4530)
Purch. Agent: Donald D. Long
Sales Mgr.: John Ford GS, GE, T

SPECTROL ELECTRONICS CORP.
1704 S. Del Mor Ave., San Gobriel, Calif. (Tel. ATlantic 7-9761)
Purch. Agent: H. J. Fedora
Sales Mgr.: Robert K. Burtner GS, GE, R&I

SPECTRONIC PLATING CO., INC., DIV-SPEC-TRANOME PLATING CO., INC.
330 W. 13th St., New York 14, N. Y. (Tel. ALgonquin 5-8677)
Purch. Agent: K. Philips
Sales Mgr.: E. J. Brennan MM, R&I

SPECTRUM INSTRUMENTS, INC.
Box 61 Steinway Sta., Long Island City 3, N. Y. (Tel. AStoria 8-8033)
Purch. Agent: J. F. McCleon TS, R&D

SPENCER DIV.-METALS & CONTROLS CORP.
34 Forest St., Attleboro, Mass. (Tel. ATtleboro 1-2800)
Purch. Agent: E. B. Corpenter
V. P.-Mktg.: J. F. Wilson GS, GH, GE

SPENCER-SAFFORD
Augusta, Kons.

SPERRY ELECTRONIC TUBE DIV.-SPERRY RAND CORP.
Gainesville, Flo. (Tel. FRonklin 2-0411)
Sales Mgr.: J. R. Whitford GS, GE, CO, TS, TR, R&D

SPERRY FARRAGUT CO., DIV.-SPERRY RAND CORP.
Bristol, Tenn. (Tel. WOodland 8-1151)
Purch. Agent: S. J. Nastri
Buyer, Subcontracts: J. V. Wilsan
Buyers: C. R. Keith, H. W. Peters, T. R. Rutledge & W. R. McCracken
Sales Mgr.: C. W. Brown GE, R&D

SPERRY GYROSCOPE CO., MARINE DIV.-SPERRY RAND CORP.
Roosevelt Field, Gorden City, L. I., N. Y. (Tel. Pioneer 2-4400)
Sales Mgr.: C. W. Whell
Chief Buyer: L. S. Wichser, 3 Aerial Way, Syosset, L. I., N. Y. (Tel. WElls 8-8000) GE, CO, TS, R&D

SPERRY MICROWAVE ELECTRONICS CO., DIV.-SPERRY RAND CORP.
Clearwater, Flo. (Tel. REdwood 6-4161)
Sales Mgr.: E. C. Best GS, CO, TS, R&D

SPERRY PIEDMONT CO., DIV.-SPERRY RAND CORP.
Rt. 29, Charlottesville, Vo. (Tel. 3-6111)
Chief Buyer: E. Hopkins
Chief Buyer-Comm. Prods.: T. McCartin
Sales Mgr.: L. W. Gibson GE, CO, R&D

SPERRY PRODUCTS, INC.
Shelter Rock Rd., Danbury, Conn. (Tel. Pioneer 8-3581)
Purch. Agent: C. W. Penque
Asst. Sales Mgr.: R. Y. Neiley TS

ERRY RAND CORP.
30 Rockefeller Plaza, New York 20, N. Y. (Tel. Circle 6-4800)

ERRY SEMICONDUCTOR DIV.-SPERRY RAND CORP.
South Norwalk, Conn. (Tel. VOlunteer 6-1641)
Sales Mgr.: A. M. Varnum GE, TR, R&D

HERE CO. INC., THE
25 Amity St., Little Falls, N. J. (Tel. CLiffard 6-2550)
Pres.: C. E. Beronio
Sales Mgr.: A. D. Travis

HINX-AMERICAN CO.
12 Cherry Lane, Floral Park, L. I., N. Y. (Tel. HUnter 8-2600)
Dir.-Purch: Herman H. Batie
Dir.-Sales: Henry Nomburg MM

INCRAFT, INC.
158-C W. State St., Milwaukee 8, Wisc. (Tel. Division 2-0730)
Purch. Agent: Anthany Brinavec, 4122 W. State St., Milwaukee 8, Wisc.
V. P.-Sales: George F. Farley MF, WN, MM, R&D

SROID DIV.-ILLINOIS TOOL WORKS
501 N. Keeler Ave., Chicago, Ill. (Tel. CA 7-2200)
Purch. Agent: Arthur Fraehlich
Div. Mgr.: F. Bahle

S.IT BALLBEARING, DIV.-MPB
Lebanon, N. H. (Tel. 800)
Purch. Agent: R. E. Tinkham
Sales Mgr.: A. J. Renz PS, GE

S:AYING SYSTEMS CO.
201 W. Randolph St., Bellwaad, Ill. (Tel. LInden 4-0380)
Purch. Agent: W. C. Blaomer
Sales Mgr.: Joseph Pelej GS

RSPRUCE CO.
An Affiliate of American Aviation Publications, Inc., 608 S. Dearborn St., Chicago 5, Ill. (Tel. WAbash 2-1279)
Mgrs.: Robert E. Tynan & Paul W. Higgins TP

SPRUCE PINE MICA CO.
P. O. Box 456, Spruce Pine, N. C. (Tel. POplar 5-4241)
Pres.: S. A. Montague
V. P.-Sales: E. H. Farnam MM

STERS GAGE CO.
784 W. 11 Mile Road, Berkley, Mich. (Tel. JO 4-5980)
Purch. Agent: C. F. McDonald
Pres.: R. D. Squiers GS, GH, TS

STACKPOLE CARBON CO.
1542 Stackpole St., St. Marys, Pa. (Tel. TE 4-1521)
Purch. Agent: O. R. Hagan
Mgr., Carbon Sales: W. E. Clancy GE, TR, MM

STAINLESS INC.
North Wales, Pa. (Tel. OXbow 9-4871)
Purch. Agent: R. F. Farrington
Prog. Sales Mgr.: John F. Guzewicz MF, GS, GH, TS, TR, R&D

STAINLESS STEEL PRODUCTS, INC.
2880 N. San Fernando Blvd., Burbank, Calif. (Tel. VI 9-3283)
Purch. Agent: E. A. Maare
Contract Admin.: Wm. Van Oen Akker MF, PS, GS, GH, GE

STALKER CORP., THE
21 Woodside Ave., Essexville, Mich. (Tel. TWinbrook 3-7562)
Purch. Agent: R. A. Bluhm PS, R&D
Sales Mgr.: W. W. Dempsey

STAT MFG. CO., INC.
25 Shames Dr., Westbury, L. I., N. Y. (Tel. EDgewaad 4-8700)
Purch. Agent: John Vanderwoude MF, WN, PS, GS

STECIL-HOFFMAN CORP., THE
21 N. Highland Ave., Hallywood 38, Calif. (Tel. HOllywaad 4-7461)
Purch. Agent: J. V. Kelly
Sales Mgr.: R. H. Stensby GE, TS, TR

STANDARD CABINET CO.
Washington Ave., Carlstadt, N. J. (Tel. GEneva 8-1500)
Pres.: E. S. Brown
Sales Mgr.: R. O. Nartan GS, TS

STANDARD COILS PRODUCTS CO., INC., DIV.-KOLLSMAN INSTRUMENT CORP.
208 45th Ave., Elmhurst, N. J.

STANDARD CONTROLS, INC.
2130 Paplar Pl., Seattle 44, Wash. (Tel. KA 4-8888)
Pres.: W. A. Paine, II
Buyer: R. Helmick
Sales Mgr.: W. E. Forland PS, GS, GE, CO, TS

STANDARD ELECTRIC CO., INC.
P. D. Box 6356, 3016 Austin Hwy., San Antonia 9, Tex. (Tel. TA 2-3341)
Pres.: Lea Dubinski

STANDARD ELECTRIC TIME CO., THE
89 Logan St., Springfield, Mass. (Tel. REpublic 6-7237)
V. P.-Purch.: L. P. Marshall
Dir.-Sales: R. M. Warren CO, TR, R&D

STANDARD ELECTROMAGNETICS, INC.
Walkersville, Md. (Tel. VInewood 5-3041)
Pres.: E. J. Baland
Dir.-Sales & Engrg.: R. P. Bennett GS, TS, TR

STANDARD ELECTRONICS DIV., RADIO ENGRG. LABS. INC.
29-01 Bordan Ave., Lang Island City, N. Y. (Tel. STillwell 6-2100)
Purch. Agent: Wm. Dunwe
V. P.-Sales: Wm. H. Zillger

STANDARD FELT CO.
29-115 S. Palm Ave., Alhambra, Calif. (Tel. ATlantic 2-5106)
Purch. Agent: K. Brunk MF, PS

STANDARD GAGE CO., INC.
70 Parker Ave., Paughkeepsie, N. Y. (Tel. GRover 1-3100)
Purch. Agent: J. Phillips
Sales Mgr.: D. C. Cunningham

STANDARD LOCKNUT & LOCKWASHER INC.
2250 Valley Ave., Indianapalis 18, Ind. (Tel. ME 2-9505)
Office Mgr.: R. E. Ramage
V. P.-Sales: T. D. Danohue MM

STANDARD METALS CORP.
262 Braod St., N. Attlebara, Mass. (Tel. MYrtle 5-9395)
Purch.: Lloyd W. Chase, Jr.
Sales: Danold Kingman MF, WN, PS, GS, GE, TS, TR

STANDARD OIL CO. OF INDIANA
910 S. Michigan Ave., Chicago 80, Ill. (Tel. HArrisan 7-9200)
Dir.-Sales: John D. Neesley PS

STANDARD PRESSED STEEL CO.
Box 1105, Jenkintawn, Pa. (Tel. TUrner 4-7300)
Dir.-Purch.: J. P. Moorhouse
Asst. Dir.-Purch.: R. C. Gibbs
Gen. Mgr., Aircraft/Missile Div.: J. P. Villa MM, R&D

STANDARD STEEL CORP.
5001 Boyle Ave., Las Angeles 58, Calif. (Tel. LU 5-1231)
Dir.-Purch.: Claude M. Turner GS

STANDARD-THOMSON CORP., CLIFFORD MFG. CO. DIV.
152 Grave St., Waltham 54, Mass. (Tel. TWinbrook 4-7310)
Dir.-Purch.: Elmer F. Wilcox
Sales Mgr., Aircraft Div.: Gunnar G. Karlsan MF, PS

STANFORD RESEARCH INSTITUTE
333 Ravenwaad, Menla Park, Calif. (Tel. OAvenport 6-6200)
Purch. Agent: Lenora Whitman R&D

WILLIAM W. STANLEY CO. INC.
401 Broadway, New Yark, N. Y. (Tel. CA 6-5420)
V. P.-Purch.: A. R. Peer
Treas.: S. H. Daggett, Jr.

STANLEY AVIATION CORP.
2501 Dallas St., Denver 8, Cala. (Tel. EMpire 6-3581)
Dir.-Purch.: R. Fuller
Purch. Agent: C. Besemann
Buyers: A. Buschback, T. Wright
V. P.-Sales: R. H. Frost MF, GS, GH, CO, TS, TR, R&D

STANLEY-JUDD DIV.-THE STANLEY WORKS
42 S. Cherry St., Wallingford, Conn. (Tel. CDlany 9-3353)
Purch. Agent: Frank Karalshak
Comm. Sales Mgr.: Bradford M. Scatt
Asst. Sales Mgr.: Warren H. Torrant
Gen. Mgr.: H. Henry Martens WN, GS, GE

STANWYCK WINDING CO., INC.
137-151 Wolsh Ave., Newburgh, N. Y. (Tel. NEwburgh 3360)
V. P.-Purch.: Nicholos Stanwyck
Pres.: Wm. J. Stanwyck

STAR EXPANSION
Mauntainville, N. Y. (Tel. COrnwall 3-3755)
Purch. Agent: Robert Schneider
Buyers: Oanald Cracker & Jules Yanez
V. P.-Sales: Harry Fax

STAR STAINLESS SCREW CO.
655 Union Blvd., Paterson, N. J. (Tel. CLifford 6-2300)

STARK TOOL CO.
Box 288, Ann Arbor, Mich. (Tel. HUnter 3-4233)
Purch. Agent: James V. Waad
Sales Mgr.: Harald Stark

L. S. STARRETT CO., THE
121 Crescent St., Athal, Mass. (Tel. CHurchill 9-3551)
Purch. Agent: C. B. McMillan
V. P.-Sales: C. D. Newtan GS

STATE TESTING LABORATORY INC.
226 Knawltan St., Bridgeport, Conn. (Tel. ED 4-4079)
Secy. & Treas.: E. B. Pickman TS, R&D

STATES CO., THE
19 New Park Ave., Hartford 6, Cann. (Tel. ADams 3-6232)
Purch. Agent: William Steidel
Sales Mgr.: Howard N. Porter TS, R&D

STATHAM INSTRUMENTS, INC.
12401 W. Olympic Blvd., Las Angeles, Calif. (Tel. BR 2-0371)
Purch. Agent: Robert Maare
Dir.-Mktg.: Robert Lent MF, WN, PS, GS, GE, TS, TR, R&D

STATIKIL, INC.
1220 W. 6th St., Cleveland 13, D. (Tel. CHerry 1-3939)
V. P.-Purch.: Donald J. Doyle GS, TR

STATOR ELECTRIC CORP.
46-25 58th St., Woodside 77, N. Y. (Tel. HIckary 6-9092)
Pres.: Martin Blumenthal

STAVER CO., INC., THE
47 N. Saxan Ave., Bay Shore, N. Y. (Tel. 7-3620)
Secy.: R. W. Collins
V. P.: J. B. Lazarus MF, WN, PS, GS, GE, CO, TS, TR

STAVID ENGRG., INC.
U. S. Hwy. 22, Plainfield, N. J. (Tel. PLainfield 7-1600)
Purch. Agent: J. H. Tcharni
Dir.-Contracts & Sales: H. J. Bradfield GE, CO, TS, TR, R&D

STEARNS-ROGER MFG. CO., THE
P. O. Box 5370, Denver 17, Cola. (Tel. AComa 2-8484)
Chief Purch. Engr.: R. W. Graeber
Asst. Chief Purch. Engr.: J. G. Canstantine
Purch. Engrs.: J. H. Carr & O. E. Froid
Div. Mgr.: R. W. Akerlaw PS, GS, GH, TS, R&D

HERMAN D. STEEL CO.
Lafayette Bldg., Philadelphia 6, Pa. (Tel. WA 5-1990)
Head-Purch. Dept.: P. N. Steel, Jr.
Head-Sales: W. W. Woalfard MF, WN, PS, GS, GE

STEEL CITY TESTING MACHINES, INC.
8817 Lyndan Ave., Detroit 38, Mich. (Tel. WEbster 3-3500)
Purch. Agent: Jos. D'Brien
Pres.: Louis A. Welt TS

STEEL IMPROVEMENT & FORGE CO., THE
970 E. 64th St., Cleveland 3, Ohio (Tel. UTah 1-8600)
Purch. Agent: Ford Parkes
Steel Buyer: George Mahon
V. P.-Sales: H. A. Zimmerman MM

STEIN SEAL CO.
20th St. & Indiana Ave., Philadelphia 32, Pa. (Tel. BAldwin 3-3513)
Asst. Gen. Mgr.-Purch.: Lawrence Goldschmidt
Gen. Mgr.-Sales: P. C. Stein PS

STEPHENS ADAMSON MFG. CO., SEAL MASTER BEARING DIV.
Ridgeway Ave., Aurora, Ill. (Tel. AUrara 2-4311)
Purch. Agent: K. Johnsan
V. P.-Bearing Div.: C. B. Hurd PS, GH, R&D

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

STERLING GLASS CORP.
304 E. 116th St., Chicago, Ill. (Tel. PU 5-7462)
V. P.-Purch.: Blose Lazzara
Pres.: R. L. Cunningham
GE, TR, MM, R&D

STERLING PRECISION CDRP., INSTRUMENT DIV.
17 Matinecock Ave., Port Washington, N. Y. (Tel. PO 7-7200)
Purch. Agent: J. Cassota
Purch. Agent, Res. & Dev.: Arthur Chirkis
Gen. Sales Mgr.: H. J. Hannon
GS, GH, GE, CO, TS, R&D

STERLING TRANSFDRMER CORP.
297 N. 7th St., Brooklyn 11, N. Y. (Tel. STagg 2-4200)
Purch. Agent: Coleman Sanders
Sales Mgr.: E. Martoccia
GS, GE, TS, TR

STERLING-HDWARD CDRP.
561 E. Tremont Ave., New York 57, N. Y. (Tel. CYpress 9-6400)
V. P.-Purch.: Irving M. Carr
Sales Mgr.: Harry Astor

A. T. STEVENS CD.
118 E. 28th St., New York 16, N. Y. (Tel. MUrray Hill 5-1877)
Purch. Agent: R. Ouke Powell, Jr.
MF, WN, PS, GS, CO, TS

STEVENS MFG. CO., INC.
P. O. Box 1007, Mansfield, O. (Tel. TUxedo 4-1311)
Dir.-Purch.: L. C. Frasher
V. P.-Sales: G. H. Rouse
V. P.-Engrg.: C. S. Mertler
MM

STEVENS PRODUCTS, INC.
86 Main St., E. Orange, N. J. (Tel. OR 2-2140)
V. P.: Ross S. Stevens
Sales Mgr.: John Thomson
MM

M. C. STEWART
Ashburnham, Mass. (TA 7-5840)
Pres.: M. C. Stewart
GS, R&D

F. W. STEWART CORP.
4311-13 N. Ravenswood Ave., Chicago 13, Ill. (Tel. GRaceland 2-6600)
Gen. Mgr.: J. H. Jacobsen
Purch. Agent: G. O. Talley
Sales Mgr.: R. A. Thies
Chief Engr.: J. Hrouda
GH, GS, GE, TR

STEWART-WARNER CORP.
1826 Diversey Pkwy., Chicago, Ill. (Tel. LAkeview 5-6000)
Dir.-Purch., Stewart-Warner Corp., 1826 Pkwy., Chicago 14, Ill.: E. N. Osterberg
Dir.-Purch., Stewart-Warner Electronics, 1300 N. Kostner Ave., Chicago, Ill.: I. Blackberg (Tel. AL 2-1000)
Purch. Agent, Stewart-Die Casting Co., 4535 Fullerton Ave., Chicago, Ill.: R. C. Olsen (Tel. AL 2-5308)
Purch. Agent, Stewart-Warner Corp., 1514 Drover, Indianapolis, Ind.: P. Ostler
Purch. Agent, The Bassick Co., Bridgeport, Conn.: G. Raiselis
MF, WN, PS, GS, GE, TS, TR

STIC-KLIP MFG. CO.
180 Regent St., Cambridge 40, Mass. (Tel. UNiversity 4-6260)
Gen. Mgr.: G. N. Maloney
MM

EDWIN B. STIMPSON CD., INC.
70 Franklin Ave., Brooklyn, N. Y. (Tel. ULster 5-3131)
Dir.-Purch.: Mr. Schumacher
Dir.-Sales: Mr. Larson
MM

STODDART AIRCRAFT RADIO CD., INC.
6644 Santa Monica Blvd., Hollywood 38, Calif. (Tel. HOllywood 4-9292)
Purch. Agent: Glenn Fogg
Sales Mgr.: John R. Stevenson
GS, TS, R&D

F. J. STOKES CDRP.
5500 Tabor Rd., Philadelphia, Pa. (Tel. CUmberland 9-0100)
Mgr.-Materials & Prod. Planning Dept.: W. T. Minnick
Buyers: D. Law, C. Roney, W. Schmucker & F. Urban
V. P.-Sales: A. A. Hutchings
PS, GS, GH

A. U. STONE & CD., INC.
17 W. 60th St., New York, N. Y. (Tel. COlumbus 5-1350)
Purch. Agent: H. Grant
Pres.: Allan Stone
MF, WN, PS, GS

STONE CITY PRDDUCTS CO.
1206 7th St., P. O. Box 351, Bedford, Ind. (Tel. BRowning 5-3373)
Owner: O. H. Rariden

STRAND ENGRG. CD.
1354 N. Main St., Ann Arbor, Mich. (Tel. NOrmandy 2-3127)
Controller: K. L. Leighton
V. P.-Engrg.: R. E. Miller
GE, CO, TS, TR, R&D

STRATDFLEX, INC.
220 Roberts Cut-Off, Ft. Worth, Tex. (Tel. PErshing 8-6543)
Purch. Agents: E. E. Bradley & B. W. Harper
Buyer: James Clayton
Pres.: C. A. Thomas
MF, PS, GS, GH, CD, TS, MM, R&D

STRATDS, DIV.-FAIRCHILD ENGINE & AIR-PLANE CDRP.
Orinoco Dr., Bay Shore, L. I., N. Y. (Tel. MOhawk 5-0100)
Purch. Agent: John A. L'Hommedieu
Gen. Sales Mgr.-Aviation Prods.: W. Thomas Stark
Western Branch: 1800 Rosecrans Ave., Manhatton Beach, Calif. (Tel. OSborne 5-9111)
Purch. Agent: F. S. Lakin
WN, PS, GS, GH, R&D

STRAT-O-SEAL MFG. CO.
3039 W. Fullerton, Chicago 47, Ill. (Tel. HUmboldt 9-1282)
Plant Mgr.: Howard O. Walsh
GS

STRDMBERG-CARLSDN DIV.-GENERAL DYNAMICS CORP.
100 Carlson Rd., Rochester, N. Y. (Tel. HUbbard 2-2200)
Gen. Purch. Agent: John W. Averill
Purch. Agent, Electronics Div.: Miles G. Agan (Tel. FIllmore 2-8000)
Purch. Agent, Telecommunicatians Div.: Donald G. Rosin
CO, TS, TR

STRDNG SCDTT MFG. CD., THE
451 Taft St. N. E., Minneapolis 13, Minn. (Tel. STerling 1-7461)
Purch. Agent: B. H. Hollen
Mgr., Contract Div.: M. G. Mutch
WN, PS, GH, R&D

STRUTHERS-DUNN, INC.
Lamb's Rd., Pitman, N. J. (Tel. LUther 9-7500)
Purch. Agent: G. M. Herb
V. P.-Sales: G. B. Conger, Jr.

W. WHITNEY STUECK, INC.
Box 355 MR, Old Saybrook, Conn. (Tel. EV 8-9309)
Pres.: W. Whitney Stueck

P. A. STURTEVANT CO.
Addison, Ill. (Tel. ELmhurst, Ill.-TErrace 4-2000)
Purch. Agent: Joe Esposito
Sales Mgr.: Lee A. Sturtevant
TS

STURTEVANT MILL CO.
103 Clayton St., Oorchester, Boston 22, Mass. (Tel. TAlbot 5-6500)
Purch. Agent: Walter Masuret
Pres.: G. P. Towle
GS, GH

SUFFOLK PRODUCTS CDRP.
Woodbine & Scudder Aves., Northport, N. Y. (Tel. ANdrew 1-7000)
Head-Purch. Dept.: Fred Marin
Sales Engr.: C. J. Dvorak
MF, TR

H. W. SULLIVAN, LTD.
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Dir.-Sales: Si Bosworth

SUMMERS GYRDSCDPE CO.
2500 Broadway St., Santa Monica, Calif. (Tel. EXbrook 3-6711)
Dir.-Purch.: Ray Williams
Dir.-Sales: Charles Z. Becker
GS, GE, CD, TS

SUN DIAL CORP.
P. O. Box 326, Passaic Ave., Caldwell, N. J. (Tel. CApital 6-4334)
Office Mgr.: George J. Martin
Sales Mgr.: Cornelius Lokker
GS, GE, CO, TS

SUN ELECTRIC CORP., AERDNAUTICAL DIV.
Harlem & Avondales Aves., Chicago 31, Ill. (Tel. NEwcastle 1-6000)
Dir.-Purch.: R. E. Kane
V. P.-Dir., Aeronautical Div.: F. E. Draper
GS, CO, TS, R&D

SUNDSTRAND AVIATIDN, DIV.-SUNDSTRAND MACHINE TDDL CO.
2421 11th St., Rockford, Ill. (Tel. 8-6811)
Dir.-Prod. & Purch.: Quin Bowen
Purch. Mgr.: Don Bredahl
Contracts Mgr.: P. A. Anderson
MF, PS, GS, GH, GE

SUNDSTRAND TURBD
2480 W. 70th Ave., Denver 21, Colo. (Tel. HA 9-1561); Pacoima, Calif. (Tel. EM 6-8121)
Mgr.-Purch., Denver: William Hammond
Sr. Buyer, Denver: Lou Harder
Purch. Agent, Pacaima: Robert Meyersan
Mgr.-Sales, Pacaima: Robert Holzl
Chief Appl. Engr., Denver: R. Bruce Foster
MF, WN, PS, GS, GH, GE

SUPEREX ELECTRDNICS CDRP.
4-12 Radford Pl., Yonkers, N. Y. (Tel. YOnkers 5-6906)
Purch. Agent: O. Schulman
Asst. Purch. Agent: F. Gold
Sales Mgr.: Marvin L. Bucholter
GS, GH, GE, T

SUPERIOR AIR PRODUCTS CO.
132 Malvern St., Newark 5, N. J. (Tel. MArket 3-5715)
Chief Engr.: L. E. Putman
GS, GH, R&D

SUPERIOR CABLE CORP.
Box 480-A, Hickory, N. C. (Tel. OI 5-4161)
Purch. Agents: Manley Fuller & Brock Johnson
V. P.-Sales: J. H. Bowman
GS, GH, GE, TI

SUPERIOR CARBON PRDDUCTS, INC.
9115 George Ave., Cleveland 5, O. (Tel. VUlcan 3-4880)
Purch. Agent: Raymond H. Kling
Sales Mgr.: Ted Liebert
MF, WN, PS, GS, GE, TI

SUPERIDR ELECTRIC CD., THE
83 Laurel St., Bristol, Conn. (Tel. LUdlow 2-9561)
Purch. Agent: A. Greger
Sales Mgr.: J. Louden
GS, T

SUPERIOR ELECTRONICS CORP.
208 Piaget Ave., Clifton, N. J. (Tel. GRegory 2-2500)
Purch. Agent: Donald Mabey
Asst. Purch. Agent: John Witterschein
Sales Mgr.: Michael Hogan
GE, R&D

SUPERIOR FLUX & MFG. CD., THE
1536 St. Clair Ave., Cleveland 14, O. (Tel. SUperior 1-9373)
Pres.: Robert R. Mendelson
V. P.-Purch.: R. E. Handler
MF, MM

SUPERIDR PNEUMATIC & MFG., INC.
4758 Warner Rd., Cleveland 25, O. (Tel. BRoadway 1-1522)
V. P. & Gen. Mgr.: W. I. Krewson, Jr.
GS

SUPERIOR SPINNING & STAMPING CO.
4057-63 Fitch Rd., Toledo 13, O. (Tel. GReenwood 2-2175)
Secy.: L. G. Avery
Pres.: W. H. Schomburg
MM

SUPERIOR STEATITE & CERAMIC CDRP.
83-91 W. Forest Ave., Englewood, N. J. (Tel. LOwell 8-4555)
Purch. Agent: T. H. Church
MM

SUPERIOR TUBE CO.
Box 191, Norristown, Pa. (Tel. BRoadway 5-2070)
Dir.-Purch.: Elmer W. Hayes
Purch. Agent: Leroy Buckwalter
Buyers: Ralph Esser, Stanley Fretz, William Schlutz, Gerold Claycomb
Gen. Mgr.-Sales: Henry B. Brown
MM

SURFACE CDMBUSTIDN CORP.
2375 Dorr St., Toledo 1, Ohio

SURPRENANT MFG. CO.
172 Sterling St., Clinton, Mass. (Tel. 2180)
Gen. Mgr.: G. E. Forsberg
Sales: P. V. Tessier
MF, WN, PS, GS, GH, GE, TS, TR

SWAN RUBBER CO.
436 E. Mansfield St., Bucyrus, Ohio (Tel. 3-1015)
Purch. Agent: R. L. Stoneburner
Asst. Purch. Agent: T. W. Painter
Gen. Sales Mgr.: H. A. Loewy
GS

SWARTWDUT CD., THE
P. O. Box 2468, Cleveland 12, Ohio (Tel. IVanhoe 1-0780)
Dir.-Sales: John Weber

SWAYNE, RDBINSON & CO.
200 Main St., Richmond, Ind. (Tel. 2-4071)
Purch. Agent: Jo Sickmann
V. P.-Sales: C. K. Robinson, Jr.
MF, GS, MM

SWEDLDW INC.
6986 Bandini Blvd., Los Angeles, Calif.; 394 N. Meridian Rd., Youngstown, Ohio (Tel. RAymond 3-3211)
Dir.-Purch.: R. H. Affeld
Buyer: J. Ruth
Dir.-Contracts: W. H. Face
MM, R&D

B. K. SWEENEY MFG. CD.
6300 E. 44th Ave., Denver 16, Colo. (Tel. FLorida 5-2355)
Purch. Agent: E. Salwasser
Pres.: John F. Sweeney
V. P.-Sales: A. C. Linburg
GS, TS, R&D

SWISS JEWEL CO.
Lafayette Bldg., Philadelphia 6, Pa. (Tel. WA 5-1990)
Purch.: P. N. Steel, Jr.
Sales Mgr.: W. W. Woolford
MM

SWITCHCRAFT, INC.
5555 N. Elston Ave., Chicago, Ill. (Tel.

SPring 4-1515)
Purch.: Bjorn Hestad
Sales: W. L. Larson GS, GE, TS, TR

YLVANIA ELECTRIC PRODUCTS INC., CHEMICAL & METALLURGICAL DIV.
P. D. Box 70, Tawanda, Pa. (Tel. ANdrew 5-2121)
Purch. Agent: T. R. Coyle
Buyers: W. F. Heatwale & D. D. Stalford
Gen. Sales Mgr.: R. Beatty MM

YLVANIA ELECTRIC PRODUCTS INC., ELECTRONIC TUBES-REC. TUBES DIV.
Emporium, Pa. (Tel. EMporium 301)
Purch. Agent: James M. Parish
Gen. Sales Mgr.: D. W. Gunn, 1740 Broadway, New York, N. Y. (Tel. JU 6-2424)

LVANIA ELECTRIC PRODUCTS INC., PARTS DIV.
Warren, Pa. (Tel. WArren 3220)
Purch. Agent: Robert F. Marlin
Gen. Sales Mgr.: Fred A. Martin MM

LVANIA ELECTRIC PRDDUCTS INC., SEMICONDUCTOR DIV.
Woburn, Mass. (Tel. WOburn 2-3500)
Purch. Agent: John Taylor
Gen. Sales Mgr.: Ernest Ulm MM, R&D

LVANIA ELECTRIC PRODUCTS INC., SPECIAL TUBE OPERATIONS
500 Evelyn Ave., Mt. View, Calif. (Tel. YOrkshire 8-6211)
Purch. Agent: A. F. Beazel
Mktg. Mgr.: Thomas D. Fuller, 1891 E. Third St., Williamsport, Pa. (Tel. WIlliamsport 3-4691)
Dir.-Purch.: Edward J. Millen
Buyer: Fred Andrews GE, TR, R&D

LVANIA ELECTRIC PRODUCTS INC., SYLVANIA ELECTRONIC TUBES DIV.
Seneca Falls, N. Y. (Tel. LOgan 8-5881)
Purch. Agent: Glen W. Victory
Gen. Sales Mgr.: D. W. Gunn, 1740 Broadway, New York, N. Y. (JU 6-2424) MM, R&D

LVANIA ELECTRONIC SYSTEMS, DIV.-SYLVANIA ELECTRIC PRODUCTS INC.
100 1st Ave., Waltham, Mass. (Tel. TWinbrook 3-9200)
Purch. Agent-Waltham Labs.: W. L. Hanson
Purch. Agent-Buffalo Opns.: C. A. Rae (Tel. Buffalo, N. Y.-VIctoria 7100)
Purch. Agent-Williamsport Systems Plant: D. E. D'Shea (Tel. Williamsport, Pa.-WIlliamsport 3-4641)
Purch. Agent-Mountain View Opns.: W. A. Janes (Tel. Mountain View, Calif.-YOrkshire 8-0051)
Dir.-Customer Relations, Sylvania Electronic Systems: J. H. Brewster, III (Tel. New York, N. Y.-JUdson 6-2424) MF, GS, GE, GH, TS, TR

STRON CO.
159 Lexington Ave., Hamer City, Pa. (Tel. GRidley 9-8011)
Purch. Agent: S. A. Dick
V. P.-Sales: D. G. Black MF, WN, PS, GS, GH, GE, TR

STEMS INCORPORATED
P. O. Box 7726, 2326 Diversified Way, Orlando, Fla. (Tel. GArden 4-6538)
Purch. Agent: B. B. Moss
Pres.: S. M. Kaplan GE, CO, TS, TR, R&D

STEMS LABS. CDRP.
1852 Ventura Blvd., Sherman Oaks, Calif. (Tel. STate 9-0501)
Purch. Agent: Arthur Peterson
Corp. Secy.: A. J. F. Clement R&D

STRDN CORP.
100 Golindo St., Concord, Calif. (Tel. MUlberry 2-3650)
Purch. Agent: Mrs. Doris Torpacka
Pr.-Sales: James R. Cunningham GS, GH, CO, TS

T MFG. CORP.
1007 Alger St., Los Angeles 39, Calif. (Tel. CHapman 5-5768)
Purch. Agent: R. E. Felton
V. P.-Sales: R. Clyde Jordan GH, TS

T-DIV., DYNA-EMPIRE, INC.
1075 Stewart Ave., Garden City, L. I., N. Y. (Tel. PIaneer 1-2700)
Purch. Agent: Charles Biasi
Sales: John J. Nargi PS, GS, CO, TS

TH ELECTRIC CORP.
100 Linden Ave., Rochester 10, N. Y. (Tel. LUdlow 6-8000)
Purch. Agent: R. A. Taylor
Sales.: A. B. Treman

TA AIR VALVE DIV.-AIRCRAFT PRODUCTS CO.
4 Church Rd., Bridgeport, Pa. (Tel. BRoadway 6-1000)
Purch. Agent: T. M. Clemmency
Sales Mgr.: Frank Higgins GS, GH, GE, CO, TS

TAFT-PEIRCE MFG. CO., THE
32 Mechanic Ave., Woonsocket, R. I. (Tel. POplar 2-1000)
Purch. Agent: A. M. Rabinsan
Gen. Sales Mgr.: W. F. Carney

TALCO ENGRG. CO., THE
2685 State St., Hamden, Conn. (Tel. ATwater 8-1634)
Purch. Agent: F. DeMarco
Buyer: D. Pantera
Dir.-Sales: A. E. Ehlenberger MF, WN, PS, GS, GH, GE

TALK-A-PHONE CO.
1512 S. Pulaski Rd., Chicago 23, Ill. (Tel. LAwndale 1-8414)
Sales Mgr.: Dan F. Kagan GS

TALLEY CORP., THE
101 Highway & Caneja Rd., Newbury Park, Calif. (Tel. HUdsan 5-2121)
Purch. Agent: Meade Davis
V. P.-Sales: Narman Nicholsan
Business Mgr.: Wayne Wilson
Pres.: F. H. Talley
V. P.-Engrg.: W. J. Forcey GS, GH, GE, CO, TS, TR, R&D

TALLY REGISTER CORP.
5300 14th Ave., N. W., Seattle 77, Wash. (Tel. SUnset 4-5500)
Purch. Agent: W. I. Stephensan
V. P.-Sales: M. R. Dilling GS, TS, R&D

TALDN, INC.
626 Arch St., Meadville, Pa. (Tel. 4-1281)
Mgr.-Purch.: F. V. Hanaway
Asst. Mgr.-Purch.: A. R. Yaung
V. P.-Sales: R. M. Evans

TAMAR ELECTRONICS, INC.
1805 Colorado Ave., Santa Monica, Calif. (Tel. EX 3-9834)
Mgr.-Materiel: Walt Smith
V. P. & Gen. Mgr.: Vern Landis GS, CO, TR, R&D

TANSITOR ELECTRONICS, INC.
West Road, Bennington, Vt. (Tel. 5473–5474)
V. P.-Purch.: Gilbert E. Green
Pres.-Sales: Alfred F. Torrisi R&D

TAP-A-LINE MFG. CO.
31 S. W. 5th Caurt, P. O. Box 563, Pompano Beach, Fla. (Tel. WE 3-3262)
Sales: Robert W. McFarlin

TAPCD GROUP, THOMPSON RAMO WDOLDRIDGE INC.
23555 Euclid Ave., Cleveland 17, Ohio (Tel. IV 1-7500)
Dir.-Purch.: K. C. White
Dir.-Sales & Mktg.: J. H. Shaffer MF, WN, PS, GS, GH, CO, TR, MM, R&D

TAPE CABLE CDRP.
790 Linden Ave., Rochester 10, N. Y. (Tel. LUdlow 6-0330)
Purch: G. E. Smith
Sales Mgr.: Bab Smith MM

TAPERED AIR PRDDUCTS CORP.
10890 Stanford Ave., Lynwood, Calif. (Tel. NEvada 6-9851)
Purch. Agent: Walter Fagen
Sales Mgr.: James I. Carpenter MF, PS

TASK CORP.
1009 E. Vermont Ave., Anaheim, Calif. (Tel. PRospect 4-3100)
Purch. Agent: Carl M. Berg
Sales Mgr.: Jae A. Fryer, Jr. TR, R&D

W. A. TAYLOR & CO.
7300 York Rd., Baltimore 4, Md. (Tel. VAlley 3-1573)
Gen. Purch. & Sales Mgr.: J. A. Lambrecht
Asst. Purch. Mgr.: J. C. Kirk, Jr.
Chief Chemist: F. R. McCrumb TS

TAYLOR DEVICES, INC.
188 Main St., N. Tonawanda, N. Y. (Tel. JAcksan 3603)
Pres: Paul H. Taylor
V. P.-Sales: Charles S. Shanks MF, GH, R&D

TAYLOR ELECTRIC INC.
15400 Dale Ave., Detroit 23, Mich. (Tel. KEnwood 5-2500)
Sales: Bruce R. D. Taylor GS, GE, CD, TS, TR

TAYLDR FIBRE CD.
Norristawn, Pa. (Tel. GLendale 2-2811)
Purch. Agent: H. Fifer
V. P.-Sales: E. H. DaCosta MM

TAYLDR-WINFIELD CDRP.
1052 Mahaning Ave., N. W., Warren, Ohio (Tel. EX 2-2521)
Purch. Agent: H. Martin
Asst. Purch. Agent: G. Walchak
Chief Sales Engr.: J. H. Caaper MM

TECHALLOY CO. INC.
Raute 113, Rahns, Pa. (Tel. Norristawn HUxley 9-7211)
Pres.: D. M. Schmid MF, WN, PS

TECHNICAL APPARATUS BUILDERS
109 Liberty St., New York 6, N. Y. (Tel. REctor 2-6249)
Purch. Agent: R. A. Lyons
Sales Mgr.: R. Bernstein GS, GH, CO, TS

TECHNICAL APPLIANCE CORP.
1 Taca St., Sherburne, N. Y. (Tel. SHerburne 7-2211)
V. P. & Dir.-Purch.: Harold Senkel
V. P. & Dir.-Sales: Tore Lundahl
Asst. V. P. & Sales Mgr., Commercial Div.: Albert K. Fowler TR

TECHNICAL SERVICE CORP.
1404 W. Market St., Louisville 3, Ky. (Tel. JUniper 7-8476)
Buyer: L. H. Jones
Sales Dept.: Mary Rose Snead GS

TECHNICAL TAPE CORP.
240 Narth Ave., New Rochelle, N. Y. (Tel. BEverly 5-1000)
V. P. Dir.-Disbursements: Max Peerce
Purch. Agent: B. McGuire
Asst. Purch. Agent: Mrs. D. Steinen
V. P. Gen. Sales Mgr.: M. I. Stoal

TECHNI-CAST CORP.
11455 Check Ave., Lynwood, Calif. (Tel. NEvada 6-0678)
Purch. & Sales Mgr.: Jack Seibert GS, GH

TECHNIQUE ASSDCIATES DIV., DUNCAN ELECTRIC CD., INC.
1413 North Cornell Ave., Indianapolis 2, Ind. (Tel. MElrose 1-4904)
Purch.: T. K. Millholland
Sales: Edward C. Finlay TS, R&D

TECHNITROL ENGRG. CO.
1952 E. Allegheny Ave., Philadelphia 34, Pa. (Tel. GArfield 6-9105)
Purch. Agent: James H. Kennedy
Buyer: David Adam
V. P.-Sales: T. Kite Sharpless GS, GE

TECHNDGRAPH PRINTED ELECTRONICS, INC.
920 Northwest Blvd., Winston-Salem, N. C. (Tel. PArk 3-0767)
Purch. Agent: R. G. Vance TR

TECHNDLOGY INSTRUMENT CORP.
531 Main St., Actan, Mass., (Tel. CDlanial 3-7711)
Purch. Agent: David M. Donaldson
V. P.-Sales: H. L. Gray, Jr. GH, GS, GE, CO, TS, R&D

TECHRON CORP.
81 Washington St., Boston 8, Mass. (Tel. CApitol 7-7484)
Purch. Agent: Thamas Fahey GE

ROLAND TEINER CO. INC.
134 Tremont St., Everett 49, Mass. (Tel. DUnkirk 7-7800)
Purch.: R. Tenagilia
V. P.-Sales: K. Sawdan MF, WN, MM, R&D

TEINER ENGRG. CDRP.
115 Madisan St., Malden, Mass. (Tel. DA 4-7440)
Purch. Agent: Mrs. Berg
V. P.-Sales: Eric Sandquist
Plant Mgr.: Edward J. McKeon MF, WN, MM, R&D

TELECHRDME MFG. CDRP.
28 Ranick Dr., Amityville, N. Y. (Tel. LIncoln 1-3600)
Purch. Agent: B. Trimboli
V. P.-Sales: H. Charles Riker TR

TELE COIL CD.
2733 Saunders St., Camden 5, N. J. (Tel. EMersan 5-7528)
Pres.: Samuel Feldman GE, TS, TR, R&D

TELECTRO INDUSTRIES CDRP.
35-16 37th St., Long Island City 1, N. Y. (Tel. YEllowstone 2-8600)

CODING
Missile Frame MF
Warhead & Nose Cane WN
Prapulsian System PS
Graund Suppart GS
Graund Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Develapment R&D
Materials & Metals MM

Purch. Agent: M. I. Ross
Pres.: Harry Sussman

TELE-DYNAMICS INC.
5000 Parkside Ave., Philadelphia 31, Pa. (Tel. TRinity 8-3000)
Purch. Agent: Walter S. Longbotton
Buyers: Howard S. Messick, William A. Parch, Philip Marder
Oir.-Mktg.: Edward H. Rosen
GS, GH, GE, CO, TS, TR, R&O

TELEFLEX INC.
N. Wales, Pa. (Tel. OXbow 9-4861)
Purch. Agent: T. Walton
Chief Buyer: W. Taylor
Sales: M. C. C. Chisholm, Jr. **GS, GH**

TELEMETER MAGNETICS, INC.
2245 Pontius Ave., Los Angeles 64, Calif. (Tel. BRadshaw 2-0991)
Purch. Agent: J. D. Hoffman
Buyers: Leonard Stevenson, Irene Taraba, Frank Butteri
V. P.-Sales: Trude C. Taylor **R&O**

TELERAO MFG. CORP.
1440 Broadway, New York 18, N. Y. (Tel. BRyant 9-0892)
Purch. Agent: B. Buffone
Expediter: C. Young
Pres.: Charles George **GS, GE, TS, TR**

TELETRONICS LABORATORY INC.
54 Kinkel St., Westbury, L. I., N. Y. (Tel. EDgewood 3-1027)
Purch. Mgr.: Art Zink
Sales Mgr.: Raymond L. Johnson **GS, TS, R&D**

TELEVISION UTILITIES CORP.
112-33 Colonial Ave., Corona 68, L. I., N. Y. (Tel. TW 8-1000)
Gen. Mgr.: Abe E. Siegel
V. P.-Sales: Miles Breger **TR, R&D**

TELEVISION ZOOMAR CORP.
500 Fifth Ave., New York, N. Y. (Tel. BRyant 9-5835)
Sales Mgr.: Bill Pegler

TEL-INSTRUMENT ELECTRONICS CORP.
728 Garden St., Carlstadt, N. J. (Tel. WEbster 3-1600)
Purch. Agent: A. J. Paret
Sales Mgr.: E. W. Brinkerhaff **GS, CO, TS, TR**

TEL-LABS., INC.
1050 Second St., Manchester, N. H. (Tel. NA 3-5711)
Gen. Mgr.: J. Henry Izart **GE, TS, TR**

TELONIC INDUSTRIES, INC.
75 N. 2nd Ave., Beech Grove, Ind. (Tel. 5Tate 6-9239)
Purch. Agent: Jean Robinett
Engrg. Sales Dir.: C. R. Wainwright (Laguna Beach, Calif., Tel. HYatt 4-7581) **GS**

TEMCO AIRCRAFT CORP.
P. O. Box 6191, Dallas 22, Tex. (Tel. BRoadway 6-7111)
Materiel Mgr.: C. D. Collier
Purch. Agent: J. A. Pendleton
Mgr. Contacts & Sales: R. L. Lewis
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&D

TEMPERATURE ENGRG. CORP.
1700 Union Landing Rd., Riverton, N. J. (Tel. TAlmader 9-3880)
Pres: S. H. Perlman
Sales Mgr.: Norman Bustein

TEMPIL CORP.
132 W. 22nd St., New York 11, N. Y. (Tel. DRegon 5-6610)
Purch. Agent: M. Lacks
Oir.-Sales: M. Lefkoe
Order Supvr.: E. Lee **TS, MM, R&D**

TEMPLETON, KENLY & CO.
16th & Gardner Rd., Broadview, Ill. (Tel. AUstin 7-0695)
Buyer: Donald Bertaut **GS**

TEMPO INSTRUMENT INC.
Commercial St., P. D. Box 338, Hicksville, N. Y. (Tel. DVerbrook 1-2280)
Purch. Agent: George J. Sbordone
Sales Mgr.: F. Meyer **WN, GS, GE, CO, TS, TR**

G. H. TENNANT CO.
701 N. Lilac Dr., Minneapolis 22, Minn. (Tel. LI 5-3771)
Purch. Agent: Gilbert J. Kehr
V. P.-Mktg. & Engrg.: Drville C. Hognander
Sales Mgr.: Joseph T. Lyon **GS, GH**

TENNEY ENGRG., INC.
1090 Springfield Rd., Union, N. J. (Tel. MUrdock 6-7870)
Purch. Agent: Robert Hak
V. P.-Sales: Robert H. Brown **GS, TS**

TENSITRON, INC.
P. D. Box 185, Harvard, Mass. (Tel. GLadstone 6-3511)
Pres. & Gen. Mgr.: Dr. Erwin J. Saxl **TS, R&D**

TENSOLITE INSULATED WIRE CO., INC.
West Main St., Tarrytown, N. Y. (Tel. Medford 1-2300)
Oir.-Purch.: D. G. Keough
Purch. Asst.: G. O'Neill
V. P.-Sales: G. W. Heller

TENSOR ELECTRIC DEVELOPMENT CO., INC.
1873 Eastern Pkwy., Brooklyn 33, N. Y. (Tel. HY 5-9200)
Purch. Agent: Mrs. P. McFarland
MF, PS, GS, GH, GE, TS, TR

TEPRO ELECTRIC CORP.
408A Burke Bldg., S St. Paul St., Rochester 4, N. Y. (Tel. BAker 5-0478)
Pres.: M. A. Thom

TERADO CO.
1068 Raymond Ave., St. Paul 8, Minn. (Tel. MIdway 6-2514)
Gen. Mgr.: D. G. Munson
Purch.: George Huff
Sales Mgr.: John J. Kaul **GS, GE**

TERMINAL RADIO CORP.
85 Cortlandt St., New York, N. Y. (Tel. WDrth 4-3311)
Purch. Agents: M. Blumberg, R. Corenthal & M. Filler
V. P.-Sales: Frank Miller
PS, GS, GH, GE, CO, TS, TR

GEORGE A. TERRY CO.
356 S. Elmwood Ave., Buffalo 1, N. Y. (Tel. WA 0633)
Mgr.: George A. Terry
Sales Mgr.: Harold A. Dodge

TEXAS CAPACITOR CO., DIV.-K-C-K CORP.
922 S. 75th St., Houston, Tex. (Tel. WAlnut 6-5727)
Pres.: George S. Chaffin
Prod. Mgr.: Mrs. A. Holligan

TEXAS METAL & MFG. CO., INC.
6114 Forest Park Rd., Dallas, Tex. (Tel. FLeetwood 1-3771)
Purch. Agent: Don Hamilton
V. P.: George C. Kershaw **GH, GS, R&D**

TEXTRAN CORP.
P. D. Box 9207, 8500 Research Rd., Austin, Tex. (Tel. GL 3-8378)
Bus. Mgr.: George E. Strandtmann
V. P.-Sales: Charles Zablocki **R&D**

THAYER SCALE CORP.
1 Thayer Park, Pembroke, Mass. (Tel. TAylor 6-2373) **GS, GH**

THERM, INC.
Hudson St., Ithaca, N. Y. (Tel. Ithaca 4-9501)
V. P.-Purch.: John E. Paige
V. P.-Sales: Harry A. Davis, Jr.
V. P.-Research: Alfred Ritter **PS, R&D**

THERMAL AMERICAN FUSED QUARTZ CO., INC.
18-20 Salem St., Dover, N. J. (Tel. FDxcroft 6-2807)
Purch. Agent: R. Doormann
Sales Mgr.: John F. von Sternberg **MF, PS**

THERMAL REFRACTORIES CORP.
4501 Dell Ave., North Bergen, N. J. (Tel. UNion 5-1600)
Purch. Agent: W. C. Karsten
Sales: C. E. Nelson **WN, PS, MM, R&D**

THERMAL WIRE OF AMERICA
Keeler's Bay, South Hero, Vt. (Tel. 241)
Pres.: Horace W. Corbin, Jr.
Sales Mgr.: Michael G. Ziter **WN, PS, GE**

THERMAX WIRE CORP.
304 E. 45th St., New York 17, N. Y. (Tel. MUrray Hill 9-7120)
Purch. Dept.: R. W. Coombs
Buyer: J. May
Sales Mgr.: John E. Rattinger

THERMECH ENGRG. CORP.
1773 Lincoln Ave., Anaheim, Calif. (Tel. KEystone 3-3183)
Gen. Mgr.: C. P. Ripley
Sales Mgr.: R. L. Harris **MF, PS, GS, GH, MM**

THERMO ELECTRIC CO., INC.
109 5th St., Saddle Brook, N. J. (Tel. HUbbard 9-5800)
Treas.: J. P. McKeon
Purch. Agents: C. McColgan, A. Allee
Sales Mgr.: J. H. Collins **GS, CO, TS, R&D**

THERMO KING CORP.
314 W. 90th St., Minneapolis 20, Minn. (Tel. TUxedo 1-2601)
Oir.-Purch.: E. J. Brown
Mgr.-Govt. Sales: Miles Harvey G

THERM-O-LAB CORP.
6940 Farmdale Ave., N. Hollywood, Calif. (Tel. STanley 7-7105)
Sales Oir.: Roy Smith
MF, PS, GS, GH, GE, CO, R&D

THERMOSEN INC.
375 Fairfield Ave., Stamford, Conn., (Tel. DAvis 5-1324)
Sales Mgr.: R. S. Schenck

THETA INSTRUMENT CORP.
48 Pine St., E. Paterson, N. J. (Tel. SWarthmore 7-7700)
Purch. Agent: Ralph Rinaldi
Sales Mgr.: Stanley Handelman **GS, CO, T**

THIEBLOT AIRCRAFT CO., DIV.-VITRO CORP. OF AMERICA
Martinsburg, W. Va. (Tel. AMherst 3-3385)
Dir.-Purch.: Art Williams
V. P.-Sales: W. P. Maloney
MF, WN, PS, GS, GH, GE, CO, TS, TR

THIOKOL CHEMICAL CORP.
P. O. Box 27, Bristol, Pa. (Tel. WIndsor 6-9150)
Purch. Agent (Redstone Div.): J. Lutz, (Huntsville, Ala.)
Purch. Agent (Longhorn Div.): W. L. Teutsch (Marshall, Tex.)
Dept. Mgr. (Reaction Motors Div.): E. M. DeRome (Denville, N. J.)
Section Head (Elkton Div.): T. King (Elkton, Md.)
Oept. Head (Utah Div.): D. Young (Brigham City, Utah) **PS, GS, GH, CO, TS, MM, R&D**

THIOKOL CHEMICAL CORP., HUNTER-BRISTOL DIV.
P. D. Box 27, Bristol, Pa. (Tel. WIndsor 6-9150)
Asst. Gen Mgr.: Raymond R. Wiese
Mgr. Contracts & Sales: John W. Miller
PS, GS, GH, R&D

THIOKOL CHEMICAL CORP., REDSTONE DIV.
Huntsville, Ala. (Tel. JE 6-4411)
Purch. Agent: F. L. Quinn
Purch.: Joe Todd & Russ Fowler

THOMAS ELECTRONICS, INC.
118 Ninth St., Passaic, N. J. (Tel. GRegory 3-4040)
Mgr.-Purch.: Carl Tepel
Mgr. Special Product Sales: Peter V. Nuccio
GS, CO, TS

THOMAS INSTRUMENT CO.
41 Silver Rock, Phoenix, N. Y. (Tel. OWen 5-5134)
Sales & Prod. Mgr.: S. M. Thomas **PS**

THOMPSON ENGRG. CO., THE, MISSILE PRODUCTS DIV.
Box 2097, 22922 S. Normandie Ave., Torrance, Calif. (Tel. FAirfax 8-5315)
Mgr.-Purch.: David A. Anderson
Dir.-Sales: William A. Thompson **GS, GH, R&D**

H. I. THOMPSON FIBER GLASS CO.
1733 Cordova St., Los Angeles 7, Calif. (Tel. REpublic 3-9161)
Purch. Agent: Dean Welsh
Buyer: E. Titus
V. P.-Sales: W. E. Benke **WN, MM, R&D**

THOMPSON PRODUCTS, INC.
23555 Euclid Ave., Cleveland 17, O. (Tel. IVanhoe 1-7500)
Staff Dir.-Purch.: G. N. Hackett
V. P.-Sales: G. R. Moore

THOMPSON-BREMER & CO.
228 N. La Salle St., Chicago 1, Ill. (Tel. FRanklin 2-6858)
Sales Mgr.: Gail M. Rutledge **MF, P**

THOMPSON-RAMO-WOOLORIDGE PRODUCTS CO., THE
P. D. Box 90067, Airport Station, Los Angeles 45, Calif. (Tel. DSborne 4-5601)
Controller: Robert J. Barrett, Jr.
Oir.-Mktg.: Raymond E. Jacobson **GS, CO, TS, R&D**

THWING-ALBERT INSTRUMENT CO.
Penn St. & Pulaski Ave., Philadelphia 44, Pa. (Tel. GErmantown 8-5719)
Purch. Agent: Driscoll Nina
Treas.: Edward J. Albert
Prod. Mgr.: John Fachet **TS**

ARTHUR TICKLE ENGRG. WORKS, INC.
21 Delevan St., Brooklyn 31, N. Y. (Tel. MAin 5-4200)
Purch. Agent: Andrew Posser
Buyer: Frank Petito
Indsl. Sales Mgr.: Nicholas P. Harvey
MF, WN, PS

MES WIRE & CABLE CO., INC.
358 Hall Ave., Wallingford, Conn. (Tel. COlony 9-3381)
Purch.: Henry Dabris
V. P.-Sales: Lawrence J. DeGeorge
MF, PS, GS, GH, TS, TR

MKEN ROLLER BEARING CO., THE
1835 Deuber Ave., S. W., Canton, O. (Tel. GL 3-4511)
Dir.-Purch.: Paul Young
V. P.-Sales: P. J. Reeves MF, PS, GH, GE, MM

NGSTOL CO.
1461 W. Grand Ave., Chicago 22, Ill. (Tel. CAnal 6-1520)
Purch. Agent: J. Machina
V. P.-Sales: John P. Zopp GE

NNERMAN PRODUCTS, INC.
Dept. 16, P. O. Box 6688, Cleveland 1, O. (Tel. SHadyside 1-9300)
Dir.-Purch.: R. F. Merriam
Dir.-Sales: L. H. Flora MF

NSLEY LABS., INC.
2526 Grove St., Berkeley, Calif. (Tel. THornwall 3-6836)
Purch. Agent: Robert J. Johnson
Pres: Harvey L. Martan GE, TR, R&D

TAN METAL MFG. CO.
Bellefonte, Pa. (Tel. EL 5-4712) (Also Newark, Calif.)
V. P.-Purch.: M. J. Rathrock
Gen. Purch. Agent: B. R. Tingue
Tech. Asst. to Gen. Purch. Agent: R. H. Eiser
Purch. Agent-Raw Material: O. T. Lambert
V. P.-Sales: R. H. Lightner MM

TANIUM METALS CORP. OF AMERICA
333 Broadway, New York 7, N. Y. (Tel. WOrth 4-7620)
Dir.-Mktg.: T. W. Lippert
Sales Mgr.: Robert S. Nycum MF, WN, MM

TEFLEX, INC.
Glendee St., Springfield 4, Mass. (Tel. REpublic 9-5631)
Purch. Dir.: S. J. Souis
Buyers: R. Brennan, M. Raichelsan
V. P.-Sales & Adv.: D. H. Arthur
PS, GS, GH, GE, R&D

TBE DEUTSCHMANN CORP.
Providence Hwy., Norwood, Mass. (Tel. NOrwood 7-2620)
Purch. Agent: Henry P. Shopneck
Sales Mgr.: Thomas A. Crawford

TCO DIV., THE OHIO CRANKSHAFT CO.
800 Harvard Ave., Cleveland 5, Ohio (Tel. DIamond 1-2300)
Dir.-Purch.: B. Seidel
Asst. Gen. Mgr.: L. S. Schweitzer

TECHNICAL PATRON, INC.
12 E. Ojai Ave., Ojai, Calif., (Tel. MIlton 6-1600)
Purch. Agent: S. E. Brown
Sales Mgr.: L. H. Appleman GS, CO, TS, R&D

TECHNIFLIGHT CORP.
40 E. 9th Ave., York, Pa. (Tel. 8-1541)
Purch. Agent: R. O. Thomas
Sales Dir.: R. M. Dent MF, PS

TECHNIPER MFG. CO., INC.
37-12 Liberty Ave., Jamaica 35, N. Y. (Tel. AXtel 7-5742)
Sales Mgr.: Fred Greil GE, MM

TECHNIT MFG. CO.
292 Walnut St., St. Paul, Minn. (Tel. CApital 2-4419)
Purch. Agent: George Huna
V. P.-Sales: Fronk Chase

TECHNO, TORNGREN CO., INC.
16 Pearl St., Somerville 45, Mass. (Tel. MOnument 6-3250)
Purch. Agent: Wm. DeCain
Pres.-Sales: Kenneth A. Casavant MF, WN, PS, GS

TECHNIQUE CONTROLS INC.
15 E. Broadway, San Gabriel, Calif. (Tel. CUmberland 3-4182)
Purch. Agent: F. M. Sheehy GS

TORRINGTON CO., THE
Field St., Torrington, Conn. (Tel. HUnter 2-4441)
Purch.-Purch.: W. V. Viering
Sales Mgr.: R. G. O'Connell
MF, WN, P5, GS, GH, GE

TORRINGTON MFG. CO. INC., THE, SPECIALTY BLOWER DIV.
10 Franklin Drive, Torrington, Conn. (Tel. HUnter 2-4422)
Purch. Agent: R. J. Geiger
Sales: A. M. Wilczenski G5, GH, CO, TS, TR

TORSION BALANCE CO., THE
35 Manhegan St., Cliftan, N. J. (Tel. GRegary 3-6900)
Purch. Agent: C. Wesley
Div. Sales Mgr.: E. H. Enberg TS

TORWICO ELECTRONICS, INC.
1090 Marris Ave., Union, N.J. (Tel. ELizabeth 4-5650)
Purch. Agent: H. G. Riche GS, GE, TR, R&D

TOWACO ELECTRONICS
Pine Brook Rd., Towaca, N.J. (Tel. DE 4-4443)
Pres.: Samuel I. Cory, Jr.

TOWER CONSTRUCTION CO.
2700 Hawkeye Drive, Siaux City, Iawa (Tel. 5-7653)
Purch. Agent: J. R. Edwards
Asst. Sales Mgr.: G. 5. Chesen
Gen. Mgr.: C. A. Wright GS, GH

TOWER MFG. CORP.
158 Pine St., Providence, R I. (Tel. GAspee 1-2061)
Gen. Mgr.: Louis J. Shatkin

*TOWNSEND CO., CHERRY RIVET DIV.
1224 E. Delhi Rd., Santa Ana, Calif. (Tel. KI 5-5511)
Purch. Agent: Ralph E. Herndan
Buyer: Leray F. Levers
Mgr., Aircrft Sales: John H. Ray MF, WN, PS, MM
*(See Page 36 for Advertisement)

TRAID CORP.
17136 Venturo Blvd., Encina, Calif. (Tel. STanley 3-3373)
Purch. Agent: Anthony De Marca
Merchandising: Mark MacIntash TS, TR

TRAILMOBILE INC.
31st & Robertsan Sts., Cincinnoti 9, O. (Tel. REdwaad 1-2323)
Dir.-Purch.: Wm. H. French
V. P.-Sales: Harry Eyler GS, GH

TRANE CO., THE
2nd & Cameran Ave., La Crasse, Wisc. (Tel. 2-8000)
V. P.-Purch.: R. H. Pearse
Exec. V. P.-Sales: Thamas Hancack
GS, GH, GE, TS, TR

TRANS ELECTRONICS, INC.
7349 Canago Ave., Canaga Park, Calif. (Tel. DIamond 0-3334)
Purch. Agent: J. V. Ritenaur
Dir.-Sales: Williom J. Miller CO, TS

TRANSCO PRODUCTS, INC.
12210 Nebraska Ave., Las Angeles 25, Calif. (Tel. BRadshaw 2-5687)
Purch.: Hugh P. Rice
Buyer: William Waakey
Sales: E. M. Cleland

TRANSDYNE CORP.
5815 57th Drive, Maspeth 78, N. Y. (Tel. TW 4-6681)
Dir.-Purch.: E. Braun GS, GE, CO, TS

TRANSFORMER DESIGN, INC. OF MILWAUKEE
7377 North 76th St., Milwaukee 18, Wisc. (Tel. FLagstane 3-8017)
Pres.: Howard S. Knapow
V. P.: Rubin B. Lesgald GS, GE, TR, R&D

TRANSFORMER SPECIALTY CO.
221 Rockhill Rd., Bala-Cynwyd, Pa. (Tel. MOhawk 4-5770)
Pres.: H. D. Hosier

TRANSISTOR ELECTRONICS CORP.
3357 Republic Ave., Minneapalis 26, Minn. (Tel. WEst 9-6754)
Dir.-Purch: Raymand P. Deeney
Sales Mgr.: R. C. Skae GE, CO, TS, TR

TRANSITRON ELECTRONIC CORP.
168 Albian St., Wakefield, Mass. (Tel. CRystal 9-4500)
Purch. Agent: Ralph Yaung
Sales Mgr.: H. T. Neavitt GE

TRANSMARES CORP.
15 Williom St., New York 5, N. Y. (Tel. HAnnaver 2-6156)
V. P.: Alfans A. Jakab TR

TRANSONIC, INC.
808 16th St., Bakersfield, Calif. (Tel. FA 7-5701)
Dir.-Purch.: Harvey A. Lipp
Gen. Sales Mgr.: C. P. Cushway GS, GE, TS, TR

TRANS-SIL CORP.
55 Haneck Street, Englewaad, N. J. (Tel. LOwell 7-1720)
Gen. Mgr. Purch.: L. J. Grennell
Sales Mgr.: I. Weinstein WN, GS, CO, TS

TRANS-SONICS, INC.
P. O. Box 328, Lexington 73, Moss. (Tel. BRawning 2-1000)
Purch. Agent: Robert L. Meader
Gen. Sales Mgr.: Sheldan W. Kennedy GS, TS, TR

TRANSUE & WILLIAMS STEEL FORGING CORP.
1300 Ely, Alliance, O. (Tel. Talbat 1-5741)
Purch. Agent: H. C. Martin
Asst. Purch. Agent: R. H. Cast
Sales Mgr.-Stamping Div.: C. J. Brunn
Sales Mgr.-Forge Div.: J. W. Ament MF, WN, PS

TRANS-WESTERN ELECTRONICS
P. O. Box 1473 Ventura, Calif. (Tel. MIller 2-4219)
Purch. Agent: G. Reins
Sales Mgr.: M. M. Neer TS

TRANTER MFG., INC.
735 E. Hazel, Lansing, Mich. (Tel. IV 4-4531)
Purch. Agent: M. C. Nolen
Sales Mgr.: S. J. Stawell SP, MM

TRESCO, INC.
3824 Terrace St., Philadelphia 28, Pa. (Tel. IV 3-1383)
Purch. Agent: Stanley Fisher
Sales: Stan Auerbach MF, PS, GS, GE, TS, TR

TRIAD TRANSFORMER CORP.
4055 Redwaad Ave., Venice, Calif. (Tel. EXmant 7-2145)
Purch. Agent: G. L. Howard
Sales Mgr.-Jabber: Ernest Clover
Sales Mgr.-Industrial: Edmund Shimbel
GE, CO, TS, TR

TRICRAFT PRODUCTS CORP.
1124 W. Newport Ave., Chicaga 13, Ill. (Tel. WEllington 5-5383)
Sales Mgr.: Bud Nylen
Gen. Mgr.: E. A. Gancae GS, GH, GE, TS, TR

TRI-DEX CO.
P. O. Box 1207, Lindsay, Calif. (Tel. LIndsay 2-4051)
K. B. Haward
MF, WN, PS, GS, GH, GE, CO, TS, TR

TRIMOUNT INSTRUMENT CO.
3119 W. Lake St., Chicago 12, Ill. (Tel. NEvada 2-3747)
Purch.: F. R. Arens
Sales Mgr.: D. E. Haines GS, TS

TRINDL PRODUCTS, LTD.
1807-11 S. Clark St., Chicaga 16, Ill. (Tel. VIctory 2-7716)
V. P.-Purch.: Joseph H. Trindl, Jr. PS, GS

TRIO CHEMICAL WORKS, INC.
341 Scholes St., Brooklyn 6, N. Y. (Tel. HYacinth 7-3595)
Purch.: Harold Blank
Sales: M. M. Blank MF, WN, PS, GS, GH

TRIO LABORATORIES, INC.
Plainview, L. I., N. Y. (Tel. OVerbrook 1-0400)
Purch. Agent: Thomas M. Curry
Sales Mgr.: Jay S. Salz GS, TS

TRION, INC.
1000 Island Ave., McKees Racks, Pa. (Tel. FEderal 1-3300)
Purch. Agent: Jahn L. Hergenraeder
Dir.-Sales: R. R. Pryar

TRIONICS CORP.
P. O. Box 548, Madison 1, Wisc. (Tel. CEdar 8-2616)
Treas. & Sr. Chem.: Stanley E. Rahawetz
Pres.: Robert L. Slater, Jr. MM, R&D

TRIPLETT & BARTON, INC.
831 N. Lake St., P. O. Box 3128, Burbank, Calif. (Tel. VIctoria 9-1291)
Asst. Gen. Mgr.-Purch.: Chas. W. Sextan
Pres. & Gen. Mgr.-Sales: Tam A. Triplett
TS, R&D

TRIPLETT ELECTRICAL INSTRUMENT CO.
Harman Rd., Bluffton, Ohia (Tel. 323-W)
Purch. Agent: P. W. Stauffer
V. P.-Sales: N. A. Triplett

TRI-POINT PLASTICS INC.
175 I. U. Willets Rd., Albertsan, L. I., N. Y. (Tel.

CODING
Missile Frome MF
Warhead & Nose Cone WN
Propulsian System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkaut Equipment CO
Test Equipment TS
Trocking & Telemetering TR
Research & Develapment R&D
Materials & Metals MM

MAyfair 1-5800)
Purch. Agent: Sid Kipnes
Dir.-Sales: Pat Ruggieri
PS, GS, GE, TS, TR, R&D

TROMBETTA SOLENOID CORP.
329 N. Milwaukee St., Milwaukee, Wisc. (Tel. BRoadway 1-8347)
Gen. Mgr.: Panfilo Trombetta GH

TRU-CONNECTOR CORP.
416 Union St., Lynn, Mass., (Tel. LY 8-9379)
Gen. Mgr.: James J. O'Neil, Jr.

TRUE ALLOYS INC.
284 S. Summit St., Detroit 9, Mich. (Tel. VInewood 2-8686)
Pres.: J. P. Carritte MF, WN, PS, GE, MM

TUBE DISTRIBUTORS CO., INC.
1415 Kellum Place, Garden City, N. Y. (Tel. Pioneer 7-5000)
Head-Purch.: Sam Warren
Purch. Agent: Sam J. Sinacore
Sr. Buyer: Albert Salis
Sales Mgr.: David Reeves
Sales Pram. Mgr.: Joseph D. Shipman MM

TUBE METHODS INC.
Depot & Rambo Sts., Bridgeport, Montg. Co., Pa. (Tel. BRoadway 9-7700)
Exec. V. P.: Paul V. Fly
Sales Mgr.: John E. MacNamara
PS, GS, GE, TS, TR, MM

TUBE REDUCING CORP.
520 Main Ave., Wallington, N. J. (Tel. PRescott 7-3700)
Purch. Agent: E. P. McMahon
V. P.-Sales: R. L. Tannehill MF, WN, PS, MM

TUBE-TURNS DIV., CHEMETRON CORP.
224 E. Broadway, Louisville, Ky. (Tel. JUniper 7-7551)
Purch. Agent: R. J. Dilger
Buyer: Robert Love
Sales Mgr.: Charles F. Morris WN, PS, GH

TUCSON INSTRUMENT CORP.
1050 E. Valencia Rd., P. O. Box 11247, Tucson 2, Ariz. (Tel. MAin 2-1092)
Pres.: F. R. Perier
V. P.-Sales: Louis A. Wilson, Jr.
MF, WN, PS, GS, GH, GE, CD, TS, TR

TURBO MACHINE CO.
840 W. Main St., Lansdale, Pa. (Tel. ULysses 5-5131)
Purch. Agent: Alfred S. Karcewski WN, MM

TURBO PRODUCTS, INC.
12177 Montague St., Pacoima, Calif. (Tel. EMpire 9-5252)
Purch. Agent: Howard Wade
V. P.-Sales & Engrg.: J. H. Overholser
MF, PS, GS, GH, MM

TURCO PRODUCTS, INC.
6135 S. Central Ave., Los Angeles, Calif. (Tel. ADams 2-6111)
Dir.-Purch.: A. H. Dekker
Las Angeles Purch.: D. W. Eckroad
V. P.-Mktg.: Dan T. Buist
MF, WN, PS, GS, GH, CO, TS

TWENTY-FIRST CENTURY ELECTRDNICS, INC.
6227 Columbus Ave., P. D. Box 2326, Riverside, Calif. (Tel. OVerland 8-0780)
Purch. Agent: J. W. MacDonald
V. P.-Sales: C. R. Springer GE, R&D

TWIGG INDUSTRIES
1827 E. National, Brazil, Ind. (Tel. 2293)
Purch. Agent: B. Siwik
Buyer: J. Bateman
Sales Mgr.: W. L. Hahn MF, WN, PS, GS, GH

TWIN COACH CO., AIRCRAFT-MISSILES
Buffalo 25, N. Y. (Tel. PLaza 5150)
Materials Mgr.: E. E. Rhoads
V. P.-Contracts Admin.: G. R. Hecht
MF, GS, GH, R&D

E. F. TWOMEY CO., INC.
728 W. 10th Pl., Los Angeles 15, Calif. (Tel. RI 9-9451)
Secy.-Treas.: E. F. Twomey, Jr. MF, GS

TYPHOON AIR CONDITIONING CO., DIV.-HUPP CORP.
505 Carroll St., Brooklyn 15, N. Y. (Tel. ULster 8-0800)
Purch. Agent: George W. Weinberg
Asst. Purch. Agent: T. E. Krawetz
V. P.-Sales: John A. Gilbreath MF, GS, GE

UCINITE CO., THE, DIV.-UNITED-CARR FASTENER CDRP.
459 Watertown St., Newtonville 60, Mass. (Tel. LAsall 7-8400)
Purch. Agent: T. J. Costello
V. P.-Sales: G. V. Sweetnam
MF, WN, PS, GS, GH, GE, TR

UEHLING INSTRUMENT CO.
473 Getty Ave., Paterson, N. J. (Tel. SHerwood 2-8710)
Purch. Agent: J. W. Riccobene
Sales Mgr.: P. F. Riccobene

GEDRGE ULANET CO.
413 Market St., Newark 5, N. J. (Tel. MArket 2-4876)
Sales: H. Ulanet

ULLMAN DEVICES CORP.
Danbury Rd., Ridgefield, Conn. (Tel. Idlewood 8-6577)

ULTRA ELECTROFORMING & MFG. CO.
110 Cedar Ave., Pitman, N. J. (Tel. LUther 9-7666)
Treas.: E. P. Carter MM

ULTRADYNE, INC.
2624 San Mateo, N. E., Albuquerque, N. M. (Tel. AMherst 8-2431)
Mgr.-Tech. Sales: Edward L. Amonette TR, R&D

***ULTRA-VIOLET PRODUCTS, INC.**
5114 Walnut Grove Ave., San Gabriel, Calif. (Tel. CUmberland 3-3193)
Factory Supt.: Melvin D. Hershey
Sales Mgr.: T. S. Warren
MF, WN, PS, GS, CO, TS, TR
*(See Page 79 for Advertisement)

UNDERWOOD ELECTRIC & MFG. CO., INC.
4926 W. Grand Ave., Chicago, Ill. (Tel. NAtional 2-9450)
Purch.: Edward J. Meier
Sales: Robert G. Futterer

UNGAR ELECTRIC TOOLS, INC.
4101 Redwood Ave., Los Angeles 66, Calif. (Tel. EXmont 8-5718)
Purch. Mgr.: Frank Hurd
Sales Mgr.: William L. Nehrenz MM

UNIFLOW VALVE CORP.
19 Quine St., Cranford, N. J. (Tel. BRidge 6-8300)
Dir.-Purch.: Mary Hummel
Dir.-Sales: Kenneth Grosse PS, R&D

UNIFORM TUBES, INC.
Level Rd., Collegeville, Pa. (Tel. HUxley 9-7276)
Purch. Agent: Gordon Hattersley
Sales Mgr.: D. T. MacNair MM

UNIMAX SWITCH DIV., THE W. L. MAXSON CORP.
Ives Rd., Wallingford, Conn. (Tel. COlony 9-8701)
Purch. Agent: J. Dsias
Sales Mgr.: J. Martinez GE

UNION ASBESTOS & RUBBER CO.
1111 W. Perry St., Bloomington, Ill. (Tel. 3-8081)
Purch. Agent: L. Vicha
Sales Mgr.: E. T. Plummer MM, MF, WN, PS, TR

UNION CARBIDE METALS CO., DIV.-UNION CARBIDE CORP.
30 E. 42nd St., New York 17, N. Y. MM

UNION SWITCH & SIGNAL, DIV.-WESTINGHOUSE AIR BRAKE CO.
Braddock Ave., Pittsburgh 18, Pa. (Tel. CHurchill 2-5000)
Mgr.-Purch.: H. I. McKeever
Sr. Buyer: C. S. Poxon
Supvr.-Purch. Research: R. J. Cook
Mgr.-Gen. Apparatus: P. K. Eckhardt
PS, GS, GE, CO, TS, TR

UNISON PRODUCTS, INC.
705 W. Savidge St., Spring Lake, Mich. (Tel. VIking 2-1349)
Buyer: M. Bakels
Sales Mgr.: Raymond Berwald GE, TR

UNIT CRANE & SHOVEL CORP.
6411 W. Burnham St., Milwaukee, Wisc. (Tel. MItchell 5-8840)
Asst. to Pres. & Works Mgr.: A. B. Py
Purch. Agent: W. F. Ellingson
V. P.-Sales: A. R. Corbett
Sales Mgr.: J. Lenahan GH

UNIT PROCESS ASSEMBLIES, INC.
61 E. 4th St., New York 3, N. Y. (Tel. SPring 7-1398)
Purch.: C. Cirilli
Sales Mgr.: S. U. Lieber TS

UNITED AIRCRAFT PRODUCTS, INC.
1116 Bolander Ave., Dayton, O. (Tel. BAldwin 4-3841)
Dir.-Purch.: John Shroyer
Asst. V. P.-Contractual Engrg. Mgr.: F. A. Ryan
GS, GH, MM, R&D

UNITED CARBON PRODUCTS CO.
1318 N. Madison St., Bay City, Mich. (Tel. TWinbrook 3-4575)
Purch. Agent: M. D. Sordyl
Sales Mgr.: E. J. Musinski MA

UNITED CONTROL CORP.
4540 Union Bay Pl., Seattle 5, Wash. (Tel. LAkeview 5-9200)
Purch. Dir.: Martin K. Lilleberg
Asst. Purch. Dir.: Hugh LaVille
Engrg. Sales Mgr.: Robert L. Hancock
MF, PS, GS, GH, GE, CO, TS, TR

UNITED ELECTRIC CONTROLS CO.
85 School St., Watertown, Mass. (Tel. Walnut 6-1000)
V. P.-Purch.: G. McNally
Purch. Agent: R. Rando
Asst. Purch. Agent: M. Tutunjian
PS, GS, GH, GE, TS, R&D

UNITED ELECTRODYNAMICS, INC.
200 Allendale Rd., Pasadena, Calif. (Tel. SY 9-7161)
Purch. Agent: E. H. Lemke
Buyers: W. G. Martin, C. D. Morrison
Sales Mgr.: Frank A. Fleck CO, TS, TR, R&D

UNITED MFG. CO., THE
5250 Dobeckmun Ave., Cleveland 2, O. (Tel. DLympic 1-6310)
Purch. Agent: Harold L. Murphy
Sales Mgr.: W. R. Albrecht
MF, WN, PS, GS, GH, GE, TS, TR

UNITED MFG. CO. DIV., THE W. L. MAXSON CORP.
41 Haig St., Hamden 14, Conn. (Tel. New Haven-CH 8-4491)
Purch. Agent: C. W. Redmond
V. P.-Sales: V. A. Stancliff GS, CO, TS

UNITED MINERAL & CHEMICAL CDRP.
16 Hudson St., New York 13, N. Y. (Tel. Beekman 3-8870)
Purch. Agent: Terry D. Koncelik
Sales: Herbert M. Rosenthal MF, PS, GS, GE, TS

UNITED PLATING WORKS
4118 N. Mingo Rd., Tulsa, Okla. (Tel. TEmple 5-4683)
Purch.: S. A. Bergman
Sales: Meredith L. Sutton MI

UNITED SHOE MACHINERY CORP.
140 Federal St., Boston 7, Mass. (Tel. LIberty 2-9100)
Mgr.-Purch. Dept.: H. F. Pfaff
Purch.: R. J. Carroll, George E. Bowen & E. McCau
V. P.-Sales: C. R. Todd MF, WN, PS, G

UNITED SHOE MACHINERY CORP., ORDNANCE CORP.
Balch St., Beverly, Mass. (Tel. WAlker 2-0160)
Mgr.-Ordnance Dept.: D. Hall

UNITED SMELTING & ALUMINUM CO., INC.
P. O. Box 1910, New Haven, Conn. (Tel. MA 4-2181)
Gen. Supt.: F. A. Merliss
Exec. V. P.-Sales: Milton E. Rosenthal MI

U. S. A.C. TRANSPORT, INC.
457 W. Fort St., Detroit, Mich. (Tel. WDodward 3-7913)
Dir.-Cust. Rel.-Sales: J. Wade Jacobson
MF, WN, PS, GS, GH, GE, CO, TS, TR, MM, R&

U. S. COMPDNENTS INC.
454 E. 148th St., New York 55, N. Y. (Tel. CYpress 2-6525)
V. P.-Purch.: B. A. Jackson
Sales: H. Nalbantian
PS, GS, GH, GE, CO, TS, T

U. S. ELECTRICAL TOOL CO.
3640 Llewellyn St., Cincinnati, Dhio (Tel. Mulberry 1-3410)
V. P.-Purch.: G. D. Behlen
Dir.-Sales: P. D. Schneider

U. S. FIBER & PLASTICS CORP.
Union St., Stirling, N. J. (Tel. Millington 7-0514)
Purch. Agent: Earle Ooll
Sales Mgr.: Robert A. Goodfellow

U. S. FLEXIBLE METALLIC TUBING CO.
454 E. Third St., Los Angeles, Calif. (Tel. MAdison 4-2121)
Purch.: E. Almonor; E. O. Mohring
Sales Mgr.: Wm. H. Tice PS, GS, G

U. S. GAUGE DIV.,-AMERICAN MACHINE & METALS, INC.
Sellersville, Pa. (Tel. ALpine 7-6531)
Dir.-Prac.: Clayton Kirkpatrick
Purch. Agent: M. H. Blackwell
Mgr.-Aircraft Sales: David A. Winer
PS, GE, CO, TS, T

U. S. GEAR CDRP.
81 Bay State Rd., Wakefield, Mass. (Tel. CRystal

6-4900)
Engr.-Purch.: A. P. Cotreou
Purch. Expediting: Alex Comaro
Sales Mgr.: Dovid M. Abbot GS, GE, TR, R&D

S. HAMMERED PISTON RING CO., INC.
Roil Rood Ave., Stirling, N. J. (Tel. Millington 7-0100)
/. P.-Purch.: A. A. Wenzel
Purch.: R. Bossmonn & A. Thoms MF, WN, PS, GS

S. INDUSTRIES, INC.
250 Pork Ave., New York, N. Y. (Tel. Oxford 7-4141)
Sales: T. Petrides
MF, GS, GH, GE, CO, TS, R&D

S. RELAY CO.
17 N. Coney Ave., Azuso, Colif. (Tel. CUmberlond 3-8241 or EDgewood 4-8206)
Pres.: Louis Fox
/. P.-Purch.: Horold Fox
Purch. Agent: S. J. Astricon
Sales Mgr.: Lyle D. Bunce
MF, PS, GS, GH, GE, CO, TS, TR, R&D

S. SCIENCE CORP., DIV.-TOPP INDUSTRIES, INC.
221 W. 102nd St., Los Angeles, Colif. (Tel. Spring 6-0450)
Dir.-Purch.: W. B. Miller
Asst. Purch. Agent: W. J. Chonter
Buyers: J. D. Bloke, W. J. Steffy, G. H. Wood
Mgr.-Cust. Rel.: M. A. Pohlovon GS, GH, GE, TR

S. SEMICONDUCTOR PRODUCTS, INC.
540 W. Osborn Rd., Phoenix, Arizona (Tel. AP 8-5591)
Purch. Agent: Roymond W. DeLor
. P.-Soles: Joseph C. Worth GS, GE, CO, TS

S. STEEL SUPPLY DIV., UNITED STATES STEEL CORP.
08 S. LoSolle St., Chicago, Ill, (Tel. CEntrol 6-9200)
Mgr.-Material Cont.: J. E. Gront
. P.-Sales: K. P. Rindfleisch MM

TED STATES CHEMICAL MILLING CORP.
700 Rosecrons Ave., Monhotton Beoch, Colif. (Tel. ORegon 8-4041)
Purch. Agent: R. V. McCullach, J. H. Vincent
. P.-Contracts: M. L. Johnson
MF, WN, GS, GH, MM, R&D

TED STATES DYNAMICS CORP.
250 Columbus Ave., Boston 20, Mass. (Tel. HI 5-3850)
Pres.: Walter E. Strimling
Sales Mgr.: Button D. Lenk GH, GE, TR

TED STATES PLYWOOD CORP.
6 W. 44th St., New York 36, N. Y. (Tel. MU 2-1900) GS

TED STATES RADIUM CORP.
O. Box 246, Morristown, N. J. (Tel. JEfferson 9-4000)
Purch. Agent: R. Von Epps
Asst. Purch. Agent: D. Weover
P.-Sales: C. W. Wallhousen
MF, WN, GH, GE, CO, TS, TR

TED STATES RUBBER CO.
30 Ave. of the Americos, New York, N. Y. (Tel. CIrcle 7-5000)
Pres.-Purch.: S. W. MocKenzie
Asst. Dir.-Purch.: W. H. Sprotling
Invt. Dept.-Sales: Douglos K. Bonn, Mgr., 1700 K Street, N. W., Woshington, D. C. PS, MM, R&D

TED STATES STEEL CORP.
5 William Penn Pl., Pittsburgh 30, Po.
Media Suprvsr.: A. F. Berliner MF, PS

TED STATES TIME CORP.
terbury 20, Conn. (Tel. Plozo 8-2444)
stern Sales Mgr.: H. D. Armstrong, 375 Pork Ave., New York 22, N. Y. (Tel. PLozo 9-5665)
stern Sales Mgr.: R. Loncoster, 346 Tejon Pl., Polos Verdes Estotes, Colif. (Tel. FRontier 5-9526) GE, TR, R&D

TED STATES VARNISH CO.
O. Box 2, #625 Fronklin Ave., Hosbrouck Hts., N. J. (Tel. ATlos 8-0373)
rch.: Henry G. Hose

TED SUPPLY CO.
76 S. Broodway Pl., Los Angeles 7, Calif. (Tel. ADoms 3-4384)
ch. Agent: Horry L. Guss
es Mgr.: Morris C. Guss
MF, WN, PS, GS, GH, GE, MM

TED TRANSFORMER CORP.
0 Vorick St., New York 13, N. Y. (Tel. ALgonquin 4-3500)
ch. Agent: J. Kromer
es Mgr.: H. Russell GS, GE, CO, TS, TR

TED WIRE & SUPPLE CORP.
17 Elmwood Ave., Providence, R. I. (Tel. STuort 1-3000)
Gen. Sales Mgr.: J. G. Londrigon MM

UNITED-CARR FASTENER CORP.
31 Ames St., Combridge 42, Moss. (Tel. KIrkland 7-4900)
Purch. Agent: F. J. Ross
Asst. Purch. Agent: Dovid Erb
Sales: Arthur W. Rice, Jr.
MF, WN, PS, GS, GH, GE, TR

UNIVERSAL CIRCUIT CONTROLS CORP.
3610 Ookton St., Skokie, Ill. (Tel. ORchord 5-2620)
Chief Engr. & Gen. Mgr.: Sander B. Friedmon
Sales Mgr.: Eorl R. Soyre GE, TR

UNIVERSAL DRAFTING MACHINE CORP.
7960 Lorain Ave., Clevelond 2, O. (Tel. OL 1-4747)
Purch. Agent: R. F. Bornes
Asst. Purch. Agent: D. DeVito
V. P.-Sales: S. W. Hoover

UNIVERSAL DYNAMICS CORP.
P. O. Box 9814, 1441 N. 19th St., Arlington 9, Va. (Tel. JAckson 5-4541)
Purch. Agent: Dovid L. Wotson
Sales Mgr.: Kirk L. Burns GS, GH, TS

UNIVERSAL ELECTRIC CO.
300 E. Moin St., Owosso, Mich. (Tel. SArotoga 5-7174)
Dir.-Purch.: Gerold Hoddy
Dir.-Sales: A. E. Kerscher PS

UNIVERSAL ELECTRONICS CO.
1720 22nd St., Sonto Monico, Colif. (Tel. EXbrook 3-7707)
Purch. Agent: P. A. McGreevey
Sales Mgr.: Richord Londis (Tel. CRestview 4-8185) PS, GS, GE

UNIVERSAL MFG. CO., INC.
1168 Grove St., Irvington 11, N. J. (Tel. ESsex 4-9800)
Sales Engr.: Anthony O. Vicori

UNIVERSAL METAL PRODUCTS INC.
331 Vinelond Ave., Puente, Colif. (Tel. EDgewood 6-4561)
Purch. Agent: M. G. Miller
Sales Mgr.: O. J. Miller MF, GS, GH

UNIVERSAL MICROPHONE CO.
Box 55, Inglewood, Colif. (Tel. EX 8-6898)
Purch. Agent: D. Horrison
Sales Mgr.: R. Horrison GS

UNIVERSAL MOULDED PRODUCTS CORP.
Commonwealth Ave., Bristol, Vo. (Tel. NO 9-1181)
Purch. Agent: J. G. Barnes
Dir.-Sales: C. L. Meteer
MF, WN, PS, GS, MM, R&D

UNIVERSAL TOROID COIL WINDING, INC.
171 Coit St., Irvington 11, N. J. (Tel. ESsex 4-9800)
Purch. Agent: Williom E. Arends
Sales Engr.: Anthony O. Vicori

UNIVERSAL TRANSISTOR PRODUCTS CORP.
17 Brooklyn Ave., Westbury, N. Y. (Tel. EDgewood 3-3304)
Purch. Agent: I. R. Zeller
GS, GH, GE, CO, TS, TR

UNIVERSAL UNLIMITED, INC.
Prott Ovol, Glen Cove, N. Y. (Tel. ORiole 6-4600)
Purch. Agent: Henry J. Belmont
Sales Mgr.: Mork L. Steiner MF, GE, TS, TR

UNIVERSAL-CYCLOPS STEEL CORP.
Bridgeville, Po. (Tel. CAnol 1-8000)
Plant Mgr.-Purch.: F. E. Gorrah
V. P.-Sales: W. J. Long MM

UNIVERSITY LOUDSPEAKERS, INC.
80 S. Kensico Ave., White Ploins, N. Y. (Tel. WHite Ploins 6-7700)
Purch. Agent: Rocco Di Rico
Sales Mgr.: Chorles Roy GS, R&D

UTICA DROP FORGE & TOOL DIV.-KELSEY HAYES CO.
2415 Whitesboro St., Utico 4, N. Y. (Tel. 5-6411)
Purch. Agent: Russell Jones
Asst. Purch. Agent: E. Kern
Mgr.-Missile Div.-Soles: W. K. Norris
MF, WN, PS, GS

UTRAD CORP.
305 N. Briont St., Huntington, Ind. (Tel. 4088 & 4089)
Purch. Agent: Norbert A. Miller
Pres.-Sales: A. R. Koufmon

VACAP CORP.
1905 Summit Ave., Union City, N. J. (Tel. UNion 7-6699)
V. P.-Purch. & Sales: L. Dolinko GH, TR

VACUUM METALS CORP., DIV.-CRUCIBLE STEEL CO. OF AMERICA
P. O. Box 977, Syrocuse 1, N. Y. (Tel. HOword 8-2571)
Dir.-Purch.: R. O. Bridge, Crucible Steel Co. of Americo, Oliver Bldg., Pittsburgh 30, Po. (Tel. ATlontic 1-3800)
Head-Purch. Dept.—Syrocuse: F. G. Hefti
Sales Mgr.-Syrocuse: F. J. Coates MF, WN, PS

VACUUM RESEARCH CO.
420 Morket St., Son Francisco 11, Calif. (Tel. YUkon 2-3565)
Purch.: H. F. Perezone, 1929 Williams St., Son Leondro, Colif. (Tel. LOckhoven 8-1252)
Sales: Lorry Wright, San Francisco
PS, GS, GH, GE

VACUUM TUBE PRODUCTS, DIV.-HUGHES AIRCRAFT CO.
2020 Short St., Oceonside, Calif. (Tel. SArotogo 2-7648)
Purch. Agent: L. J. Huking
Mgr.-Sales: J. J. Sutherlond GS, GH, R&D

VALCOR ENGRG. CORP.
Cornegie Ave., Kenilworth, N. J. (Tel. CHestnut 5-1665)
Purch. Agent: M. A. Kreitchmon
Buyer: Anthony Pios
Gen. Sales Mgr.: Murroy Moslow
PS, GS, GH, GE, CO

VALPEY CRYSTAL CORP.
1244 Highlond St., Holliston, Moss. (Tel. GArden 9-4851)
V. P.-Purch.: T. S. Volpey, Jr.
Sales Engr.: Nelson B. Piper, Jr. GE, TS, TR

VAN DER HORST CORP. OF AMERICA
1645 Eost Stote Rd., Oleon, N. Y. (Tel. 3173)
Purch. Agent: A. B. Roop
Sales Mgr.: Fronk Jorstod WN, MM, R&D

VAN KEUREN CO.
176 Wolthom St., Wotertown 72, Moss. (Tel. WAtertown 4-4394)
Pres.: R. T. Porsons
Sales Mgr.: Williom Mark

VAN ZELM ASSOCIATES, INC.
7803 Puloski Hwy., Baltimore 6, Md. (Tel. MUrdock 7-1414)
Purch. Agent: Mr. Robert Henning
Business Mgr.-Sales: Gerald McBride GS, GH, R&D

VANADIUM CORP. OF AMERICA
420 Lexington Ave., New York, N. Y. (Tel. LE 2-3580)
Dir.-Purch.: F. W. Thomos
V. P.: R. H. Filsinger, Jr. MM

VANADIUM-ALLOYS STEEL CO.
Lotrobe, Po. (Tel. KEystone 7-5551)
Purch. Agent: Lewis M. Potter
Asst. Purch. Agent: Alex B. Smith
V. P.-Sales: R. Burns George MM

VANGUARD ELECTRONICS CO.
3384 Motor Ave., Los Angeles 34, Colif. (Tel. TExos 0-7344)
Pres.-Purch.: Simon A. Golbert
Sales Mgr.: Fred Finoly GS, GE, TS

VAP-AIR AERONAUTICAL PRODUCTS DIV., VAPOR HEATING CORP.
6444 Howord St., Chicogo, Ill. (Tel. NEwcastle 1-9200)
Purch. Agent: Robert W. Currer
Buyers: Ronald R. Krenek & Fronk Slopak
V. P.-Sales: L. H. Gillick GS, R&D

VAPOR BLAST MFG. CO.
3025 W. Atkinson Ave., Milwoukee 9, Wis. (Tel. CUster 3-6500)
Purch. Agent: A. Odehnol
Sales Mgr.: H. F. Potin
MF, WN, GS, GH, GE, TS, MM, R&D

VARD INC.
2981 E. Colorado St., Posodeno, Colif. (Tel. SYcamore 6-9281)
Purch. Mgr.: Gordon Withall
Buyers: Jim Gilbert, John Allen

CODING
Missile Frame MF
Warhead & Nose Cone WN
Propulsion System PS
Ground Support GS
Ground Handling GH
Guidance Equipment GE
Checkout Equipment CO
Test Equipment TS
Tracking & Telemetering TR
Research & Development R&D
Materials & Metals MM

Sales Administrator: G. L. Gillespie
Exec. V. P.-Sales: Phillip R. Heim

VARFLEX CORP.
512 W. Court St., Rome, N. Y. (Tel. 7200)
Purch.: Merrick Drummond
Sales: J. H. Finnegan — MF, WN, PS

VARIAN ASSOCIATES
611 Hansen Way, Palo Alto, Calif. (Tel. OAvenport 6-4000)
Chief-Purch.: Hamilton Shutts
Sales Mgr.: W. M. Silhavy, Tube Div.
Sales Mgr.: Emery Rogers, Instrument Div.
Sales Mgr.: Paul I. Corbell, Radiation Div.
GE, CO, TS, TR, R&D

VARIETY AIRCRAFT CORP.
2901 W. 3rd St., Dayton, Ohio (Tel. AM 3-2664)
Gen. Mgr.: C. A. Coppock
Ch. Engr.: W. H. Kuntz — MF, GS, GH

VARI-L CO., INC.
432 Fairfield Ave., Stamford, Conn. (Tel. FIreside 8-0091)
Pres.: J. L. Kiser — GS, TS, TR

VARO MFG. CO.
2201 Walnut St., Garland, Tex. (Tel. BRoadway 6-6141)
Purch. Agent: Brad Riggs
Buyer: Al Armstrong
Sales Mgr.: J. R. Gilmer
GS, GE, CO, TS, TR, R&D

VASCOLOY-RAMET CORP.
800 Market St., Waukegan, Ill. (Tel. ON 2-5220)
Purch. Agent: L. P. Paluska
Sales Mgr.: B. F. Naden — MM

VECTOR ELECTRONIC CO.
1100 Flower St., Glendale 1, Calif. (Tel. CHapman 5-1076)
Purch. Agent: Jerry Strickland
Gen. Mgr.: R. R. Scoville — MF, GE, TS, TR

VEECO VACUUM CORP.
86 Oenton Ave., New Hyde Park, L. I., N. Y. (Tel. Pioneer 6-1161)
Purch. Agent: E. Potter
V. P.-Sales: A. Nerken
PS, GS, GH, GE, CO, TS, TR

VEEDER-ROOT INC.
70 Sargeant St., Hartford 2, Conn. (Tel. JAckson 7-7201)
Purch. Agent: R. I. Bond
Sales Mgr.: G. L. Logan — CO, TS, TR

VEET INDUSTRIES
25753 Groesbeck Hwy., E. Detroit, Mich. (Tel. PRescott 6-3000)
Purch. Agent: A. Stewart
Sales Mgr.: W. Clyde Nav — PS

VEMALINE PRODUCTS CO.
P. O. Box 222, Hawthorne, N. J. (Tel. MUlberry 4-4688)
Purch. Agent: Wm. Venema
MF, WN, PS, GS, GH, GE, CO, TR

VENDORLATOR MFG. CO.
2550 S. Railroad Ave., Fresno, Calif. (Tel. AMhert 6-9401)
Purch. Agent: O. J. McMillin
Asst. Purch. Agent: Howard Henry
Sales: E. E. Brown (West Coast), Bert Schwarz (East Coast) — GH

VERNISTAT DIV., THE PERKIN-ELMER CORP.
772 Main Ave., Norwalk, Conn. (Tel. VIctor 7-2441)
Sales Mgr.: Lionel Robbins — GS, GE, TS

VERSON ALLSTEEL PRESS CO.
9300 Kenwood Ave., Chicago 19, Ill. (Tel. REgent 4-8200)
Purch. Agent: H. Wiggins — MF, WN, MM, R&D

VICKERS INC., DIV.-SPERRY RAND
Administrative & Engrg. Ctr., Detroit 32, Mich. (Tel. Royal Oak—LIberty 9-1122)
Gen. Purch. Agent: R. V. Sharkey
Gen. Sales Mgr.: J. T. Burns
GS, GH, GE, CO, TS, R&D

VICKERS INC., MARINE & ORDNANCE DEPT., MACHINERY HYDRAULICS DIV.
172 E. Aurora St., Meriden, Conn., (Tel. PL 6-3684)
Purch. Agent: Harold Carberry
Sales Mgr.: R. J. Mitchell

VICON CORP.
1369 Industrial Rd., San Carlos, Calif. (Tel. LYtell 3-8003)
Purch. Agent: O. Scofield
V. P.-Sales: H. Johnston — GS, TS, TR

VICTOR ADDING MACHINE CO.
3900 N. Rockwell St., Chicago 18, Ill. (Tel. KEystone 9-8210)
Dir. Purch.: L. E. Covey
Purch. Agent: J. E. Jasch
V. P.-Sales: A. F. Bakewell
Buyers: G. A. Moeller, Richard Bergman, John Mickey
V. P.-Electronic Sales: A. C. Buehler, Jr.
GS, GH, CO, TS, R&D

VICTOR MFG. & GASKET CO.
5750 W. Roosevelt Rd., Chicago 50, Ill. (Tel. AUstin 7-6180)
Gen. Purch. Agent: Harold G. North
V. P.-Indsl. Sales: Albert J. Aukers — MF, PS

VICTOR R. F. & MICROWAVE CO.
36 W. Water St., Wakefield, Mass. (Tel. CRystal 9-4472)
Gen. Mgr.: George P. Victor — TS, MM, R&D

VICTORY ENGRG. CORP.
Springfield Rd., Union, N. J. (Tel. MUrdock 8-7150)
Purch. Agent: R. W. Blimm
Sales: W. B. Huston — PS, GS, GE, CO, TS, TR

VIDEO INSTRUMENTS CO., INC.
3002 Pennsylvania Ave., Santa Monica, Calif. (Tel. EXbrook 3-1244)
Purch. Agent: Richard Brommer
Prod. Mgr.: Bob Cobery
V. P. & Gen. Mgr.: Peter Pohl

VIDEON ELECTRONIC CORP.
902 E. Michigan St., Indianapolis 2, Ind. (Tel. MElrose 6-5461)
Purch. Agent: Charles Gallagher
Sales Mgr.: Arthur J. Schultz — GE, TS, TR

VILTER MFG. CO., THE
2217 S. First St., Milwaukee 7, Wisc. (Tel. SHeridan 4-0111)
V. P.-Purch.: L. E. Loos
V. P.-Sales: A. O. Vogel — R&D

VINCO CORP.
9111 Schaefer Hwy., Detroit 28, Mich. (Tel. WEbster 3-4350)
Purch. Agent: E. L. Camen
Buyer: E. St. Onge
Asst. Buyer: J. Davis
Asst. Sales Mgr.: J. J. Kessel — GS, GE, TS

VINSON MFG. CO. INC.
8044 Woodley Ave., Van Nuys, Calif. (Tel. STanley 3-3510)
Factory Mgr.: F. Gallagher
Sales: William A. Goodman
MF, WN, PS, GS, GH, GE, TS, TR

VIRGINIA ELECTRONICS CO., INC.
River Rd. & B& O R. R., Washington 16, O. C. (Tel. OLiver 4-6680)
Purch. Agent: Edward Schwartz
V. P.-Sales: Millard Nachtwey
GE, CO, TS, TR, R&D

VIRGINIA PLAK CO.
270 Madison Ave., New York 16, N. Y. (Tel. MUrray Hill 3-9516)
Gen. Mgr.: S. N. Weis — MF, WN, GE, CO, TS, TR

VITRO CORP. OF AMERICA
261 Madison Ave., New York, N. Y. (Tel. MUrray Hill 2-5700)
Purch. Agent: E. S. Fowler
Exec. V. P.-Sales: W. A. Bain — GS, GH, TR, R&D

VITRO LABS.
200 Pleasant Valley Way, West Orange, N. J. (Tel. REdwood 1-3400)
Procurement Mgr.: J. E. Eaton
New Proj. Mgr.-Sales: W. L. Slover
GS, GH, CO, TS, TR, MM, R&D

VLCHEK TOOL CO., THE
3001 E. 87th St., Cleveland 4, O. (Tel. GA 1-2480)
Purch. Agent: F. J. Tkach
V. P.-Sales: L. F. Storie — MF

VOI-SHAN MFG. CO., DIV.-PHEOLL MFG. CO.
8463 Higuera St., Culver City, Calif. (Tel. TExas 0-5321)
Purch. Agent: Miss Glory Fields — MF

VORAC CO., THE
147 Meadow Rd., Rutherford, N. J. (Tel. WEbster 3-1000)
Dir.-Purch.: Robert Geist
MF, WN, PS, GS, GE, TS

VOUGHT CO.
8907 Melrose Ave., Los Angeles 46, Calif.
Mailing Add.: P. O. Box 1350, Beverly Hills, Calif. (Tel. CRestview 6-1131)
Contract Officer: W. E. Lanctot
Mgr.-Sales: A. O. Fraser — GS, GE, TR

WJZ GAGE & TOOL CORP.
Hyde Park, N. Y. (Tel. CApitol 9-2929)
Sales Mgr.: Jed Daly

W-S FITTINGS WORKS, FORGE & FITTINGS DIV., H. K. PORTER CO. INC.
P. O. Box #95 Aldene Rd., Dept. 359, Roselle, N. J. (Tel. CH 1-1600)
Purch. Agent: Walter Lewis
Sales Mgr.: James H. Wyres — PS, GH, CO, TS, R&I

WAAGE ELECTRIC, INC.
720 Calfax Ave., Kenilworth, N. J. (Tel. CHestnut 5-9363)
Curtis Frantz — G

WACLINE, INC.
35 S. St. Clair St., Dayton 2, O. (Tel. BAldwin 8-5161)
Purch. Agent: R. G. Swanson
V. P.-Sales: M. E. Goll — PS, GS, GE, CO, TS, TI

H. A. WAGNER CO.
14707 Keswick St., Van Nuys, Calif. (Tel. ST 3-1260)

WAIMET ALLOYS CO., DIV.-CONSOLIDATED FOUNDRIES AND MFG. CORP.
1999 Guoin St., Detroit, Mich. (Tel. LOrain 7-1545)
Tech. Dir.: W. P. James
Purch. Agent: Opal Koonter
Sales Mgr.: R. J. Metzler — MI

WAKEFIELD ENGRG. CO.
P. O. Box 471, Coeur d'Alene, Idaho (Tel. MUrray 5-5541)
V. P.: O. Bresnan — G

WAKMANN WATCH CO. INC.
15 W. 47th St., New York, N. Y. (Tel. JU 6-1750)
V. P.: Jack Waller — GS, GH, GE, CO, TS, R&I

WALBAR MACHINE PRODUCTS INC.
74 Maple St., Stoneham, Mass. (Tel. Stoneham 6-3035)
Purch. Agent: James E. Gallagher
Sales Mgr.: T. J. Caveney — P

WALDES KOHINOOR, INC.
47-16 Austel Place, Long Island City 1, N. Y. (Tel. EXeter 2-3100)
Purch. Agent: H. M. VanCleaf
V. P.-Sales: George Waldes
Asst. to V. P.-Sales: Gordon A. Moos — M

WALDOM ELECTRONICS INC.
4625 W. 53rd St., Chicago 32, Ill. (Tel. LUdlow 5-1212) — MF, WN, PS, GS, GH, GE, CO, TS, T

WALDORF ELECTRONICS. DIV.-F.C. HUYCK & SONS
Park Ave., Huntington, L. I., N. Y. (Tel. HA 7-5800)
Purch. Dir.: Nick Schwetz
Buyers: Al Fritz, Donald Greenberg, Rudulf Hoch
Dir.-Sales: Norbert E. Andres, Jr.
GS, GE, CO, TS, TR, R&

WALDORF FLUID SYSTEMS, DIV.-F. C. HUYCK & SONS
Wolf Hill Rd., Huntington Station, L. I., N. Y. (Tel. HAmilton 7-7500)
Dir.-Purch.: Nicholas Schwetz
Sr. Buyer: Edward M. Stockus
Sub-Contract Buyer: Harold V. Isacksen
WN, PS, GS, GH, CO, TS, R&

WALES STRIPPIT INC., UNIT OF HOUDAILLE INDUSTRIES, INC.
Buell Rd., Akron, N. Y. (Tel. 9441)
Purch. Agent: George MacFayden
Gen. Sales Mgr.: Russell A. Johnson — MF, G

WALKIRT CO.
141 W. Hazel St., Inglewood 3, Calif. (Tel. ORegon 8-4814)
Purch.: L. Wilgus
Gen. Mgr.-Sales: Wes L. Kirchoff
GS, GE, CO, TS, T

P. WALL MFG. CO.
Erie St., Grove City, Pa. (Tel. 910)
Purch. Agent: Paul Northcott
V. P.-Sales: M. A. Silverman — GS, G

***WALL COLMONOY CORP., STAINLESS PROCESSING DIV.**
19345 John R St., Detroit 3, Mich. (Tel. TWinbrook 3-3800)
Office Mgr.: D. Hunter
Sales Mgr.: F. Cruse — MF, WN, F
*(See Page 72 for Advertisement)

WALL TUBE & METAL PRODUCTS CO.
P. O. Box 330, Newport, Tenn. (Tel. 2391)
Purch. Agent: James P. Masters
V. P. & Gen. Sales Mgr.: Frank L. Dempsey — M

WALLACE & TIERNAN INC.
25 Main St., Belleville 9, N. J. (Tel. PLymouth 9-8000)
Purch. Agent: I. Gordon
Asst. Purch. Agent: T. A. Moore
V. P.-Sales: T. T. Quigley — CO, TR, R&

WALLINGFORD STEEL CO.
Valley St., Wallingford, Conn. (Tel. COlony 9-3361

Purch. Agent: D. Norton Williams
Asst. Purch. Agent: William Dennison
V. P.-Chg. Sales: G. J. Griffin MF, PS, MM

ALTHAM ELECTRONICS CORP.
751 Main St., Walthom 54, Mass. (Tel. TWinbrook 4-6048)
Purch. Agent: Irving Kodesh TS, TR, R&D

ALTHAM ENGRG. CORP., SUB.-WALTHAM PRECISION INSTRUMENT CO.
221 Crescent St., Waltham 54, Mass. (Tel. TWinbrook 3-4000)
V. P.-Sales: Fred Konn

ALTHAM HOROLOGICAL CORP.
395 Lynnway, Lynn, Mass. (Tel. LY 8-4750)
Purch. Agent: Eugene Decareou
Sales Dept.: E. J. Arnold

ALTHAM PRECISION INSTRUMENT CO.
221 Crescent St., Waltham, Mass. (Tel. TWinbrook 3-4000)
Purch. Agent: Donold Lyons
Pres.: Louis R. Ripley
Gen. Sales Mgr.: Fred M. Burmann GE, R&D

ALTHAM SCREW CO.
77 Rumford Ave., Waltham 54, Mass. (Tel. TWinbrook 3-5830)
Purch. Agent: Lyman Viles MF, WN, PS, MM

LWORTH CO.
50 3rd Ave., New York 17, N. Y.

LWORTH CO., ELECTRONICS DIV.
9 Union St., Mineola, L. I., N. Y. (Tel. Ploneer 2-1010) GE, TR

NG LABS., INC.
7 Hurley St., Cambridge 41, Mass. (Tel. UNiversity 4-8380)
Pres.: A. Wang R&D

RNER ELECTRIC BRAKE & CLUTCH CO.
eloit, Wisc., (Tel. Dunkirk 9-2211)
urch. Mgr.: Hugh Kays
. P.-Sales: N. K. Anderson MM

RREN COMPONENTS, DIV.-ELTRONICS, INC.
Irvine St., Warren, Pa. (Tel. 4630)
urch. Agent: Richard Swanson
aterial Contral: Harry Anderson
ales Mgr.: MacBain Sears

RREN TRANSFORMER CO., INC.
03 Warren St., Tunkhannock, Po. (Tel. TErrace 6-8411)
en. Mgr.: G. W. Moslin MF, GS, GE, TS, TR

RREN WIRE CO.
ownol, Vt. (Tel. VA 3-7321); 1601 Chestnut St., Alhambra, Colif. (Tel. ATlantic 9-5081)
urch.: John Borber
P.-Sales: F. W. Kunzelmonn MM

/HINGTON ALUMINUM CO., INC.
ennsylvania RR & Knecht Ave., Baltimore 29, Md. (Tel. Circle 2-1000)
urch. Agent: Bruner Dicus
P.-Sales: Robert S. Sanford MF, GH, GE, TR, R&D

/HINGTON MACHINE & TOOL WORKS, INC.
111 Wayzata Blvd., Minneopolis, Minn. (Tel. Liberty 5-5611)
urch. Agent: B. C. Lysio
es.: R. S. Lanier
P.-Prod.: H. B. Merrell GE, GS

/HINGTON STEEL CORP.
oodland & Griffith Ave., Washington, Pa., (Tel. Baldwin 2-8000)
rch. Agent: R. O. Fulton
les Mgr.: John C. Richards MM

/HINGTON TECHNOLOGICAL ASSOCIATES, INC.
9 Rollins Ave., Rockville, Md. (Tel. HAzelwood 7-7550)
ief Purch. Agent: Ernest Tingle
st. Purch. Agent: John McPherson GS, GH, GE, CO, TS, TR, R&D

/LEY PRODUCTS, INC.
llege Highway, Plainville, Conn. (Tel. SHerwood 7-2784)
P.-Purch. & Sales: A. Justin Wasley MM, R&D

/SCO ELECTRIC PRODUCTS CORP.
32 2nd Ave., S., St. Petersburg 12, Fla., (Tel. DRchard 1-2948)
es.: Henry G. Wasserlein

/TE KING CORP., TECHNICAL PRODUCTS DIV.
50 Harbor St., Los Angeles 22, Calif. (Tel. RAymond 3-9601)
r.-Mfg. Services: Robert L. Potter
r.-Engrg. Program Development: Frank L. Spencer PS, GS, GE, CO, TS, R&D

/AERBURY COMPANIES, INC.
5 S. Main St., Waterbury, Conn. (Tel. PL 6-5551)
Purch. Agent: F. Johnson
V. P.-Sales: W. F. Reibold MF, WN, PS, GS, TR

WATERBURY PRESSED METAL CO., THE
300 Chase Ave., Waterbury, Conn. (Tel. PLaza 6-8891)
Purch. Agent: H. R. Morrow
Sales Mgr.: Miss Merle Munson MF

WATERMAN PRODUCTS CO., INC.
2445 Emerold St., Philadelphia, Pa. (Tel. GArfield 6-8600)
Purch. Agent: S. Marritz
Buyer: J. Nathan
Field Engrg. Mgr.: J. M. Boyle
Product Mgr.: I. P. Plotkin GS, CO, TS, R&D

WATERS MFG., INC.
Boston Post Rd., Woyland, Mass. (Tel. ELmwood 8-2777)
Purch. Agent: M. P. Brown
Gen. Sales Mgr.: W. W. Bartell

WATERTOWN DIV., THE NEW YORK AIR BRAKE CO.
Starbuck Ave., Watertown, N. Y. (Tel. SUnset 2-7000)
Dir.-Purch.: R. R. Peterson
Purch. Asst.: H. A. Hardman
Buyers: P. F. Hoag & R. H. Madden
Gen. Mgr.-STRATOPOWER, Aircraft Equipment Sales: H. R. Doughty R&D

WATSON MFG. CO., INC.
5000 Taylor St., Jamestown, N. Y. (Tel. 7-191)
Purch. Agent: M. L. Adams
Buyer: H. O. A. Johnson
Metal Specialties Div.-Sales: L. P. Blanchard MM

WAUGH ENGRG. CO.
7842 Burnet Ave., Van Nuys, Calif. (Tel. ST 3-1055)
Purch. Agent: Allan L. Grotsky
Sales Mgr.: Reuel H. Smitter WN, PS, GS, TS, R&D

WAUKESHA FOUNDRY CO.
Lincoln Ave., Waukesho, Wisc. (Tel. Liberty 2-6657)
Purch. Agent: Joseph C. Kehoss
V. P. & Gen. Mgr.: John W. Weaver MM, R&D

WAVEGUIDE, INC.
1769 Placentia, Costo Mesa, Calif. (Tel. MAdison 8-7786)
Purch. Agent: N. C. Glass
Sales Mgr.: John J. Bodley WN, GS, CO, TS, TR, MM

WAVELINE, INC.
Passaic Ave., Caldwell, N. J. (Tel. CApitol 6-9100)
Purch. Agent: Wolter Specht
Gen. Mgr.: Robert H. Koenig
Sales Mgr.: Robert H. Morris GE, TR

WAYNE FOUNDRY & STAMPING CO.
3100 Hubbard, Detroit 10, Mich. (Tel. TAshmoo 5-8226)
Purch. Agent: C. D. MacPherson
Sales Mgr.: C. D. Todd, Jr. MF, WN, PS

WAYNE MFG. CO.
1275 E. Lexington Ave., Dept. E, Pomono, Calif. (Tel. National 9-4071)
Purch.: R. M. Peddicord
Sales: W. G. Wiley

WAYNE PUMP CO., THE, DIV.-SYMINGTON WAYNE CORP.
Herbert, Riverbend & Griffin Sts., Ft. Wayne 4, Ind. (Tel. EAstbrook 4664)
Purch. Agent: V. O. Pontius
Dir.-Sales: R. L. Burke, Jr. MF, WN, PS, GS, GH, GE, MM, R&D

WAYNE-GEORGE CORP.
1117 Commonwealth Ave., Boston 15, Mass. (Tel. STadium 2-3737)
Purch. Agent: Wolter Bohmer
Mgr.-Contracts: George F. GeorgeGE, TS, TR, R&D

***WEATHERHEAD CO., THE**
300 E. 131st St., Cleveland 8, O. (Tel. GLenville 1-5200)
Purch. Agent: J. A. Fanning
Gen. Sales Mgr.-Aviation & Ord. Div.: J. W. Walcott MF, PS, GS
*(See Page 60 for Advertisement)

WEAVER MFG., CO
2171 S. 9th St., Springfield, Ill. (Tel. 2-8861)
Purch. Agent: O. W. Ellis
Purch. Dept.: Anno M. Dowell
V. P.-Sales: Ruel Logan GS, GH, R&D

WEBBER ENGRG. CORP.
P. O. Box 217, Indianapolis 6, Ind. (Tel. MElrose 2-1378)
Purch. Agent: V. L. Fagin
Pres. & Sales Mgr.: Robert C. Webber TS

WEBCOR, INC., GOVERNMENT DIV.
816 N. Kedzie Ave., Chicago 51, Ill. (Tel. NEvada 2-3425)
Dir.-Purch.: C. S. Wybron
Buyers: G. L. Scheel, P. S. Kibler & J. F. Frisby MF, WN, PS, GS, GH, GE, TS, TR

WEBER AIRCRAFT CORP.
2820 Ontario St., Burbank, Calif. (Tel. VIctoria 9-1181)
Dir.-Materiel: Fred Good
Purch. Supvrs.: R. G. Askew, R. E. Fulbright & J. W. Culbertson
Dir.-Sales: Harold G. Johnson MF, GS, GH

WEIGHING & CONTROL COMPONENTS, INC.
206 Lincoln Ave., Hatboro, Pa. (Tel. OSborne 5-0901)
Purch. Agent: Alfred Krieg
Sales Mgr.: Henry J. Oursler, Jr.

WEINSCHEL ENGRG.
10503 Metropolitan Ave., Kensington, Md. (Tel. LOckwood 4-0122)
Purch. Agent: Joseph H. West
Sales Mgr.: Edward Birochak GS, GE, CO, TS, TR, R&D

WEKSLER INSTRUMENTS CORP.
195 E. Merrick Rd., Freeport, L. I., N. Y. (Tel. MAyfair 3-0100)
Purch. Agent: Milford Himmel
V. P.-Sales: F. J. Pla TS

A. W. WELCH MFG., CO., INC.
509 E. 29th St., Indianapolis 5, Ind. (Tel. WA 5-7878)
Pres.: A. W. Welch
Sales Mgr.: Jim Hutchison

WELDED CONSTRUCTION INC.
2320 W. 15th Place, Cleveland 13, Ohio (Tel. MAin 1-0103)
Purch. Agent: John Dufenetz
Sales: Joseph A. Thayer GS, GH

WELDMATIC DIV., UNITEK CORP.
380 N. Halstead Ave., Pasadena, Calif. (Tel. SYcomore 5-5995)
Purch. Agent: Robert Raney
Gen. Mgr.: Gerald E. Woods GS, TS

WELLMAN BRONZE & ALUMINUM CO.
12800 Shaker Blvd., Cleveland, O. (Tel. WYoming 1-7000)
Purch. Agent: B. E. Weimer
V. P.-Chg. Sales: Glenn F. Ihrig MF

WELWYN INTERNATIONAL INC.
3355 Edgecliff Terrace, Cleveland 11, Ohio (Tel. WInton 1-1333)
Sales Mgr.: John Buchspice MM

WENZLAU ENGRG. CO.
410 Solano Ave., Los Angeles 12, Calif. (Tel. CApital 2-3151)
Sales Mgr.: William D. Wenzlau GS, GH, MM

***R. D. WERNER CO., INC.**
295 Fifth Ave., New York 16, N. Y. (Tel. MU 6-2595)
Asst. Adv. Mgr.: Harry Nix GS, GH, TS
*(See Page 78 for Advertisement)

ALBERT WESLING & SONS INC.
2912 W. Lake St., Chicago 12, Ill. (Tel. KEdzie 3-2850)
V. P.-Sales: A. H. Wesling GS

WESREP CORP.
2022 S. Sepulveda Blvd., Los Angeles 25, Calif. (Tel. BRadshow 2-3757)
Pres.: Dudley V. Cassard
Sales Mgr.: Robert A. Hager PS, GE, TS

WEST INSTRUMENT CORP.
4363 W. Montrose Ave., Chicago 41, Ill. (Tel. Palisade 5-1007)
Purch. Agents: Lester Thurow, Robert Aerts
Sales Mgr.: Ardmore M. Willer

WESTBERG MFG. CO.
Box 239, Napa, Calif. (Tel. BA 6-5218)
Purch. Agent: R. R. Westberg
Dir.-Sales: D. A. Kratzer TS, MM

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

WESTBURY ELECTRONICS INC.
300 Shames Dr., Westbury, N. Y. (Tel. EDgewood 4-8300)
Purch. Agent: William McBride
Pres. & Sales Mgr.: H. B. Abajian GS

WESTERN ARC WELDING, INC.
749 Kohler St., Los Angeles 21, Calif. (Tel. MA 2-07S1)
Chief Engr.: E. Sherrick MF, WN, PS, GS, GH

WESTERN AUTOMATIC MACHINE SCREW CO., DIV.-STANDARD SCREW CO.
377 Woodward Ave., Elyria, O. (Tel. FAirfax 3-3341)
Purch. Agent: A. Steller
V. P.-Chg. Sales: M. R. Sorensen MF, WN, PS

WESTERN COATING CO.
P. O. Box 598, Oakridge Station, Royal Oak 3, Mich. (Tel. JUniper 8-3311)
Dir.-Prod.: Franklin B. Evans
Pres. & Head-Sales: Arthur Aaron, 8S W. Union St., Pasadena, Calif. (Tel. RYan 1-7828)
Western Sales Mgr.: L. W. Pickens, Jr. MM

WESTERN DESIGN, DIV.-U.S. INDUSTRIES, INC.; SANTA BARBARA DIV.
Santa Barbara Airport, Goleta, Calif. (Tel. WOodland 7-4S71)
Purch. Agent.: L. E. Saterstrom
Dir.-Mktg.: John M. Wright GS, GH, CO, TS

WESTERN ELECTRIC CO., INC.
120 Broadway, New York, N. Y. (Tel. WOrth 4-2100)
Radio Div.: C. R. Smith

WESTERN FELT WORKS & ACADIA SYNTHETIC PRODUCTS DIV.
4021-4139 Ogden Ave., Chicago 23, Ill. (Tel. CRawford 7-8000)
Purch. Agent: L. W. Heide
Prod. Control: Gene Wojcik
Sales Mgr.: R. H. Butz MM

WESTERN GEAR CORP.
P. O. Box 182, Lynwood, Calif. (Tel. NEvada 6-0911)
Purch. Agent: James Fortune
Mktg. Mgr.: Ron Hinman PS, GS, GH

WESTERN GOLD & PLATINUM
S2S Harbor Blvd., Belmont, Calif. (Tel. LYtell 3-3121)
Purch. Agent: Michael D. McKinney
Sales Mgr.: Harry Mason MM

WESTERN INSULATED WIRE CO.
2425 E. 30th St., Los Angeles 58, Calif. (Tel. LUdlow 7-7103)
Mgr.-Purch.: Phil Ramos
V. P.-Mgr. of Sales: Ed Kanner GS, TR

WESTERN INTERNATIONAL CO.
45 Vesey St., New York 7, N. Y. (Tel. DIgby 9-2277)
Purch. Agent: E. R. Reilly
Sales Mgr.: R. Worthington MF, PS, GS, GH, GE, TS, TR

WESTERN IRON & FOUNDRY CO., INC.
702 E. Second St., Wichita 2, Kansas (Tel. HObart 4-2311)
V. P.-Purch.: G. L. Dabler
Pres. & Gen. Mgr.: E. E. Urban MM

WESTERN PNEUMATIC TUBE CO.
P. O. Box 487, Kirkland, Wash. (Tel. VAndyke 2-2214)
Purch. Agent: N. E. Ludington
V. P.-Sales: Carson Eckmann MM

WESTERN SEALANT OF CONN.
50 Isaac Pl., Norwalk, Conn. (Tel. TEmple 8-5446)
Purch. Agent: John Harding
Dir.-Sales: K. E. Middlebrook

WESTERN TOOL & MFG. CO., THE
1620 E. Pleasant St., Springfield, O.

WESTFIELD METAL PRODUCTS CO., INC.
1040 Lower Union St., Westfield, Mass. (Tel. LOgan 2-3614)
Purch. Agent: James A. Paal
Sales Dept.: William H. Bulger & Fred H. Burr MG, WN, PS, GS, GH, GE

WESTGATE LAB., INC.
Yellow Springs, Ohio

WESTINGHOUSE AIR BRAKE CO., INDUSTRIAL PRODUCTS DIV.
P. O. Box 36, Wilmerding, Pa. (Tel. BRandywine 1-1490)
Dir.-Purch.: R. M. Hornbeck
Asst. Dir.-Purch.: R. E. Maritz
Buyers: H. I. McKeever, C. H. West, M. L. Stevens & J. E. Kruger
Sales Mgr.: E. L. Halbrook GS, GH

WESTINGHOUSE ELECTRIC CORP.
3 Gateway Center, P. O. Box 2278, Pittsburgh 30, Pa. (Tel. EXpress 1-2800)
V. P.-Purch.: A. M. Kennedy
V. P.-Sales: J. H. Jewell WN, PS, GS, GH, GE, TR, MM, R&D

WESTINGHOUSE ELECTRIC CORP., LAMP DIV.
MacArthur Ave., Bloomfield, N. J. (Tel. HUmboldt 4-3000)
Purch. Agent: F. C. Esser
Mktg. Mgr., Parts & Materials: J. Gelok MM

WESTINGHOUSE ELECTRIC CORP., METALS PLANT
Blairsville, Pa. (Tel. 1400)
Purch. Agent: S. J. Pentrack
Buyer: R. J. Merryman
Sales Mgr.: S. Chetlin
Ass't Sales Mgr.: E. V. Clarke, Jr. MM, R&D

WESTLAKE PLASTICS CO.
W. Lenni Rd., Lenni Mills, Pa. (Tel. GLobe 9-1000)
V. P.-Purch.: E. F. Westlake
Sales Mgr.: W. F. Noonan, Jr. MF, PS, GS, GE, TR

WESTLINE PRODUCTS DIV.-WESTERN LITHOGRAPH CO.
600 E. 2nd St., Los Angeles 54, Calif. (Tel. MAdison 7-2641)
Dir.-Purch.: Laird Swan
V. P. & Gen. Sales Mgr.: Maury Engle MF, PS, GS, TR, MM

WESTON HYDRAULICS LTD.-SUB., BORG-WARNER CORP.
10918 Burbank Blvd., N. Hollywood, Calif. (Tel. STanley 7-3201)
Dir.-Purch.: Robert E. Stevens
Buyers: William Bufkin & K. L. Johnsan
Regional Sales Mgrs.: K. H. Knox & Fred T. Miller PS, GS, GH, GE, TS

WESTON INSTRUMENTS, DIV.-DAYSTROM, INC.
614 Frelinghuysen Ave., Newark 12, N. J. (Tel. BIgelow 3-4700)
Purch. Agent: N. A. Dinnsen
Gen. Sales Mgr.: K. C. Moultan

WESTRONICS INC.
3605 McCart St., Fort Worth, Tex. (Tel. WA 3-8211)
Purch. Agent: Bob King
V. P.-Sales: George W. Puckett GS, CO, TS

WESTVACO CHLOR-ALKALI DIV., FOOD MACHINERY & CHEMICAL CORP.
161 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-7400)
Dir.-Purch.: J. A. Maaney
Mgr.-Sales: J. R. Harris
Mgr.-Dimazine Sales: B. L. Rase PS

WESTWOOD CABLE CORP.
3440 Overland Ave., Los Angeles 34, Calif. (Tel. TExas 0-6831)
Purch. Agent: I. M. Harris
Buyer: Jack Kendall
Gen. Sales Mgr.: John Cooner GS

WETZLER CLAMP CO. INC.
43-15 11th St., Long Island City 1, N. Y. (Tel. ST 4-2874)
V. P.-Sales: H. S. Wetzler MM

WHEEL CRAFT INC.
1120 W. Foothill Blvd., Azusa, Calif. (Tel. EDgewood 4-1261)
Purch. Agent: Phil Bockmiller
Sales Mgr.: Albin T. Sundeen

WHEELABRATOR CORP.
1469 S. Byrkit St., Mishawaka, Ind. (Tel. BLackburn 5-2141)
Dir.-Purch.: H. O. Books
Gen. Sales Mgr.: E. A. Rich

WHEELER ELECTRONIC CORP., SUB.-SPERRY RAND CORP.
150 E. Aurora St., Waterbury, Conn. (Tel. PLaza 4-5191)
Purch. Agent: W. A. Collier
Sales Mgr.: R. B. Baker GS, GE, TS, TR

WHEELER LABORATORIES, INC.
122 Cutter Mill Rd., Great Neck, N. Y. (Tel. HUnter 2-7876)
Adv. Mgr.: Patricia A. Lath R&D

WHEELOCK SIGNALS INC.
273 Branchport Ave., Long Branch, N. J. (Tel. CApital 2-6880)
Purch. Agent: J. E. Gould
Sales Mgr.: H. J. Sundermeyer

WHELAND CO., THE
Signal Mountain Rd., Chattanooga, Tenn. (Tel. AM 5-3181)
V. P.-Mfg.: H. V. McDougall
Mgr.-Special Sales: L. E. Skelly MF, WN, PS, GS, GH

WHITAKER CABLE CORP.
1301 Burlington St., North Kansas City 16, Mo. (Tel. GRond 1-4640)
V. P.-Sales: D. E. Stewart
V. P.-Indsl. Sales: C. Craig Whitaker

***WHITE DIESEL ENGINE DIV., THE WHITE MOTOR CO.**
1401 Sheridan Ave., Springfield, Ohio (Tel. FA 3-4921, Cable SUPERDIESL)
Purch. Agent: William J. Lynch
Asst. Purch. Agents: Paul E. Dunn & Arthur Dsseck
Buyer: Joe James
Sales Mgr.: J. H. Newton
*(See Page 30 for Advertisement)

WHITTAKER CONTROLS, DIV.-TELECOMPUTING CORP.
915 N. Citrus Ave., Los Angeles 38, Calif. (Tel. HOllywood 4-0181)
Supvr.-Purch.: Frank Kurvink, 3000 Imperial Hwy. Lynwood, Calif. (Tel. NEvada 6-9271)
Dir.-Field Engrg. & Sales: H. R. Alexander PS, GS,

WHITTAKER GYRO, DIV.-TELECOMPUTING COR
16217 Lindbergh St., Van Nuys, Calif. (Tel. ST 3-1950)
Purch. Agent: Vince Underwood
Buyers: Ben Valucki & J. Schwien
Dir.-Field Engrg.: Donold J. Rammage PS, GH, GE, TS,

WICKFIELD, INC.
1511 Levee St., Dallas 7, Texas. (Tel. RI 1-3395)
Purch. Agent: Harold Roasch
Sales Mgr.: L. B. Bingaman GS, GH, R

EDWIN L. WIEGAND CO.
7500 Thomas Blvd., Pittsburgh 8, Pa. (Tel. CH 2-6400)
Purch. Agent: R. D. Allshouse
Gen. Sales Mgr.: C. F. Kreiser

E. B. WIGGINS OIL TOOL CO. INC.
3424 E. Olympic Blvd., Los Angeles 23, Calif. (Tel. ANgelus 9-0181)
Purch. Agent: Ted Smart
V. P.-Mktg.: Jock Minor GS, GH, CO,

WILCOLATOR CO., THE
1001 Newark Ave., Elizabeth, N. J. (Tel. ELizabeth 4-1000)
Purch. Agent: J. Martin
Sales Mgr.: P. E. McCaughey

WILCOX ELECTRIC CO., INC.
1400 Chestnut St., Kansas City 27, Mo. (Tel. BEnton 1-0700)
Dir.-Purch.: J. Q. Kahler
Dir.-Sales: D. E. Busse
Sales Analyst: Jack F. Hill

WILCOX-CRITTENDEN DIV., NORTH & JUDD MFG. CO.
56 Warwick, Middletown, Conn. (Tel. Diamond 6-8661)
Purch. Agent: William H. Judd, Jr.
Mgr.-Gov't Sales: A. J. Crawford

WILDBERG BROS. SMELTING & REFINING CO.
742 Market St., San Francisco, Calif. (Tel. DOuglas 2-3505)
Pres.: I. I. Wildberg
Gen. Sales Mgr.: W. T. Haley

WILKS PRECISION INSTRUMENT CO., INC.
4821 Bethesda Ave., Washington 14, D. C. (Tel. OLiver 5300)
Pres. & Gen. Mgr.: W. S. Wilks
Buyer: M. Smith
Plant Supt.: Lorne Walters WN, P5, F

WILLARD STORAGE BATTERY DIV.
246 E. 131st St., Cleveland 1, O. (Tel. ULster 1-2600)
Purch. Agent: D. A. Campbell
Mgr.-Sales Engrg.: C. F. Oestermeyer GS, GH, GE,

J. H. WILLIAMS & CO.
400 Vulcan St., Buffalo 7, N. Y. (Tel. RIverside 3200)
Purch. Mgr.: J. T. Schaner
Asst. to Purch. Mgr.: Frank Weber
Sales Mgr.: E. R. Burkardt MF, WN, PS,

WILMINGTON FIBRE SPECIALTY CO.
New Castle, Del. (Tel. EA 8-7525)
Dir.-Purch.: J. R. Quinn
Sales Dept.: H. M. Romig

WILSHIRE POWER SWEEPER CO.
526 W. Chevy Chase, Glendale, Calif. (Tel. CHapman 5-5178)
Plant Mgr.: L. W. Taepper
Sales Mgr.: L. J. Langeness

G. C. WILSON & CO.
1915 8th Ave., Huntington, W. Va. (Tel. JA 3-5149)
Purch. Agent & Sales Mgr.: J. Thomas GS,

LSON EQUIPMENT CORP.
1086 Madison Ave., Paterson 3, N. J. (Tel. LAmbert 3-3102)
Pres.: R. F. Wilson

NATIC CORP., THE
50 Stage Rd., Vestal, N. Y. (Tel. ENdicott 8-1518)
Purch. Agent: D. A. Hertzog
Sales: R. W. Severson PS, GE, CO, TS, TR

NCHARGER CORP., SUB.-ZENITH RADIO CORP.
E. 7th & Division Sts., Sioux City 2, Iowa (Tel. 2-1844)
Purch. Agent: Tom Ryan
Buyers: L. J. Roeper & E. A. Brakke
Sales Mgr.: D. L. Moline
Mgr.-Defense Sales: R. A. Brewer GS, R&D

NCHESTER ELECTRONICS, INC.
Willard Rd., Norwalk, Conn. (Tel. TEmple 8-8433)
Purch. Agent: William Kronus
Sales Supvr.: Louis E. Harrod MM

NCHESTER-WEST. DIV.-OLIN MATHIESON CHEM. CORP.
275 Winchester Ave., New Haven, Conn. (Tel. SP 7-7911)
Purch. Agent: F. E. Plumley
Asst. Purch. Agent: M. W. Perrine
Buyer: W. B. Fuller
Mgr.-Industrial & Military Sales: A. S. Cogan MF, WN, PS, GS, GH, GE

ND TURBINE CO.
E. Market St. & P.R.R., West Chester, Pa. (Tel. OWen 6-3110)
Purch. Agent: G. M. Miller
Buyer: Margaret Cox
Sales Mgr.: Davis B. Oat TR

NDER AIRCRAFT CORP. OF FLORIDA
P. O. Box 2397, Lakeland, Fla. (Tel. MUtual 9-6911)
Purch. Agent: Charles G. Toundas
Purch. Dept.: Mrs. Marion Wulchak & A. B. Horris MF, WN, PS, GS, GH, GE, CO, TS, TR

NDER AIRCRAFT CORP. OF FLORIDA
P. O. Drawer 8, Dunnellon, Fla.
Pres.: Joel T. Henry MF, WN, PS, GS, GH, GE, CO, TS, TR

NKLER LABS.
2225 N. 20th St., Phoenix, Ariz.

J. WINN INC.
220 Washington St., Winchester, Mass. (Tel. PArkview 9-4400)
Purch. Agent: Arthur McWilliams
Sales Mgr.: O. T. Larson

WPOWER MFG. CO.
207 First Ave. E., Newton, Iowa (Tel. 236)
Purch. Agent: Marvin F. Ham
Gen. Sales Mgr.: F. K. Bauer GS, GH

WSLOW AUTOMATICS, INC.
193 East St., New Britain, Conn. (Tel. BAldwin 5-6321)
Pres.: George Podlasek WN, MM, R&D

WSLOW ENGRG. & MFG. CO.
569 Hollis St., Oakland 8, Calif. (Tel. OLympic 2-0288)
Purch. Agent: I. E. Thiele
Exec. V. P.-Sales: W. G. Nostrand GS

WTRONICS
3 S. Hawthorne Blvd., Hawthorne, Calif. (Tel. OSborne 5-1464)
Purch.: Daniel R. Winters GS, CO, TS, R&D

WZEN RESEARCH INC.
201 Lyndale Ave. S., Minneapolis 20, Minn. (Tel. TU 1-5871) TR, R&D

WE CO. OF AMERICA, INC.
Bldg. 247, Santa Barbara Municipal Airport, Goleta, Calif. (Tel. WOodland 7-3620)
Purch. Agent: (Miss) Petre Melvin
Gen. Mgr.: Mike Rothbart GS, GH, MM

WI CRAFT PRODUCTS, INC.
Lake, West Brookfield, Mass. (Tel. VOlunteer 7-3155)
Pres. & Dir.-Sales: Walter M. Poti GE

WI MOLD CO., THE
Hartford 10, Conn. (Tel. ADams 3-6251)
Purch. Agent: J. R. Dillon MM

WISCONSIN ALUMINUM FOUNDRY CO., INC.
838 S. 16th St., Manitowoc, Wisc. (Tel. MUrray 4-3383)
Purch. Agent: Irwin Schwartz
V. P.-Sales: Harry L. Schwartz MF

WIS AERODRAULICS, INC.
2001 Triskett Rd., Cleveland 11, Ohio (Tel. ORchard 1-4730)
Pres.: T. S. Wise

WITTEK MFG. CO.
4305 W. 24th Pl., Chicago 23, Ill. (Tel. LAwndale 1-5124)
Purch. Agent: Paul Meiering
Sales Mgr.: Edward Percival

WOLLAM AIRCRAFT & MARINE PRODUCTS CO.
222 S. Mill St., Celina, O. (Tel. 2286)
V. P.: M. J. Wollam MF, PS

WOLLENSAK OPTICAL CO.
850 Hudson Ave., Rochester, N. Y. (Tel. COngress 6-1000)
Purch. Agent: Clifford Kulver
Mgr.-Photo-Instrumentation Sales: Fred M. Emens WN, GS, R&D

N. WOOD COUNTER LAB.
1525 E. 53rd St., Chicago 15, Ill. (Tel. FAirfax 4-1114)
N. Wood R&D

WOODWORTH SPECIALTIES CORP.
182 Broad Ave., Binghamton, N. Y. (Tel. 3-5495)
Pres.: C. B. Woodworth
Secy.: R. R. Woodworth

WOOLFE AIRCRAFT PRODUCTS, INC.
3441 Filbert, Wayne, Mich. (Tel. PA 1-5330)
Pres.: Clarence Woolf MF, PS

WORCESTER PRESSED STEEL CO.
100 Barber Ave., Worcester, Mass. (Tel. PLeasant 5-4361)
Purch. Agent: C. C. Fletcher
Pres.: C. C. Higgins MM

WORK-FACTOR CO., INC., THE
206 W. Atlantic Ave., Haddon Hts., N. J. (Tel. LIncoln 7-1676)
Field Engr.-Purch.: Donald F. Diefenderfer

WORKLON, INC.
253 W. 28th St., New York, N. Y. (Tel. LOngacre 4-7390)
Sales Mgr.: Carl Robinson

WORNER ELECTRONIC DEVICES
Rankin, Ill. (Tel. EXport 7-4555)
Pres.: G. A. Worner
Sales Mgr.: Don Swanson

WORTHINGTON CORP.
426 Worthington Ave., Harrison, N. J.

WRIGHT AERONAUTICAL DIV., CURTISS-WRIGHT CORP.
Wood-Ridge, N. J. (Tel. PRescott 7-2900)
Dir.-Purch.: James M. Cowell, Jr.
V. P.-Sales: W. K. Houpt MF, WN, PS, GS, GH

WRIGHT ELECTRONICS, INC.
2537 Grand Ave., Kansas City 8, Mo. (Tel. BAltimore 1-8686)
Sales Mgr.: Robert A. Wells GS, GE, TR

WRIGHT ENGINEERING CO.
180 E. California Blvd., Pasadena, Calif. (Tel. RYan 1-8488)
Purch. Agent: Dennis Winton
Gen. Mgr.: Jack Mott

WROUGHT WASHER MFG. CO.
2137 S. Bay St., Milwaukee 7, Wisc. (Tel. SHeridan 4-0771)
Purch. Agent: Moro Davis
Gen. Sales Mgr.: Walter F. Borges

WYANDOTTE CHEMICALS CORP.
Wyandotte, Mich. (Tel. Detroit, DUnkirk 2-6000)
Dir.-Purch.: Harry Wurster
Gen. Sales Mgr.: Fred Tholen
Mgr.-Aircraft Sales: P. N. Burkard MM, R&D

WYCO METAL PRODUCTS
6918 Beck, N. Hollywood, Calif. (Tel. STanley 7-5579)
Purch. Agent: L. Teitelman
Buyer: Ronald Stone
Sales Mgr.: Lew Turner GS, GH, TS

WYE INDUSTRIES
6 Gen. Devine Way, Boston 27, Mass. (Tel. ANdrew 8-6701)
Purch. Agent & Sales Mgr.: James A. Wye MF, PS, GS, GH, MM

WYMAN-GORDON CO.
105 Madison St., Worcester, Mass. (Tel. PLeasant 6-5111)
Exec. V. P.: H. F. Wood
Gen. Sales Mgr.: J. L. Roach MF, WN, PS

WYZENBEEK & STAFF, INC.
223 N. California Ave., Chicago 12, Ill. (Tel. NEvada 2-3771)
Purch. Agent: W. F. Sheppard
Sales Mgr.: J. I. Allen

X-PANDO CORP.
43-15 36th St., Long Island City 1, N. Y. (Tel. STillwell 4-7180)
Gen. Mgr.: John Mano, Jr.
Adv. Mgr.-Purch: William F. Mano MF, WN, PS, GS, GE, MM

YALE & TOWNE MFG. CO., THE.,-GOVERNMENT DEFENSE PRODUCTS DIV.
1145 19th St., N. W., Washington, D. C. (Tel. STerling 3-8144)
Purch: Richard T. Tiebout GH, R&D

YARDNEY ELECTRIC CORP.
40 Leonard St., New York 13, N. Y. (Tel. WOrth 6-3100)
Dir.-Purch.: Leonard Katz
Mgr.-Sales & Mktg: Saul Padwo GS, GH, GE

YARDLEY PLASTICS CO.
142 Persons Ave., Columbus, Ohio (Tel. CA 1-7401)
Purch. Agent: Earl Jacobson
Sales Mgr. Custom Extrusion: Gary Fulmer PS

YARNALL-WARING CO.
102 E. Mermaid Lane, Phila. 18, Pa. (Tel. CHestnut Hill 8-2600)
Purch. Agent: John Welker
Asst. Purch. Agent: W. Bodycut
V. P.-Dist. Prod. Sales: R. S. Pollard
V. P.-Sales: J. A. Steer

YELLOW SPRINGS INSTRUMENT CO., THE
Yellow Springs, Ohio

H. L. YOH CO., INC.
123 S. Second St., Philadelphia 6, Pa. (Tel. MArket 7-7620)
Purch. Agent: Mrs. Carmel Flynn
V. P.-Sales: Milton Marder MF, WN, PS, GS, GH, GE, TR

YORK CORP.
Grantley Rd., York, Pa. (Tel. YOrk 8-1131)
Dir.-Procurement: H. L. Consley
V. P.-Marketing: Austin Rising GS

YOUNG BROTHERS CO.
1852 Columbus Rd., Cleveland 13, O. (Tel. MAin 1-2473)
V. P.-Sales: J. D. Russell
V. P.: C. H. Barnett

YOUNG DEVELOPMENT DIV., HERCULES POWDER CO.
Rocky Hill, N. J. (Tel. WAlnut 4-4040)
Purch.: Wallace J. Cullen
Sales: Douglas M. Clarke R&D

YOUNG & RIOUX WOODWORKING CO., INC.
22 Thomas St., East Hartford, Conn. (Tel. BUtler 9-0261)
Pres.: Herbert Young MM

Z & W MFG. CORP.
30240 Lake Land Blvd., Wickliffe, Ohio (Tel. WH 3-5700)
Purch. Agent: G. T. Greenfield
Mgr. Electronics Div.: R. M. Wood TR

ZACHARIAS ELECTRONICS CORP.
23 Country Side Drive., P. O. Box 172, Livingston, N. J. (Tel. WYman 2-3780)
V. P.: Ellis M. Zacharias, Jr. R&D

ZALLEA BROTHERS
Taylor & Locust Sts., Wilmington, Del. (Tel. OLympia 4-2407)
Buyer: Carl Willoughby
Eng. Sales Mgr.: Harry Wolpert PS, GS, R&D

ZENITH ELECTRIC CO.
152 W. Walton St., Chicago 10, Ill. (Tel. MIchigan 2-3322)
Purch. Agent: Rueben Shore
Sales Mgr.: Arthur Coren GH, GE, CO

ZENITH OPTICAL LABORATORY
1940 Great Neck Rd., Copiague, L. I., N. Y. (Tel. AMityville 4-4616)
Gen. Mgr.: Walter Goldstein
Sales Mgr.: M. N. Hoffman GS, GH, GE, CO, TS, TR

ZENITH RADIO CORP.
6001 W. Dickens Ave., Chicago 39, Ill. (Tel. BErkshire 7-7500)

CODING

Missile Frame	MF
Warhead & Nose Cone	WN
Propulsion System	PS
Ground Support	GS
Ground Handling	GH
Guidance Equipment	GE
Checkout Equipment	CO
Test Equipment	TS
Tracking & Telemetering	TR
Research & Development	R&D
Materials & Metals	MM

V. P.-Furch.: J. E. Anderson
Buyers: W. Morrison & R. Kehoe
V. P. & Dir.-Sales: L. C. Truesdell R&D

ZEP AERO
113 Sheldon St., El Segundo, Calif. (Tel. ORegon 8-1161)
Gen. Mgr.: H. B. McLaughlin
Sales Mgr.: Ed Wilson TS

ZEPHYR MFG. CO. INC.
201 Hindry Ave., Inglewood, Calif. (Tel. ORegon 8-4331)
Purch. Agent: Dean Meador
Sales Mgr.: W. A. Burns GS, GH, MF

ZIERICK MFG. CORP.
Beechwood & Rockdale Aves., New Rochelle, N. Y. (Tel. New Rochelle 6-8520)
V. P.-Sales: Russell Zierick
Sales Mgr.: John H. Rodlein MM

ZIPPERTUBING CO., THE
752 S. San Pedro, Los Angeles 14, Calif. (Tel. MAdison 4-6664)
Purch. Agent: G. H. Hassinger
Pres.: W. A. Plummer MF, GS, GH, CO, TS, TR, MM, R&D

ZIRCONIUM CORP. OF AMERICA
31501 Solon Rd., Solon, O. (Tel. CHurchill 8-6191)
Plant Mgr.: J. T. Welter
Sales Mgr.: S. Z. Gendel MM, F

ZOOMAR INC.
55 Sea Cliff Ave., Glen Cove, N. Y. (Tel. ORiole 6-1900)
Purch. Agent: Alfred J. Quittner
V. P.-Sales Mgr.: Walter Steuer TR, I

ZOPHAR MILLS INC.
112 26th St., Brooklyn 32, N. Y. (Tel. SOuth 8-0907)
Asst. Tech. Dir.: H. K. Saunders
Sales Mgr.: L. E. Mayer MF, WN, PS, TS, TR,

Look for these . . .

high-interest special issues

during the next twelve months

1. July 20, 1959—Engineering Progress Issue

With special emphasis on advances in skill, this all important issue is a round-up of data and progress reports, featuring the Guided Missile Encyclopedia.

2. Sept. 21, 1959—Missile Support Issue

Breadth and scope of the missile market's fastest growing segment will be the subject matter . . . Covering complexities, needs and developments estimated to total almost 40 billion dollars in the next seven years.

3. Feb. 29, 1960—Electronics and Guidance Issue

Putting the spotlight on an all important part of the missile industry, articles featuring subjects from lunar and interplanetary probe instrumentation to present and future aspects of inertial guidance make this one of the year's most important issues.

4. May 1960—Annual Missile and Product Guide

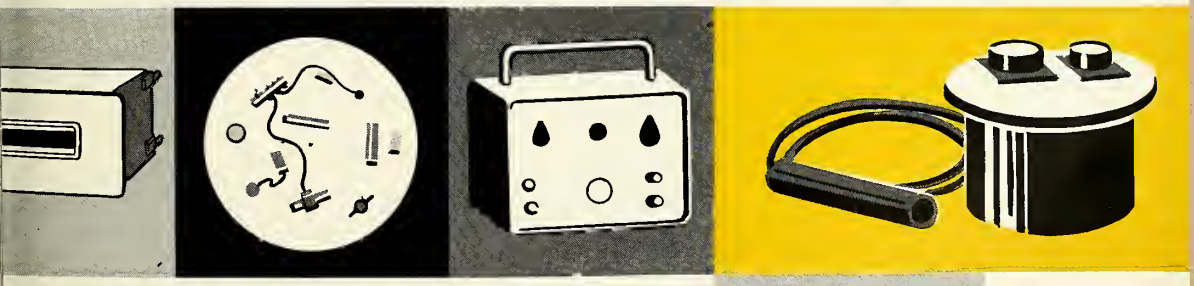
Sources of supply, industry capability, products, and manufacturers' index make this M/R special the most praised and handiest reference book in the industry. A must for anyone involved in missile or space flight work.

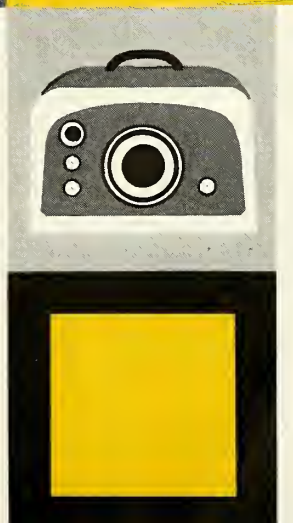


technical/news weekly of the missile/space industries



MISSILE PRODUCT DIRECTORY





Fill in No. 41 on Subcriber Service Card
for advertisement on next page.

CLOSED LOOP SERVO REGULATOR

PRESSURIZES MISSILE PROPELLANT TANKS



NOTE THESE CHARACTERISTICS

- INLET PRESSURES FROM 3000 TO 300 P.S.I.G.
- OUTLET PRESSURE RANGE FROM 12 TO 75 P.S.I.G.
- TOLERANCE ± 0.5 P.S.I.G.
- WITHSTANDS SEVERE MISSILE FLIGHT ENVIRONMENT
- CONTROLS HELIUM, NITROGEN OR AIR.
- CONTAINS INTEGRAL SOLENOID SHUT-OFF VALVE.

Please discuss your requirements with our engineers

LEONARD PASADENA

Wallace O. Leonard, Inc.
373 SOUTH FAIR OAKS AVENUE
PASADENA, CALIFORNIA
TELEPHONE SYCAMORE 2-7131
TWX-PASA CAL 7321

MISSILE PRODUCT DIRECTORY

Below are listed over 3,000 parts and products used in the missile industry. Companies manufacturing these components appear alphabetically under each product. In order to obtain the company address, telephone number, and key purchasing and sales personnel, please refer to the MISSILE PURCHASING DIRECTORY which begins on page 111 of this issue. (Products and manufacturers of Materials and Metals, a new category with this edition, appear in the section beginning on page 101.)

ABSORBERS
rcom Inc.
rtron Inc., Div.-Litton Industries
merican Aeroparts
eeze Corporations, Inc.
eveland Pneumatic Industries, Inc.
olumbia Research & Development Corp.
emornay-Bonard
nerson & Cuming, Inc.
ederal Shock Mount Corp.-Div. The Korfund Co., Inc.
Imohm Corp.
abriel Co., The, Gabriel Electronics Div.
eneral Electric Co., X-Ray Dept.
ohn & Cloy
OUDAILLE INDUSTRIES, INC., BUFFALO HYDRAULICS DIV.
W. Johnson & Co., Inc.
rd Mfg. Co.
Million Industrial Corp.
IRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
lot Chemicals, Inc.
rtchester Instrument Corp.
dar Design Corp.
d Lion Cabinet Co., Redco Tool Div.
bbercraft Corp. of California
hutte & Koerting Co.
n Electric Corp., Aeronautical Div.
ylor Devices, Inc.
pper Mfg. Co., Inc.
n Zelm Associates, Inc.
stern Felt Works & Acodia Synthetic Products Div.

ABSORBERS, MICROWAVE
e MICROWAVE ABSORBERS

ABSORBERS, POWER
e POWER ABSORBERS

ABSORBERS, SHOCK, CORD & RINGS
e SHOCK ABSORBERS, CORD & RINGS

ABSORBERS, VIBRATION
e VIBRATION ABSORBERS

ACCELERATION TEST UNITS, MILITARY
e TEST UNITS, ACCELERATION, MILITARY

ACCELERATORS, PARTICLE
is-Chalmers
erican Instrument Co., Inc.
erican Machine & Foundry Co., Government Products Group
plied Radiation Corp.
Electronics, Borg-Warner Corp.
l Aircraft Corp., Niagara Frontier Div.
oper Development Corp., Sub.-Marquardt Aircraft Co.
ystrom Pacific Div.-Doystrom, Inc.
Cliff Instruments
gin Micronics, West Coast Div.-Elgin National Watch Co.
rd Instrument Co., Div.-Sperry Rond Corp.
neral Electric Co., Missile & Space Vehicle Dept.
neral Electric Co., X-Ray Dept.
M. Giannini & Co., Inc.
gh Voltage Engrg. Corp.
mphrey, Inc.
loct-D-Graph Corp., The
l Tel Div.-Cohu Electronics, Inc.
lsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
neapolis-Honeywell Regulator Co.-Aeronautical Div.
tional Pneumatic Co., Inc., Holtzer-Cabot Divs.
diation Dynamics, Inc.
hm Instruments, Div.-Americon Machine & Metals, Inc.
d Lion Cabinet Co., Redco Tool Div.
eves Instrument Corp.
Saevitz Engrg.
chnology Instrument Corp.
S. Science Corp.
ion Associates

ACCELEROMETERS
F Industries Inc.
Logistics Corp.

***AIRESEARCH MFG. CO. OF ARIZ.**
R. C. Allen Aircraft Instr. Div., R. C. Allen Bus. Machines, Inc.
American Electronics, Inc.
American Felt Co.
American Machine & Foundry Co., Government Products Group
Arma Div., American Bosch Arma Corp.
Associated Engineers, Inc.
B & F Instruments, Inc.
B & K Instruments, Inc.
Belock Instrument Corp.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix Aviation Corp., Pioneer-Central Div.
Bourns Labs., Inc.
Brush Instruments, Div.-Clevite Corp.
Cadillac Gage Co.
Chesapeake Instrument Corp.
Cleveland Pneumatic Industries, Inc.
Consolidated Electrodynamics Corp.
Control Data Corp.
Delco-Remy Div., General Motors Corp.
Donner Scientific Co.
Electro-Mechanical Products Co.
Elgin Micronics Div.-Elgin National Watch Co.
Endevco Corp.
ERA Engrg. Inc.
Fairchild Controls Corp., Components Div.
Genisco, Inc.
Genisco, Inc., Instrument Div.
Greenleaf Mfg. Div., The, Mandrel Ind. Inc.
Gulton Industries, Inc.
Highland Rim Machine Works Inc.
Hoffman Labs Div., Hoffman Electronics Corp.
ITT Labs.
Inertia Switch, Inc.
Instrument Development Labs., Inc.
Jordan Electronics, Div.-Victoreen Instrument Co.
***KEARFOTT CO., INC.**
Leach Corp.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
***WALLACE O. LEONARD, INC.**
Litton Industries, Inc.
Massa Div.-Cohu Electronics, Inc.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Boston Div.
Northrop Corp.
Northrop Corp., The, Nortronics Div.
Pace Engrg. Co.
Pacific Scientific Co.
Pickering & Co., Inc.
Pioneer Tool & Engrg. Co.
Power-Tronic Systems Inc.
Pyles Industries, Inc.
Radiation, Inc.
Raymond Engrg. Lab., Inc.
Red Lion Cabinet Co., Redco Tool Div.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Sanders Associates, Inc.
Servomechanisms, Inc.
Sperry Farrogut Co., Div.-Sperry Rond Corp.
Statham Instruments, Inc.
Summers Gyroscope Co.
Trionics Corp.
Ultradyne, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
United States Time Corp.
Waltham Engrg. Corp.
Whittaker Gyro. Div.-Telecomputing Corp.
Wilks Precision Instrument Co., Inc.

ACCESSORIES & COMPONENTS, ENGINE
See ENGINE ACCESSORIES & COMPONENTS

ACCESSORIES, MICROWAVE
See MICROWAVE ACCESSORIES

ACCUMULATORS
American Aeroports
Americon Felt Co.
American Machine & Foundry Co., Government Products Group
Applied Dynamics Corp.
Astronautics Engrg. Co.
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Cleveland Pneumatic Industries, Inc.
Com-Air Products, Div.-A S R Products Corp.
Denison Engrg. Div., American Brake Shoe Co.
Dumont Aircraft Fitting Co.
Dunbar-Kapple Inc.-Aircraft Components Div.
Electrol Inc.
Greer Hydraulics, Inc.
Hohn & Cloy
Hannifin Co., Div.-Parker-Hannifin Corp.
Highland Rim Machine Works Inc.
Hufford Corp., The
Hydro-Power Corp.
Hydrodyne Corp., Skinner Seal Div.
Integral Corp.
Interstate Engrg. Corp.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Walter Kidde & Co., Inc., Aviation Div.
Koehler Aircraft Products Co.
Menasco Mfg. Co.
Minneapolis-Honeywell Regulator Co., Drdnance Div.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Natl. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc.
Norris-Thermador Corp.
Parker Hydroulics Div., Porker-Hannifin Corp.
Portland Copper & Tonk Works Inc.
Rondoll Engrg. Corp.
Red Lion Cabinet Co., Redco Tool Div.
S-P Mfg. Corp., The
Sargent Engrg. Corp.
Toylor Devices, Inc.
U. S. Industries, Inc.
Vickers Inc., Div.-Sperry Rand
Vilter Mfg. Co., The
Vinson Mfg. Co. Inc.
***WEATHERHEAD CO., THE**

ACCUMULATORS, HYDRAULIC
American Aeroparts
American Bosch Arma Corp.
American Machine & Foundry Co., Government Products Group
Applied Dynamics Corp.
Arma Div., Americon Bosch Arma Corp.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Com-Air Products, Div.-A S R Products Corp.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Denison Engrg. Div., American Brake Shoe Co.
Diversey Engrg. Co.
Dumont Aircraft Fitting Co.
Eostern Industries Inc.
Electrol Inc.
Greer Hydraulics, Inc.
Hahn & Clay
Hannifin Co., Div.-Parker-Hannifin Corp.
Haskel Engrg. & Supply Co.
Horkey-Moore Associates
Hufford Corp., The
Hydro-Power Corp.
Hydrodyne Corp., Skinner Seal Div.
Integral Corp.
Interstate Engrg. Corp.
Jack & Heintz, Inc.
Koiser Aircraft & Electronics, Div.-Koiser Industries Corp.
Lear, Inc.
Menasco Mfg. Co.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Natl. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc.
Norris-Thermodor Corp.
Dil-Dyne, Inc.
Ozone Metal Products Corp.
Parker Aircraft Co.
Parker Hydraulics Div., Parker-Hannifin Corp.
Parts Engrg. Co., Inc.
Portland Copper & Tank Works Inc.
Randall Engrg. Corp.
Ravenna Metal Products, Div.-Standard Screw Co.
Red Lion Cabinet Co., Redco Tool Div.
Ronson Hydraulic Units Corp.
S-P Mfg. Corp., The
Sargent Engrg. Corp.
Stratos Div.-Fairchild Engine & Airplane Corp.
Taylor Devices, Inc.
U. S. Industries, Inc.

Vickers Inc., Div.-Sperry Rand
Vickers Inc., Marine & Drdnance Dept., Machinery Hydraulics Div.
Vinco Corp.
Vinson Mfg. Co. Inc.
Waldorf Fluid Systems. Div.-F.C. Huyck & Sons
Washington Technological Associates Inc.
Waste King Corp., Technical Products Div.
Watertown Div., The New York Air Brake Co.
*WEATHERHEAD CO., THE
Wickfield, Inc.
Wise Aerodraulics, Inc.

ACTUATORS
a. Electric
b. Hydraulic
c. Linear
d. Pneumatic
e. Ratary
ACF Industries Inc., a, b.
Abrams Instrument Carp., e.
Actuation Research Corp., a thru e.
Actuator Products Div., Geartronics Corp., a thru e.
Adel Precision Products of Califarnia, Div.-General Metals Corp., b.
Aeroflex Carp., The, Aeroflex Labs. Div., a, b, c.
Airborne Accessories Corp., c, e.
*AIRESEARCH MFG. CO. DIV.-THE GARRETT CORP., a thru e.
Alco Valve Co., a, b.
American Aeroparts, a, b, c.
American Bosch Arma Corp., a, b, d.
American Electronics, Inc., c.
American Machine & Foundry Co., Government Products Group, a thru d.
American Machine & Foundry Co., Greenwich, a thru d.
American Measurement & Control, Inc., a, b, c, e.
*ANNIN CO., THE, a, b, d.
Artisan Electronics Carp., a, c, e.
Associated Engineers, Inc., a thru d.
Astronautics Engrg. Co., b.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., a.
Atlas Precision Products, Co., e.
Banner Industries, a, b, d.
Barber-Colman Co., a, c, d, e.
Beaver Precision Products Inc., b, e.
Bell Aircraft Corp., Niagara Frontier Div., b.
Bellofram Corp., b.
Belock Instrument Corp., a, c, e.
*BENDIX AVIATION CORP.-HAMILTON DIV., b, e.
Bendix-Pacific Div., Bendix Aviation Corp., a thru e.
Bendix Utica Div., Bendix Aviation Corp.
Blackhawk Mfg. Co., b.
Bobrick Mfg. Corp., b, d.
Bogue Electric Mfg. Co., a.
Bowser, Inc., Defense Dept., b.
Breeze Corporations, Inc., a thru e.
Bristol Co., The, a, b, d, e.
Bruning Co., The, b.
CDC Control Services, Inc., a, b.
Cable Electric Products, Inc., a.
Cadillac Gage Co., b, c.
Capital City Mfg. Co., b, d.
Carter Controls, Inc., b, d, e.
Chicago Aerial Industries, Inc., a.
Chicago Pneumatic Tool Co., a, d.
Clary Dynamics, a, b, d.
Clemco Aero Products, Inc., b, c, e.
Cleveland Pneumatic Industries, Inc., a thru e.
Clippard Instrument Lab., Inc., b, d.
Com-Air Products, Div.-A S R Products Corp., b, c, d.
Conoflow Corp., a, d, e.
Consolidated Controls Corp., b.
Consolidated Diesel Electric Corp., a thru e.
James Cunningham Son & Co., Inc., a, c.
Curtiss-Wright Corp.-Propeller Div., c, e.
Dalmotor Div., Yuba Consolidated Industries, Inc., a, e.
Delco-Remy Div., General Motors Corp., a.
Denison Engrg. Div., American Brake Shoe Co., b.
Diversey Engrg. Co., b, d.
Dukes Co., Inc., b.
Dumont Aircraft Fitting Co., b, d, e.
Dynamic Controls Corp., b, d.
Eastern Industries, Inc., a, b, e.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., e.
*ELECTRICAL ENGRG. & MFG. CORP., c, e.
Electrol Inc., b, d, e.
Electro-Mechanical Products Co., a.
Electronic Communications, Inc., a, c, e.
Electro-Seal Corp., a.
Exact Engrg. & Mfg. Inc., a, e.
Foote Bros. Gear & Machine Corp., a, c, e.
Ford Instrument Co., Div.-Sperry Rand Corp., a.
Fulton-Irgon Corp., The, c, e.
General Electric Co., Apparatus Sales Div., c, d, e.
General Electro-Mechanical Corp., a, e.
Gilfillan Bros. Inc., a thru e.
Greer Hydraulics, Inc., b, c, e.
Hamilton Standard, Div.-United Aircraft Corp., a, b, d.
Haskel Engrg. & Supply Co., b, d, e.
*A. W. HAYDON CO., THE, a, e.
Highland Rim Machine Works, Inc., c, e.
Hoover Electric Co., a, c, e.
Horkey-Moore Associates, d.

*HOUDAILLE INDUSTRIES, INC., BUFFALO HYDRAULICS DIV., b, e.
Hufford Carp., The, b.
Hughes Tool Co., Aircraft Div., a, d.
Hupp Aviation Co., e.
Walter J. Hyatt Co., The, a thru e.
Hycan Mfg. Co., b, c, e.
Hydra-Power Corp., b thru e.
Hydrodyne Carp., Skinner Seal Div., d.
Hydramatics, Inc., b, d.
Integral Corp., b, d.
Interstate Engrg. Corp., b, d.
Jack & Heintz, Inc., a, b, c, e.
Javelin Aircraft Co., Inc., a thru e.
Jordan Co., Inc., The, a, c, e.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., d.
*KEARFOTT CO., INC., b thru e.
Kelsey-Hayes Co., b thru e.
Kemp Aera Products, b, d, e.
Walter Kidde & Co., Inc., Aviation Div., d.
Korda Industries, a thru e.
Land-Air, Inc., a, c, e.
Lear, Inc., a thru e.
Lear, Inc., Grand Rapids Div., a thru e.
Leetronics, Inc., a, e.
Leland Airborne Products, Div.-American Machine & Foundry Co., a, e.
Leslie Co., b, c, d.
Lundy Mfg. Carp., a thru e.
Lyndon Aircraft, Inc., a, c, e.
Magtrol, Inc., a, e.
Marquardt Aircraft Co., b, d.
Mason-Neilan, b, d.
McDowell-Wellman Companies, The, b, d.
Menasco Mfg. Co., b thru e.
Mercury Tool & Mfg. Carp., b, d.
Minneapolis-Haneywell Regulatar Co.-Aeranautical Div., a, b, d, e.
Minneapolis-Honeywell Regulatar Co., Industrial Product Group, a, b, d.
Minneapolis-Honeywell Regulator Co., Ordnance Div., a, b.
Monogram Precision Industries, a, b.
Moog Valve Co., Inc., a, b, c, e.
Morse Instrument Co., The, c, e.
Heinz Mueller Eng. Co. Inc., a, e.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., a thru e.
Natl. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc., a, b, d, e.
Newbrook Machine Corp., a thru e.
Norwood Controls Unit Detroit Controls Div., a.
Oil-Dyne, Inc., b.
Ozone Metal Products Corp., b thru e.
Parker Aircraft Co., b, e.
Parts Engrg. Co., Inc., b.
Pesco Products Div.-Borg-Warner Corp., a.
Phillips Aviation Co.-Marples Gears, a, b, d.
Photomation, Inc.
Pioneer Tool & Engrg. Co., a, b, d.
Power-Tronic Systems, Inc., a.
*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.
Randall Engrg. Corp.
Raymond Engrg. Lab., Inc., a.
Red Lion Cabinet Co., Redco Tool Div., a, b.
Regent Jack Mfg. Co., Inc., b.
Reinhold Engrg. & Plastics Co., d.
Republic Mfg. Co., b.
Robot Industries, Inc., a, c.
Ronson Hydraulic Units Corp., b, d.
Royal Industries, Inc., a, b, c.
S-P Mfg. Corp., The, b, d.
Sage-Craft, Inc., a.
Sancor Corp., a.
Sargent Engrg. Corp., a thru e.
Servomechanisms, Inc., Mechatrol Div., e.
Singer Mfg. Co., The, Military Products Div., c, e.
Sirvalco Systems Corp., b, d, e.
Skinner Precision Products, d.
Small Motors Inc., a.
Smith-Morris Corp., a, b, c.
Southwestern Industries, Inc., c, e.
Space Corp., a, b, e.
Sperry Farragut Co., Div.-Sperry Rand Corp., a, b.
Standard Controls, Inc., b.
Stanley Aviation Corp., d.
Stratos, Div.-Fairchild Engine & Airplane Corp., b, c, d.
Summers Gyroscope Co., a.
Swartwout Co., The, a.
Tactair Valve Div.-Aircraft Products Co., b, d.
Talley Corp., The, a thru e.
Tapco Group, Thompson Ramo Wooldridge Inc., b, d.
Task Corp., a, b, c, e.
Telectro Industries Corp., a.
Transco Products, Inc., e.
Turbo Products, Inc., b, d.
Twigg Industries, b.
U. S. Industries, Inc., a, c.
United Aircraft Products, Inc., b.
United Supply Co., a.
Vap-Air Aeronautical Products Div., Vapor Heating Corp., d.
Vard Inc., a thru e.
Vickers Inc., Div.-Sperry Rand, b, e.
Vickers Inc., Marine & Drdnance Dept., Machinery Hydraulics Div., b.
Walbar Machine Products Inc., b.
Waldorf Fluid Systems Div.-F. C. Huyck & Sons, b, d.
Waltham Engrg. Corp., a.
Washington Technological Associates Inc., b.
Waste King Corp., Technical Products Div., b, d.
Watertawn Div., The New York Air Brake Co., b, e.
*WEATHERHEAD CO., THE, b.
Western Design, Div.-U. S. Industries, Inc., Santa Barbara Div., a, c, e.
Western Gear Carp., a thru e.
Westinghouse Electric Carp., a, b.
Weston Hydraulics Ltd.-Sub., Barg-Warner Carp., b, d.
Westranics Inc., a, c.
Whittaker Controls, Div.-Telecamputing Corp., a, b, d.
Whittaker Gyro. Div.-Telecomputing Corp., a, e.
Wickfield, Inc., b, d.
Wise Aerodraulics, Inc., b.

ACTUATORS, EMERGENCY
*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.

ADAPTERS
a. Battery
b. Crystal
c. Field Sequential
d. Fareign
e. Lamp Socket
f. Line & Dot Sequential
g. Phase
h. Plug
i. Test
j. Tube
k. Tube Socket
Accurate Electranics Corp., Dept. D., a, h, k.
Aerolite Electronics Corp., a, e, h, i.
Airtranics International Corp., g.
Alden Products Ca., h, j.
American Aeroparts, a.
Anaheim Electronics Co., Inc., i.
Anchor Metal Spinning Co., The, j, k.
Anchor Specialty Mfg. Co. Inc., h, i.
Arrow-Hart Hegeman Electric Co., The, e, h.
Associated Engrg. & Mfg. Corp., k.
Associated Engineers, Inc., h, i.
Baldwin Mfg. Co., Inc., The, h.
W. A. Beauchaine & Sons Inc., i, k.
Cable Electric Products Inc., a, d, g, h, i.
Chase Brass & Copper Co., Inc., j.
Coaxial Connector Co., Inc., g.
Cole Electric Co., a, h, i.
Cole-Hersee Co., e.
Dytronics Co., g.
Eagle Electric Mfg. Co., Inc., c, d, h.
Elco Corp., k.
Eldema Corp., e.
Electro-Mechanical Products Co., a, i.
*ELECTROSNAP CORP., e.
Ericson Mfg. Co., The, h.
FXR, Inc., i.
Highland Rim Machine Works Inc.
Indusl. Prod.-Danbury Knudsen Div. Amphenol-Bo Electronics Corp., h.
Jettron Products, Inc., j, k.
Korda Industries, h.
Kulka Electric Corp., d, e, h.
Meridian Metalcraft, Inc., b.
Meteor Production Engr., Inc., a.
Microwave Development Labs., Inc.
Monogram Precision Industries
Frank W. Morse Co., d, e.
National Pneumatic Co., Inc., Holtzer-Cabot Divs a, f, i.
Paul Nurches Co., h, i, j.
Permacel, k.
Pomona Electronics Co., Inc., i, k.
Projects Unlimited Inc., i.
State Testing Lab. Inc., i.
Sylvania Electric Products Inc., Parts Div., i, j, k
Tamar Electronics, Inc.
Technical Apparatus Builders, a, h, i, j.
Vector Electronic Co., i, k.
Victor R. F. & Microwave Co., a.
Warren Components, Div. El-Tronics, Inc., k.
Wayne Pump Co., The, Div.-Symington Wayne Corp
Western International Co., h.
Winder Aircraft Corp. of Florida, a.

ADHESIVES, HIGH TEMPERATURE
Adhesive Engrg., Div.-Hiller Aircraft Corp.
Aerojet-General Corp.
Aeronca Mfg. Corp.
American Latex Products Corp.
American Rocket Co.
Aries Laboratories, Inc.
Armour & Co., Armour Alliance Industries
Carl H. Biggs Co.
Bloomingdale Rubber Co.
Borden Chemical Co.
Samuel Cabot Inc.
Connecticut Hard Rubber Co., The
Corning Glass Works
DBM Research Corp.
Dayton Rubber Co., The
Delta Chemical Works, Inc.
*DOW CORNING CORP.
Dresser Mfg. Div., Dresser Industries, Inc.
E. I. Du Pont De Nemours & Co. Inc.

Dyno-Therm Chemicol Corp.
Emerson & Cuming, Inc.
Fulton-Irgon Corp., The
Furone Plostics, Inc.
B. F. Goodrich Industriol Products Co.
Grant Chemicol Co., Inc.
Hoveg Industries, Inc.
Homolite Corp., The
Honeycomb Co. of Americo, Inc.
Houghton Loborotories, Inc.
Johns-Monsville
Lomtex Industries, Inc.
Lebec Chemicol Corp.
Leffingwell Chemicol Co.
Morblette Corp., The
Minnesoto Mining & Mfg. Co.
Minnesoto Mining & Mfg. Co.-Adhesives, Cooting & Sealers Div.
Monogram Precision Industries
Morningstor-Poisley, Inc.
Notionol Berylliо Corp.
Olin Mothieson Chemicol Corp., Energy Div.
Permocel
Products Reseorch Co.
Protex-A-Cote, Inc.
Roybestos-Monhotton, Inc.
Roybestos-Monhotton, Inc., Po.
Rubber & Asbestos Corp.
Soureisen Cements Co.
Shell Chemicol Corp., Industriol Chemicols Div.
Smooth-On Mfg. Co.
Spectro-Strip Wire & Cable Corp.
Stic-Klip Mfg., Co.
Thermol Refroctories Corp.
Topper Mfg. Co., Inc.
United Stotes Rubber Co.
Vesrep Corp.
Westline Products Div., Western Lithogroph Co.

ADHESIVES, METAL TO METAL

Adhesive Engrg., Div.-Hiller Aircroft Corp.
Aerojet-Generol Corp.
Embroid Co. Inc.
Americon Lotex Products Corp.
Americon Rocket Co.
Aries Loboratories, Inc.
Armstrong Cork Co.
Armstrong Products Co.
Atlontic Instrument Corp., Sub.-Americon Electronics, Inc.
Bocon Industries, Inc.
Borl H. Biggs Co.
Bloomingdole Rubber Co.
Borden Chemicol Co.
Borboline Co.
Connecticut Hord Rubber Co., The
Cox & Co., Inc.
CBM Reseorch Corp.
Dayton Rubber Co., The
Delto Chemicol Works, Inc.
Dennis Chemicol Co.
Devcon Corp.
Dresser Mfg. Div., Dresser Industries, Inc.
Dyno-Therm Chemicol Corp.
Emerson & Cuming, Inc.
Fenwol Electronics, Inc.
Fenwol Inc.
B. F. Goodrich Industriol Products Co.
Front Chemicol Co., Inc.
Houghton Loboratories, Inc.
Johns-Monville
Lebec Chemicol Corp.
Maas & Woldstein Co.
Morblette Corp., The
Minnesoto Mining & Mfg. Co.
Minnesoto Mining & Mfg. Co.-Adhesives, Cooting & Sealers Div.
Monogram Precision Industries
Morningstar-Poisley, Inc.
Morton Co., New Products Dept.
Nesstite Div., Americon-Morietto
Noducts Reseorch Co.
Protex-A-Cote, Inc.
Roybestos-Monhottan, Inc.
Roybestos-Monhotton, Inc., Po.
Saw. Renneburg & Sons Co.
Shober & Asbestos Corp.
Soureisen Cements Co.
Shell Chemicol Corp., Industriol Chemicols Div.
Smooth-On Mfg. Co.
Stic-Klip Mfg., Co.
Stiokol Chemicol Corp.
Topper Mfg. Co., Inc.
Tronics Corp.
Ve Industries

ADJUSTING SHIMS
See SHIMS, ADJUSTING

AFTERBURNERS

AF Industries Inc.
Curtiss-Wright Corp., Reseorch Div.
Curtiss-Wright Corp., Wright Aeronoutical Div.
Jersey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Fairn Aeronoutical Div., T. R. Finn & Co., Inc.
Fletcher Mfg. Co., Inc., The
Hopp Aviotion Co.
I-E Circuit Breoker Co.
Ihorr Corp.
Kolcost Industries-Div. Thompson Romo Wooldridge Inc.
*LAVELLE AIRCRAFT CORP.
Morquordt Aircroft Co.
Mercury Tool & Mfg. Corp.
Norton Co., New Products Dept.
Penn-Michigon Mfg. Corp.
Portlond Copper & Tonk Works Inc.
Edw. Renneburg & Sons Co.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
C. F. Roork Welding & Engrg. Co., Inc.
Ryon Aeronouticol Co.
Smith-Morris Corp.
Solor Aircroft Co.
Stoinless Steel Products, Inc.
Teiner Engrg. Corp.
United Aircroft Products, Inc.
Westinghouse Electric Corp.

AFTERCOOLERS

R. P. Adoms Co., Inc.
*AIRESEARCH MFG. CO. DIV.-THE GARRETT CORP.
Aro Equipment Corp.
Diversey Engrg. Co.
Dunhom-Bush Inc.
Griscom-Russell Co., The
Mercury Tool & Mfg. Corp.
Portlond Copper & Tonk Works Inc.
Rome-Turney Rodiotor Co., The
Stoinless Steel Products, Inc.
Teiner Engrg. Corp.
Thompson Engrg. Co., The, Missile Products Div.
Trone Co., The
United Aircroft Products, Inc.
Westinghouse Electric Corp.

AIR ADAPTERS

Bendix Utico Div., Bendix Aviotion Corp.
Highlond Rim Mochine Works Inc.
Monogrom Precision Industries
Strotos Div.-Foirchild Engine & Airplone Corp.

AIR BAFFLES
See BAFFLES, AIR

AIR COMPRESSORS
See COMPRESSORS, AIR

AIR CONDITIONING EQUIPMENT

ACF Industries Inc.
Accessory Controls & Equipment Corp.
*AIRESEARCH MFG. CO. DIV.-THE GARRETT CORP.
Airtemp Div., Chrysler Corp.
Alco Volve Co.
Americon Air Filter Co., Defense Products Div.
Americon Electronics, Inc.
Americon Electronics, Inc., Electric Mochinery & Equipment Div.
Aro Equipment Corp.
Associoted Engineers, Inc.
Bendix Utico Div., Bendix Aviotion Corp.
Blowers Inc.
Bobrick Mfg. Corp.
Colifornio Aircroft Products
Combridge Filter Corp.
Corrier Corp.
Clorage Fon Co.
Consolidoted Diesel Electric Corp.
Droyer-Honson Div., Notionol-U.S. Rodiotor Corp.
Dresser Industries, Inc.
Dunhom-Bush Inc.
Eostern Industries Inc.
Ellis & Wotts Products, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
FWD Corp.
Flexoust Co., The
Generol Americon Tronsportotion Corp.
Homilton Stondord, Div.-United Aircroft Corp.
Paul Hordemon, Inc.
C. G. Hokonson Co., Inc.
Hughes Tool Co., Aircroft Div.
Hussmann Aircroft Div.
ILG Electric Ventiloting Co.
Internotionol Rodiont Corp.
Jet-Heet, Inc.
Marlo Coil Co.
Minneopolis-Honeywell Regulotor Co.-Aeronouticol Div.
Monogrom Precision Industries
Monrovio Aviotion Corp.
Mueller Bross Co.
Perfection Industries, Div.-Hupp Corp.
Pioneer Industries Div., Almor-York Co. Inc.
Pre-Flite Industries Corp.-Sub.-Avco Corp.
Rodex Corp.
Randoll Engrg. Corp.
Sofety Electricol Equipment Corp.
Scoico Controls, Inc.
Scientific Instrument Co.
South Wind Div., Stewort Worner Corp.
Stoinless Steel Products, Inc.
Strotos, Div.-Foirchild Engine & Airplone Corp.
Surface Combustion Corp.
Talley Corp., The
Tenney Engrg., Inc.
Torrington Mfg. Co. Inc., The, Specialty Blower Div.
Trane Co., The
Tranter Mfg., Inc.
United Aircroft Products, Inc.
United Control Corp.
United Electric Controls Co.
Universol Dynomics Corp.
Vilter Mfg. Co., The
Waste King Corp., Technicol Products Div.
Wenzlou Engrg. Co.
York Corp.

AIR DATA COMPUTERS
See COMPUTERS, AIR DATA

AIR INLET GUIDE VALVES

Anchor Metol Spinning Co., The
Boldwin Mfg. Co. Inc., The
Bobrick Mfg. Corp.
Clory Dynomics
Curtiss-Wright Corp.-Wright Aeronoutical Div.
Homilton Stondord, Div.-United Aircroft Corp.
Monogram Precision Industries
Rondoll Engrg. Corp.
Reseorch Development Mfg. Inc.
Smith-Morris Corp.
Solor Aircroft Co.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Tolley Corp., The
Woldorf Fluid Systems. Div.-F.C. Huyck & Sons

AIR INLET SCREEN SUPPORTS

Americon Missile Products Co., Inc.
Anchor Metol Spinning Co., The
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp.-Wright Aeronoutical Div.
Finn Aeronouticol Div., T. R. Finn & Co., Inc.
Konorr Corp.
Kentucky Metol Products Co.
Monogrom Precision Industries
Smith-Morris Corp.
Tolley Corp., The

AIR TURBINES
See TURBINES, AIR

AIRBORNE FILM RECORDERS
See RECORDERS, AIRBORNE FILM

AIRBORNE HOISTS
See HOISTS, AIRBORNE

AIRBORNE IGNITION SYSTEMS
See IGNITION SYSTEMS, AIRBORNE

AIRBORNE LANDING SYSTEMS

Americon Missile Products Co., Inc.
Associoted Engineers, Inc.
Atlos Precision Products, Co.
Beaver Precision Products Inc.
Emerson Rodio & Phonogroph Corp.
Gilfillon Bros. Inc.
ITT Lobs.
ITT-Kellogg
Jonsky & Boiley, Inc.
Kemp Aero Products
Kordo Industries
Litton Industries, Moryland Div.
Menlo Research Lob.
Mercury Tool & Mfg. Corp.
Minneopolis-Honeywell Regulator Co.-Aeronouticol Div.
Motorolo Inc., Military Electronics Div.
Northrop Corp., The, Nortronics Div.
Philco Corp., Government & Industriol Div.
Rodiotion, Inc.
Roytheon Mfg. Co., Government Equipment Div.
Spoce Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Westinghouse Electric Corp.

AIRBORNE MAGNETIC RECORDERS
See RECORDERS, AIRBORNE MAGNETIC

AIRBORNE RADAR
See RADAR, AIRBORNE

AIRBORNE REFRIGERATION EQUIPMENT
See REFRIGERATION EQUIPMENT, AIRBORNE

AIRBORNE ROCKET LAUNCHERS
See LAUNCHERS, AIRBORNE ROCKET

ALARM SYSTEM CONTROLS
See CONTROLS, ALARM SYSTEM

ALARM SYSTEMS

Alto Scientific Co., Inc.
American Aeroports
Americon Electronics, Inc., Toller & Cooper Div.
*ARNOUX CORP.
Assembly Products, Inc.
Atlontic Instrument Corp., Sub.-American Electronics, Inc.
Bendix Aviotion Corp., York Div.
Bristol Co., The
Centronix Inc.
Control Circuits Inc.
Davis Instruments
Thomos A. Edison Ind. Instrument Div.-McGrow-Edison Co.
Electronic Control Corp.
*ETS-HOKIN & GALVAN

Federal Mfg. & Engrg. Corp.
Fenwal Electronics, Inc.
Fenwal Inc.
Globe Automatic Sprinkler Div., The Fyr-Fyter Co.
Hamilton Standard, Div.-United Aircraft Corp.
ITT-Kellogg
Jordan Electronics, Div.-Victoreen Instrument Co.
Magnetrol, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Miratel, Inc.
***MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.**
Motorola Inc., Military Electronics Div.
North Electric Co.
Northrop Corp., The, Nortronics Div.
Philco Corp., Government & Industrial Div.
Photobell Co., Inc.
Scoico Controls, Inc.
Scam Instrument Corp., The
H. H. Scott, Inc.
Simmonds Aerocessories, Inc.
Stanley Aviation Corp.
Systron Corp.
Thermo Electric Co., Inc.
Thiokol Chemical Corp.
Thompson-Ramo-Wooldridge Products Co., The
U. S. Science Corp., Div.-Topp Industries, Inc.
Western Gear Corp.
Westronics Inc.
Wintronics

ALARMS, AUTO

Bendix Aviation Corp., York Div.
Bristol Co., The
Cole-Hersee Co.
***ETS-HOKIN & GALVAN**
Northrop Corp., The, Nortronics Div.
Scaico Controls, Inc.
Scam Instrument Corp., The
Telectro Industries Corp.
Thompson-Ramo-Wooldridge Products Co., The
United Electric Controls Co.

ALIGNMENT TOOLS
See TOOLS, ALIGNMENT

ALNICO

Arnold Engrg. Co., The
Barker Sales Co.
Bogue Electric Mfg., Co.
Bram Metallurgical & Chemical Co.
Crucible Steel Co. of America
Jeta, Inc.
Magnetic Seal Corp.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Waimet Alloys Co., Div. Consolidated Foundries & Mfg. Corp.
Westinghouse Electric Corp.

ALTERNATORS

Aerojet-General Corp.
***AIRESEARCH MFG. CO. DIV.-THE GARRETT CORP.**
American Aeroparts
American Bosch Arma Corp.
American Electronics, Inc.
American Machine & Foundry Co., Government Products Group
Bendix Aviation Corp., Red Bank Div.
D. & R. Ltd.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Delco-Remy Div., General Motors Corp.
Eicor Div.-Scranton
Electric Motors & Specialties, Inc.
Electro-Mechanical Products Co.
General Electric Co., Apparatus Sales Div.
Gerator Corp.
Greer Hydraulics, Inc.
Hallomore Electronics Co.
Hoover Electric Co.
International Fermont Machinery Co., Inc.
Jack & Heintz, Inc.
Leach Corp.
Lear, Inc., Grand Rapids Div.
Leland Airborne Products, Div.-American Machine & Foundry Co.
***LYCOMING DIV., AVCO MFG. CORP.**
Motoresearch Co.
Heinz Mueller Eng. Co. Inc.
Pioneer Tool & Engrg. Co.
Talley Corp., The
Tapco Group, Thompson Ramo Wooldridge Inc.
Task Corp.
Technical Apparatus Builders
Western Design, Div.-U. S. Industries, Inc., Santa Barbara Div.
Westinghouse Electric Corp.
Wincharger Corp., Sub.-Zenith Radio Corp.

ALTIMETERS, BAROMETRIC PRESSURE

***AIRESEARCH MFG. CO. DIV.-THE GARRETT CORP.**
Airguide Instrument Co.
Bendix Aviation Corp., Pioneer-Central Div.
A. Biederman, Inc.
Bourns Labs., Inc.
Colvin Labs., Inc.
Computer Instruments Corp.
Consolidated Diesel Electric Corp.
Curtiss-Wright Electronics Div., IMI Branch
Daystrom Pacific Div.-Daystrom, Inc.
Donner Scientific Co.
Fairchild Controls Corp., Components Div.
Kollsman Instrument Corp., Sub.-Standord Coil Products Co. Inc.
***WALLACE O. LEONARD, INC.**
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Power-Tronic Systems Inc.
Rahm Instruments, Div.-American Machine & Metals, Inc.
Rosemount Engrg. Co.
Walloce & Tiernan Inc.
Waltham Engrg. Corp.
Waste King Corp., Technical Products Div.
Winzen Research Inc.

ALTIMETERS, RADIO & RADAR

American Machine & Foundry Co., Greenwich
Atlas Precision Products, Co.
Bendix-Pacific Div., Bendix Aviation Corp.
Collins Engrg. Corp.
Dayton Aviation Radio & Equipment Corp.
Electra Development Corp.
Electronic Communications, Inc.
Electronics Div., Van Norman Industries Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Emerson Radio & Phonograph Corp.
General Communication Co.
Gilfillan Bros. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Labs.
Lear, Inc.
Litton Industries, Maryland Div.
W. L. Maxson Corp., The
Minneapolis-Honeywell Regulator Co., Ordnance Div.
Motorola Inc., Military Electronics Div.
Ralph M. Parsons Co., The, Electronics Div.
Patterson, Moos Div.-Universal Winding Co., Inc.
Radiation, Inc.
Roytheon Mfg. Co., Government Equipment Div.
Telectro Industries Corp.

ALUMINIZERS, VACUUM
See VACUUM ALUMINIZERS

ALUMINUM FOIL
See FOIL, ALUMINUM

AMMETERS

Assembly Products, Inc.
Beede Electrical Instrument Co. Inc.
Bristol Co., The
Burton-Rogers Co., Sales Div.-Hoyt Electrical Instruments.
Cambridge Instrument Co., Inc.
Columbia Electric Mfg. Co.
Dejur-Amsco Corp., Electronic Sales Div.
Electric Design & Mfg. Co.
Electro-Tech Equipment Co.
Epic, Inc.
General Electric Co., Apparatus Sales Div.
Greibach Instruments Corp.
Helipot Div.-Beckman Instruments Inc.
Hewlett-Packard Co.
Hoyt Electrical Instrument Works, Burton Rogers Co.
Industrial Instruments Inc.
Internationol Instruments Inc.
Marion Instrument Div.
Meters Inc.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
National Electronics
New England Scientific Instruments Co.
Pace Electrical Instruments Co., Inc.
Physics Research Laboratories, Inc.
Rochester Mfg. Co. Inc.
Simpson Electric Co.
Sun Electric Corp., Aeronautical Div.
Technique Associates Div., Duncan Electric Co., Inc.
Triplett Electrical Instrument Co.
Wacline, Inc.
Waters Mfg., Inc.
Westinghouse Electric Corp.
Weston Instruments, Div.-Daystrom, Inc.

AMPLIDYNES

Allis-Chalmers
Bogue Electric Mfg., Co.
General Electric Co., Apparatus Sales Div.
Hoover Electric Co.
Waldom Electronics Inc.
Westinghouse Electric Corp.

AMPLIFIERS

a. Antenno
b. Audio Subminiatures
c. Booster
d. Cathode Followers
e. Compressar
f. Computer
g. Cantral
h. Cuing
i. Data Recording
j. DC
k. Decade, Audia
l. Develapment
m. Differential
n. Direct Current
o. Distributian, Audia
p. Distributian, RF & IF
q. Encapsulated
r. Industrial Sound
s. Instrumentatian
t. Integrating
u. Intermediate Frequency
v. Isalation
w. Limiting
x. Line
y. Line, Audio
z. Lagarithmic
a1. Magnetic
b1. Micraphone
c1. Microwove
d1. Mixing Audio
e1. Mixing, RF
f1. Monitaring Audio
g1. Monitaring RF
h1. Noise-Suppressing
i1. Operatianal
j1. Oscilloscape
k1. Peak Limiting
l1. Photacell
m1. Plug-In
n1. Power
o1. Power, Special Service
p1. Printed Circuit
q1. Servo
r1. Single-Sideband
s1. Stabilizing
t1. Stroin Gage
u1. Tone Cantral
v1. Tronsistor
w1. Ultrosonic
x1. Vibration Pickup
y1. Wideband, Audio
z1. Wideband, RF

***AC ELECTRONICS DIV., GENERAL MOTORS CORP., q, i-1, p-1, v-1.**
ACF Industries Inc., a, i, j, l, n, q, s, o-1, p-1, q-1
Acromag Inc., f, j, m, n, q, s, t, v, o-1, i-1, l-1, m-q-1, s-1.
Acton Labs. Inc., k.
Adept Industries inc., p-1.
Adler Electronics, Inc., o, u, d-1, v-1, z-1.
Advanced Electronics, Inc., x-1.
Aeroflex Corp., The, Aeroflex Labs. Div., g, n-1, q-1, s-1, v-1.
Aerolab Development Co., f, g, j, l, m, n, t thru z, a-1, h-1, i-1, k-1, m-1 thru q-1, s-1, t-1, v-1.
Aerolite Electronics Corp., q.
Aeronautical & Instrument Div., Robertshaw-Fultor Controls Co., s-1, v-1.
Aeronutronic Systems, Inc., Sub.-Ford Motor Co., f, p-1.
Aerovox Corp., h, x, y, d-1.
Aetna Electronics Corp., w-1.
Air Logistics Corp., g, h, l, m, q, y, h-1, p-1, x-1.
Airborne Accessories Corp., g, a-1, q-1, v-1.
Airborne Instruments Lab., Div.-Cutler-Hommer, In f, t, u, i-1.
Aircom Inc., c-1.
Aircom Inc. of New Jersey, c-1.
Airpax Electronics Inc., Seminole Div., f, g, i, j, m, n, a-1, m-1, p-1, s-1.
Airtronics International Corp., p-1, v-1.
Alfred Electronics, j.
Allegany Instrument Co., Inc., f, j, m, n, s, t, j-1, t
Alto Scientific Co., Inc., v-1, z-1.
Amelco, Inc., a thru d, g, i, k thru n, s, u, z, e-1, g-1, h-1, i-1, k-1, l-1, n-1, p-1, q-1, s-1, t-1, v-1.
Amerac Inc., c-1.
American Bosch Arma Corp., f, g.
American Electronic Labs., Inc., j, m, s.
American Electronics, Inc., f, g, j, a-1, n-1, q-1, v-
American Machine & Foundry Co., Government Products Group, a thru d, g, l, s, c-1, e-1, f-1, n-1, q-1.
American Machine & Foundry Co., Greenwich, a.
American Measurement & Control, Inc., g, j, m, q-1 t-1.
American Missile Products Co., Inc., c, f, g, j, n, q, s, u, i-1, m-1, p-1, v-1, x-1, y-1.
American Printed Circuits Co., Inc., t-1.
American Research & Mfg. Corp., j, n, q, s, t, v, w a-1, m-1, n-1, o-1, q-1, t-1, v-1, x-1.
Amplifier Corp. of America, w, x, y, n-1.
Anaheim Electronics Co., Inc., n, v-1.
Analogue Controls, Inc., q-1.
Andersen Labs., b thru g, j thru y, a-1, c-1 thru n-1, p-1 thru w-1.
Antlab Inc., i.
Applied Science Corp. of Princeton, i, j, p, s, v-1, z-1.
Abenberg Ultrasonic Lab., Inc., w-1, z-1.
***ARNOUX CORP., d, q, s, a-1, q-1, t-1.**
Associated Engineers, Inc., e, l, s, v-1, w-1.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., n, q, z.
Atlantic Research Corp., b, d, l, s, b-1, m-1, v-1, x-1, y-1.
Audio Instrument Co., Inc., d, z.
Audio-Master Corp., r, y, a-1, v-1.
Automation Dynamics Corp.,, g, v-1.
Automation Instruments Inc., w-1.
***AVCO MFG. CORP., CROSLEY DIV.**
Avien, Inc., q-1.
B & F Instruments, Inc., i.
B & K Instruments, Inc., k, s, b-1, t-1, x-1.
Baldwin Piano Co., The, Industrial Products Div., k, l, a, x, y, b-1, d-1 thru g-1, l-1, n-1, o-1, p-1, y-1, z-1.

Elantine Labs., Inc., k.
Eber-Colman Co., q-1.
Eker Sales Co., q.
Eker & Williamson Inc., q-1.
Ekman Instruments, Inc., Berkeley Div., j, t, i-1.
Ekman-Systems Div., j, s, t-1.
*HLMAN ENGRG. CO., m-1, n-1.
B Aircraft Corp., Niagara Frontier Div., j, o-1, 1, q-1.
B & Gossett Co., v-1.
B & Howell Co., l, r, s, l-1.
Bck Instrument Corp., a, b, c, f, g, m, n, q, s, t, z, n-1, q-1, v-1.
Bdix Aviation Carp., Eclipse-Pioneer Div., f, g, 1, q-1.
Bdix Aviation Corp., Pioneer-Central Div., w-1.
Bdix Aviation Carp., Red Bank Div., c-1, n-1, 1, v-1.
Bdix Aviation Corp.-Semiconductar Praducts, Red nk Div., v-1.
Bdix Aviation Corp., York Div., d, q, s, c-1, e-1.
Bdix Computer, Div.-Bendix Aviation Corp., j, t.
*INDIX PRODUCTS DIV., BENDIX AVIATION ORP., g, i, l, n, q, s, a-1, m-1, p-1, q-1, v-1.
Bdix Radio Div., Bendix Aviation Corp., u, v, y, 1.
Bden Labs., Inc., d, l, q-1, v-1.
Bo Lab., Inc., d, g, i, w, k-1, s-1, y-1.
Aiederman, Inc., l.
Bis Electranic Carp., j, v-1.
Bilder-Tongue Labs., Inc., b, d, i, k, l, o, p, r, thru y, a-1, c-1, d-1, e-1 g-1, y-1, z-1.
Bon-Presto Co., Div.-Siegler Corp., The, o, r, y, 1, f-1, m-1.
Boe Electric Mfg., Co., g, j, n, a-1, n-1, q-1, v-1, 1.
Bth Mfg. Carp., Div.-General Bronze, n, a-1, n-1, l, q-1, s-1, v-1.
Bulsan Instruments, Inc., w-1.
Brgs Assaciates, Inc., f, g, i, r, s-1.
Brtol Co., The, f, g, i, j, m, n, s, t, q-1, t-1.
Burn Engrg. Co., Inc., b, f, g, j, k, l, a, n-1, a-1, l, q-1, v-1, y-1, z-1.
Brh Instruments, Div.-Clevite Corp., d, f, g, j, j, m, n, s, t, v, x, z, i-1, j-1, n-1, p-1 thru s-1, v-1.
Bu man Electronics Corp., c-1, z-1.
Bova Watch Co., Electronics Div., b, d, f thru n, q, s thru w, z, d-1 thru g-1, i-1, k-1, m-1, n-1, l, q-1, v-1.
Bow Electric Co., a, b, f, i, j, m thru p, s, x, y, l, d-1, e-1, n-1, a-1, q-1, s-1, v-1, y-1, z-1.
Bu Brown Research Corp., f, g, j, k, m, s, t, x, l, m-1, p-1, q-1, v-1, w-1, y-1.
Bum-Rodgers, Inc., f, g, l, n, r, t, d-1, n-1 thru l, u-1, v-1.
C K Campanents, Inc., q, a-1.
Calornia Technical Industries, Div.-Textron Inc., z.
Ceraflex Corp., i.
Carthers & Fernandez, Inc., b, d, k, l, o, q, x, y, l, m-1, a-1.
Cer Engrg. Div.-Control Data Corp., a-1, v-1.
Cep (Constantine Engrg. Labs. Co.), a-1, v-1.
Ceralab, Div.-Globe-Union, b.
Ceronix Inc., b, c, d, f thru q, s thru y, c-1 thru l, m-1 thru w-1, x-1, y-1, z-1.
Ceury Electronics & Instruments, Inc., i, s, t.
Chca Engrg. Corp., e, m, n, s, t, x, y, b-1, i-1, l, p-1, q-1, v-1.
Chald Co., a.
Chapeake Instrument Corp., b-1, v-1, w-1.
Chgo Aerial Industries, Inc., e, f, i, r, s, t, i-1, l, p-1.
Cima Engrg., y.
Cleland Instrument Co., m, s.
Cleland Metal Specialties Co., Electronics Div., l, q, p-1.
Co-Electronics, g, l, s, a-1, q-1, v-1.
Co Collins Corp., q-1.
Cons Radio Co.
Colado Research Corp., f, m, n, t, w, i-1, p-1, l, s-1.
Combia Products Co., a.
Comunity Engrg. Corp., a, c, p, z-1.
Coputer Engrg. Associates, Inc., f, g, i, j, m, n, t, v, i-1, t-1, x-1.
Colidated Avionics Corp., f, g, i, j, n.
Colidated Controls Corp., g, j, l, n, s, a-1, q-1, l.
Colidated Diesel Electric Corp., f, g, j, s, a-1, l, q-1, v-1.
Colidated Electrodynamics Corp., i, s, t-1, x-1.
Conental Mfg., Inc., n-1.
Cotrol Circuits Inc., g, j, m, q, s, a-1, a-1, q-1, l, v-1.
Cotrol Data Corp., a-1.
Coter Development Corp., Sub.-Marquardt Aircraft C, a, i, j, l, n, q, s.
Cuss-Wright Corp., Electronics Div., f, j, s.
Cuss-Wright Corp., Research Div., z, b-1, w-1.
Cuss-Wright Corp., South Bend Div., h-1.
Cy Transformer Corp., a-1.
DE Research Corp., a, i, l, p, q, u, v, v-1.
D. R. Ltd., a-1.
Dabtor Div., Yubo Consolidated Industries, Inc., l, i, m, n, q, s, t, u, a-1, i-1, m-1, n-1, p-1, q-1, l, v-1.
Da Instruments Div.-Telecomputing Corp., s.
Da Control Systems, Inc., s.
Da Corp., j, s.
Dan Electronics, Div.-Mid-Continent Mfg., Inc., c.
Dan Co., The, q, x thru z, a-1, g-1, m-1, n-1, p-1, v.
Davenport Mfg. Co., j, n, r, s, l-1.
Daystrom Pacific Div.-Daystrom, Inc., f, q-1.
Daystrom Transicoil Div., Daystrom Inc., q-1.
Dayton Aircraft Products, Inc., a, q-1.
Dayton Aviatian Radio & Equipment Corp., b, c, g, l, n thru q, u, d-1, e-1, m-1, v-1.
Daytronic Corp., s, t-1.
Delco-Remy Div., General Motors Corp., a-1, a-1, q-1, v-1.
Detronic Industries, g, l-1, q-1.
Di-An Controls, Inc., q-1, v-1.
Digitronics Corp., p-1.
Donner Scientific Co., c, f, g, i, j, m, q, s, t, w, i-1, m-1, a-1, s-1, y-1.
Dorsett Labs., Inc., j, n, m-1.
Doty Acoustica Electranic Labs., b, j, k, l, q, m-1, p-1, v-1.
Douglas Microwave Co., Inc., c-1.
Dresser Industries, Inc., b, d, f, g, i thru a, q thru t, x, y, a-1, b-1, j-1 thru a-1, q-1, s-1, t-1, v-1 thru y-1.
Du Kane Corp., b thru g, j, l thru s, u thru y, a-1, b-1, d-1 thru g-1, m-1 thru q-1, s-1, u-1, v-1, y-1, z-1.
Dynamics Instrumentation Co., Div.-Alberhill Corp., f, i, j, m, n, s, t, v, i-1, m-1, t-1, v-1, x-1, y-1.
Dytronics Co., m.
Edgerton, Germeshausen & Grier, Inc., z, j-1, l-1.
Edin-Div.-Epsco, Inc., j, n-1, t-1, x-1.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., a-1, q-1, v-1.
Elcor, Inc., j, k, n, s, t, j-1, y-1, z-1.
Eldorado Electronics, n, s, t, h-1, k-1.
Electro Development Corp., c, q.
Electra Instruments, Inc., f, g, i, j, k, m, n, s, t, v, i-1, j-1, l-1, m-1, p-1, q-1, t-1, v-1, y-1.
Electra Precision Corp., f, g, j, s, t, i-1, m-1, p-1, q-1, t-1.
Electro Products Labarataries, Inc., g.
Electro-Mechanical Research, Inc., o, c, d, e, f, h, i, j, m.
Electro-Medical Lab., Inc., m.
Electronic Applications, Inc., l, u thru x, b-1, c-1, j-1, v-1, y-1.
Electronic Communications, Inc., f, g, l, q, s thru x, z, a-1, c-1, e-1, g-1, h-1, m-1 thru s-1, v-1, z-1.
Electronic Control Corp., g, l-1.
Electronic Engrg. Co. of California, d, f, g, i, l, k-1, m-1, p-1, v-1.
Electronic Instrument Co., Inc. (EICD), y-1.
Electronic Research Associates, Inc., b, j, v-1.
Electronic Tube Corp., i, j, m, n, s, j-1, l-1, a-1, p-1.
Electronics of Clearfield, Inc., p, j-1.
Electron-Radar Products, l-1.
Electro-Tech Equipment Co., r, k-1.
Elgin Micronics Div.-Elgin National Watch Co., b, i, l, s, p-1, v-1.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., d, f, i, l, m, n, p, s, v, w, x, d-1, h-1, k-1, l-1, p-1.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., a, d, f, g, i, l, m, p, q, r, t thru w, z, c-1, e-1, h-1, k-1, n-1, p-1, q-1, s-1, v-1.
Emerson Radio & Phonograph Corp., f, g, i, l, p, u, x, z, a-1, c-1, p-1, z-1.
Empire Products Sales Corp., c-1.
Endevco Corp., d, s, x-1.
Engineered Magnetics, Div.-Gulton Industries, Inc., i, j, s.
Ensco, Inc., f, j, i-1, t-1, v-1.
Entron, Inc., a, p, e-1, z-1.
FXR, Inc., c-1, e-1, z-1.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., f, g, k, l.
Fairfield Engrg. Corp., g, a-1, n-1, q-1, v-1.
Farmer Electric Products Co., Inc., k-1.
Federal Mfg. & Engrg. Corp., b, l, o, p, s.
Feedback Controls, Inc., f, g, l, a-1, i-1, q-1, v-1.
Ferrotran Electronics Co., Inc., b, q, u, m-1, n-1, p-1, q-1, v-1.
Fidelity Amplifier Co., l-1, n-1, v-1.
Fidelity Instrument Corp., a-1, n-1.
Forbes & Wagner, Inc., t.
Ford Instrument Co., Div.-Sperry Rand Corp., b, f, h, m, s, t, a-1, m-1, n-1, q-1.
Forest Electro Co., The., a, q, v, x.
Foto-Video Labs., Inc., c, d, p, v, w, s-1.
Freed Transformer Co. Inc., a-1, w-1.
General Communication Co., c-1.
General Devices, Inc., i, j, l, m, n, p, r, s, t, e-1, j-1, m-1, p-1, v-1, z-1.
General Electric Co., Apparatus Sales Div., a-1, n-1, w-1.
General Electric Co., Computer Dept., f, i, i-1, m-1, p-1.
General Electric Co., Heavy Military Electronics Dept., a thru g, i, l, m, n, p, s, t, u, z, e-1, f-1.
General Magnetics, Inc., a-1, q-1.
Genisco, Inc., n-1, w-1, y-1.
Geotronic Labs. Inc., b thru f, i, k, l, m, q, s, a-1, v-1.
Gilmore Industries, Inc., s.
Good Electronic Corp., d, f, g, l, q, s, m-1, p-1, s-1, t-1.
Gordon Enterprises, i, s.
Goslin Electric & Mfg. Co., z.
Graflex Inc., f, t, q-1.
Guided Missile Div.-De Havilland Aircraft of Canada, Ltd., a-1.
Gulton Industries, Inc., i, v-1, x-1.
Hagan Chemicals & Controls, Inc., j, n.
Hallamore Electronics Co., j, m, s, f-1.
Haller, Raymand & Brawn Inc. Div., Singer Mfg. Co., a, l, p, a-1, z-1.
Hallicrafters, a, f, i, j, l, n, p, u, c-1, e-1, r-1, v-1, z-1.
Hamiltan Standard, Div.-United Aircraft Corp., f, g, i, j, l, m, n, q, s, t, z, i-1, l-1, n-1 thru q-1, s-1, v-1, x-1.
Hamilton Watch Co., t-1.
Hammarlund Mfg., Co., Inc., u, y, d-1, f-1, r-1, u-1, v-1, y-1, z-1.
Hanson-Garrill-Brian, Inc., n-1, a-1, q-1, v-1.
Paul Hardeman, Inc.
Harvey-Wells Electranics Inc., f, a-1, m-1, p-1, z-1.
Hays Corp., The, q-1.
Heiland Div.-Minneapolis-Haneywell, i, t, t-1, x-1.
Hewlett-Packard Co., k, n, r, y, c-1, j-1, m-1, n-1, y-1, z-1.
E. Vernon Hill & Ca., s.
Hoffman Electronics Corp., Semiconductor Div., l-1.
Haaver Electric Co., c, g, j, l, m, n, a, p, q, s, t, u, w, z, a-1, e-1, n-1, a-1, q-1, v-1.
Walter J. Hyatt Ca., The, a, c-1, q-1.
Hycon Mfg. Co., g, j, l, m, n.
I-L-S Instrument Div., The Meriam Instrument Co., t.
ITT Federal Div., International Telephone & Telegraph Carp., a, e, f, g, k, m, a, t, v, w, x, z, a-1, b-1, c-1, i-1, l-1, m-1, n-1, q-1, r-1, s-1, w-1, x-1, y-1.
ITT Labs., l, c-1.
Industrial Control Co., j, a-1, n-1, p-1, q-1, t-1, v-1.
Industrial Television Inc., b, j-1, v-1.
Industrial Test Equipment Co., l, s, t, v, n-1, a-1, q-1.
Instrument Carp. of Fla., g-1, h-1, k-1.
Instrument Development Labs., Inc., s-1, v-1.
Instrument Labs., v-1.
Instrumentation Div.-Amplex Corp., a-1, d-1, y-1.
Instruments For Industry, Inc., a, l, p, s, u, z, e-1, j-1, i-1, v-1, w-1, y-1, z-1.
International Research Associates, a, b, c, k, n, x, z, a-1, n-1, a-1, v-1, x-1, y-1.
Interstate Electronics Corp., z.
ITT-Kellogg, a, w.
J-V-M Microwave Co., c-1, g-1.
Jansky & Bailey, Inc., w, z-1.
E. F. Johnson Co., n-1.
Jordan Co., Inc., The, q-1.
Jordan Electronics, Div.-Victoreen Instrument Co., v-1.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., b, a-1, c-1, f-1, j-1, r-1, v-1.
Kauke & Co., i, m, n, s, t-1, v-1.
Kay Electric Co., b, s, m-1, v-1.
*KEARFOTT CO., INC., g, l, s, t, a-1, c-1, m-1, q-1.
*KEARFOTT CO., INC., MICROWAVE DIV., c-1.
Keithley Instruments, Inc., j, k, m, n, v.
Kelsey-Hayes Co., d, f, g, n, q-1, i-1, p-1.
Ketay Dept., Norden Div., United Aircraft Corp., f, g, a-1, q-1, v-1.
Keystone Products Co., a-1.
Kin Tel Div.-Cohu Electronics, Inc., g, i, j, m, n, s, i-1, t-1, v-1, w-1, x-1.
Kinevox Div.-Electromation Co., b, i, s, a-1, d-1, t-1.
Kollmorgen Optical Corp., a-1, q-1.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., a-1, m-1, q-1.
Land-Air Inc., f, g, i, l, n, s thru v, z, m-1, a-1, p-1, x-1, z-1.
Langevin Div., W. L. Maxson Corp., The, a, b, c, g, h, a, r, v thru y, a-1, b-1, d-1, f-1, m-1, n-1, a-1, u-1, v-1, y-1.
La Pointe Industries Inc., c-1, e-1, p-1, q-1.
Lavoie Laboratories Inc., j-1.
Leach Corp., g, j, j, n, q, s, a-1, t-1, y-1.
Lear, Inc., b, d, f, g, l, q, t thru w, a-1, m-1, p-1, q-1, s-1, v-1, z-1.
Lear, Inc., Grand Rapids Div., a, g, l, q, s thru w, a-1, l-1, m-1, p-1, q-1, v-1.
Leeds & Northrup Co., g, j, s.
L E L, Inc., a, b, l, a, t, v, y, b-1, j-1, p-1, u-1, z-1.
Leland Airborne Products, Div.-American Machine & Foundry Co., z.
Levinthal Electronic Products, Inc., c-1, n-1.
*LEWIS ENGRG. CO., THE, s.
Librascope Inc., f, g, q-1.
Ling Electronics, Inc., c, d, e, g, b-1, c-1, n-1, a-1, x-1.
Liquidometer Corp., The, g, r, s, z, q-1, v-1.
Litton Industries, Inc., z.
Litton Industries, Maryland Div., a, u, a-1, m-1.
Lockheed Aircraft Corp., Missiles & Space Div., b, f, i, m, q thru t, c-1, d-1, e-1, g-1, k-1, p-1, v-1.
J. M. Loge, Sound Engineers, r.
MB Mfg. Co., x-1.
MF Electronics Co., b, q.
Magnasync Mfg. Co., Ltd., y.
Magnavox Co., The, t.
Magnetic Controls Co., f, j, q, s, a-1, p-1, q-1, r-1, v-1.
Magnetic Instrument Co. Inc., g, i, j, l, m, n, s, v, m-1, q-1, t-1, v-1.
Magnetic Research Corp., j, a-1.
Magnetico, Inc., g, a-1, q-1, v-1.
Magnetics, Inc., Control Div., a-1.
Maico Electronics, Inc., b, i, p-1, v-1, w-1.
Manson Labs., Inc., m-1.
Massa Div.-Cohu Electronics, Inc., j, l, m, s, m-1, p-1, q-1, s-1, v-1, w-1.
Mast Development Co., Inc., s.
W. L. Maxson Corp., The, a, f, g, l, m, p, s, t, u, z, a-1, c-1, e-1, p-1, q-1, v-1, w-1, z-1.

Mergentholer Linotype Co., a-1, q-1.
Micro Gee Products, Inc., g, j, m, i-1, m-1, q-1, v-1.
Micrometrical Mfg. Co., s, x-1.
Microwave Associates, Inc., c-1, e-1.
Midwestern Instruments, Inc., i, j, l, m, n, s, t, i-1, t-1, v-1, y-1.
Milgo Electric Corp., d, f, g, i, j, l, m, s, t, v, q-1, v-1.
Minitran Corp., a-1.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., f, g, n, q-1, v-1.
Minneapolis-Honeywell Regulator Co., Boston Div., f, g, i, j, m, n, s, v, t-1.
Minneapolis-Honeywell Regulator Co., Davies Labs. Div., i, j, s, p-1, q-1.
Minneapolis-Honeywell Regulator Co., Industrial Div., f, g, i, n, s, q-1.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, i, j, m, n, s, p-1, q-1, t-1.
Minneapolis-Honeywell Regulator Co., Ordnance Div., b, k, l, n, q, t, z, h-1, l-1, p-1, v-1.
Miratel, Inc., c, d, j, a, p, r, v, y, b-1, c-1, e-1, f-1, g-1, y-1, z-1.
*MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV., a.
Missouri Research Labs., Inc., j.
Monogram Precision Industries, a, b, v, c-1, h-1, j-1, m-1, n-1, r-1, s-1, u-1 thru z-1.
Moran Instrument Corp., l, n, r, q-1.
Morse Instrument Co., The, g, i, l, s, t, l-1, q-1.
F. L. Moseley Co., z, q-1.
Motorola Inc., Military Electronics Div., b, f, g, i thru l, o, p, q, s thru x, z, a-1 thru s-1, v-1, w-1, y-1, z-1.
Heinz Mueller Eng. Co. Inc., j, l, n.
George L.Nankervis Co., i, r, q-1, v-1.
Narda Microwave Corp., The, b-1.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., a, f, j, k, o, p, q, u, y, b-1, d-1 thru g-1, k-1, m-1, q-1, u-1, v-1, y-1, z-1.
National Ultrasonic Corp., f, k-1, l-1, p-1, v-1.
Navigation Computer Corp.
Naz-Dar Co., p-1.
Neff Instrument Corp., i, j, m, s, v-1, x-1.
Networks Electronic Corp., g, i, j, m, n, q, s, a-1, m-1, n-1, q-1, t-1, v-1, x-1, l.
Newbrook Machine Corp.
North Atlantic Industries, Inc., p-1.
North Electric Co., b, g, l, n, q, s, u, n-1.
Northeast Electronics Corp., b, d, j, n, q, l-1, p-1, v-1.
Northrop Corp., p-1, q-1, v-1.
Norton Co., New Products Dept., q.
Nuclear Products-Erco Div.-ACF Industries, Inc., f.
Offner Electronics Inc., j, m, n, s, q-1, t-1, v-1.
Ohio Semiconductors, Inc., n.
Orbitran Co., Inc., i, j, n, s, v-1.
Ortho Filter Corp., a-1.
Osborne Electronic Sales Corp., a-1.
Pic Design Corp., Sub.-Benrus Watch Co., Inc., m.
Pacific Magnetic Corp., b, a-1.
Paramount Designs Co., f, g, i, s, t, c-1, m-1, q-1, s-1, v-1.
Paraplegics Mfg. Co., Inc., a-1.
Peer, Inc., e, g, w, y, v-1.
Perkin Engrg. Corp., j, n, a-1.
Perry Plastics, Inc., b, l, b-1, f-1, n-1, v-1.
Peschel Electronics, Inc., g.
George A. Philbrick Researches, Inc., c, f, j, s, i-1, m-1, n-1, p-1.
Philco Corp., Government & Industriol Div., b thru g, i, j, l thru u, w thru z, b-1 thru k-1, m-1 thru v-1, y-1, z-1.
Photobell Co., Inc., g, s, a-1, k-1, p-1, v-1.
Photocon Research Products, j, s, t-1.
Photo-Crystals, Inc., b-1, l-1.
Photomation, Inc., l-1.
Photron Instrument Co., i, j, n, s, i-1, m-1, s-1, t-1, x-1.
Polytechnic Research & Development Co., Inc., c-1.
Portchester Instrument Corp., c-1.
Power Supplies Inc., q-1, w-1.
Power-Tronic Systems Inc., b, c, d, f, g, j, l, s, t, v, a-1, i-1, n-1, p-1, q-1, s-1, v-1, y-1.
Precise Development Corp., c, d, f, j, k, l, n, a, s, u, w, b-1, d-1 thru g-1, j-1, n-1, p-1, v-1, y-1, z-1.
Process & Instruments, j, m, s.
Projects Unlimited Inc.
Quan-Tech Labs., g, j, k, m, n, v, j-1, p-1, t-1, v-1.
RS Electronics Corp., l, p, s, u, z, e-1, g-1, n-1, p-1, v-1, z-1.
Radiophone Co. Inc., a thru d, i, l, p, s, u, e-1, m-1, p-1, v-1, w-1, y-1, z-1.
Radiation, Inc.
Radiatronics, Inc., a.
Raytheon Mfg. Co., z.
Raytheon Mfg. Co., Government Equipment Div., c-1.
Reeves Instrument Corp., f, g, j, t, q-1.
Reflectone Corp., The, c, g, a-1, q-1, v-1.
Edw. Renneburg & Sons Co., h-1.
Resdel Engrg. Corp., a, c, l, p, s, u, x, c-1, e-1, n-1, a-1, z-1.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV., j, m, p, s, a-1, p-1, v-1, x-1, z-1.
Rixon Electronics Inc., d, j, l, m, q, v-1.
Roanwell Corp., b.
Robot Industries Inc., a-1, l-1.
Royol Industries, Inc., a, f, i, l, q-1.
Rutherford Electronics Co., y-1.
Ryon Aeronautical Co., g, l, n, p-1, q-1.
Safety Electrical Equipment Corp., a-1.
Soge-Craft, Inc., a, c, p, x.
Sanborn Co., j, m, n, s, z, m-1, t-1.
Sangamo Electric Co., a-1, v-1.
Santa Barbara Research Center
Schaevitz Engrg., q-1.
Scientific-Atlanta, Inc., a, q-1, z-1.
H. H. Scott, Inc., b, d, k, l, a, r, s, y, z, b-1, f-1, h-1, j-1, n-1, a-1, w-1, x-1, y-1.
Seeburg Corp., The, a, b, j, s.
Seiscor Mfg. Co., i, j, k, u, e-1, a-1, w-1, x-1.
Sequoia Wire & Cable Co.-Div.-Mandrel Industries, Inc., j, k, l, n, a, v-1.
Servo Corp. of America, p-1.
Servomechanisms, Inc., c, d, f, g, j, l, n, q, s, t, w, a-1, d-1, i-1, l-1 thru q-1, s-1, v-1.
Servomechanisms, Inc., Mechatrol Div., g, s, a-1, q-1, v-1.
Shure Brothers, Inc., x-1.
Sigma Instruments, Inc., a-1.
Signol Transformer Co., a-1.
Singer Mfg. Co., The, Military Products Div., a, f, g, l, p, p-1, q-1, v-1, z-1.
Skiatron Electronics & Television Corp., f, g, i, j, l, t, q-1, v-1, y-1, z-1.
Solar Aircraft Co., v-1.
Southwestern Industries Electronics Co., b, f, g, i, m, n, s, u, a-1, h-1, i-1, j-1, n-1, a-1, q-1, t-1, u-1, v-1, w-1, x-1.
Space Corp., h, l, s, y, a-1.
Specialties, Inc., a-1.
Specialty Engrg. & Electronics Co., l-1.
Spectrol Electronics Corp., j, q-1, v-1.
Sperry Electronic Tube Div., Sperry Rond Corp., c-1.
Sperry Farragut Co., Div.-Sperry Rand Corp., f, s, m-1, p-1, q-1, v-1.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp., s-1.
Sperry Microwave Electronics Co., Div.-Sperry Rond Corp., c-1.
Sperry Piedmont Co.-Div.-Sperry Rand Corp., s-1.
Squiers Goge Co., a.
Statham Instruments, Inc., h, i, s, t-1, v-1.
Sterling Precision Corp., Instrument Div., e, f, s, l-1, p-1, v-1.
Strand Engrg. Co., q, u.
Stromberg-Carlson Div.-General Dynamics Corp., g, a, r, f-1, v-1.
Systems Inc., a thru z, a-1 thru z-1.
T-C Div., Dyna-Empire, Inc., l.
Tolley Corp., The, a-1.
Topco Group, Thompson Ramo Wooldridge Inc., f, g, j, a-1, q-1.
Technical Apporatus Builders, M-1, N-1, a-1, v-1.
Technitrol Engrg. Co., n-1, q-1.
Technology Instrument Corp., k, n-1.
Teiner Engrg. Corp., a.
Telechrome Mfg. Corp., b, c, d, f, i, j, l, m, p, q, s, u thru x, z, c-1, e-1, g-1, m-1 thru p-1, r-1, s-1, t-1, v-1, z-1.
Telectro Industries Corp., a thru q, s thru z, a-1 thru v-1, x-1, y-1, z-1.
Tele-Dynamics Inc., b, c, i, j, l, m, s, d-1, m-1, v-1, y-1, z-1.
Telerad Mfg. Corp., u, c-1, z-1.
Television Utilities Corp., p, r, x, f-1.
Tel-Instrument Electronics Corp., p.
Thermo Electric Co., Inc., q-1.
Thomas Electronics, Inc.
Topper Mfg. Co., Inc., q, p-1, v-1, w-1.
Torwico Electronics, Inc., a-1.
Transistor Electronics Corp., f, y, m-1, v-1.
Transonic, Inc., n, q, a-1, m-1, p-1, v-1.
Tresco, Inc., z.
Trionics Corp., b, f, g, l, n, q, s, t, p-1, q-1, v-1, w-1.
Tube-Turns Div., Chemetron Corp., m-1.
Turbo Machine Co., a, d, g, j, s, u.
Twenty-First Century Electronics, Inc., m-1, w-1.
United Control Corp., g, j, m, n, p, a-1, q-1, v-1.
United Electrodynomics, Inc., d, i, j, n, s, n-1, p-1, t-1, v-1, x-1.
U. S. Industries, Inc., a, b, c, g, h, i, m.
U. S. Science Corp., Div.-Topp Industries, Inc., c, e, f, i, l, m, q, s, t, a-1, g-1, r-1, v-1.
United Transformer Co., a-1.
Universal Toroid Coil Winding, Inc., a-1.
Varian Associates, c, l, c-1, n-1.
Vori-L Co., Inc., a-1.
Vicon Corp., p, v, x.
Victor R. F. & Microwave Co., b-1.
Video Instruments Co., Inc., j, m, n, s, i-1, t-1, v-1.
Virginia Electronics Co., Inc., p, w, x, y, d-1, e-1, m-1, n-1, p-1.
Waldorf Electronics Div.-F.C. Huyck & Sons, f, g, s, i-1, m-1, q-1.
Wolkirt Co., b, d, f, k, m, q, m-1, v-1.
Wolthom Electronics Corp., z-1.
Warren Components, Div. El-Tronics, Inc., n-1.
Warren Transformer Co., Inc., q, a-1.
Watermon Products Co., Inc., j-1.
Wough Engrg. Co., q-1, s-1.
Waveline, Inc., c-1.
Webcor, Inc., Government Div., a, f, g, i, m, q, f-1, p-1, v-1.
Westbury Electronics Inc., a, p, q, u, a-1, v-1.
Western Design, Div.-U.S. Industries, Inc., Santa Barbara Div., s.
Western Geor Corp., q-1.
Westinghouse Electric Corp., a, c, f, j, k, l, p, a-1, c-1, n-1, q-1, r-1, v-1, y-1, z-1.
Weston Hydroulics Ltd.-Sub., Borg-Worner Corp., q-1.
Weston Instruments, Div.-Doystrom, Inc., g, j, m, n, t, n-1.
Westronics Inc., g, i, s, q-1, t-1.
Wheeler Electronic Corp., Sub.-Sperry Rond Corp j, n thru q, s, u thru y, a-1, c-1, n-1, a-1, p-1,
Winder Aircroft Corp. of Florida, a, j-1.
Winzen Research Inc., s.
Worner Electronic Devices, g.
Wright Engrg. Co., p, c-1, e-1, g-1, z-1.
Wye Industries, w-1.
Zacharias Electronics Corp., b, d, k, l, a, s, u, y, b-1, d-1, f-1, j-1, p-1, u-1, w-1, w-1, x-1, y-1

ANALYSIS EQUIPMENT, ELECTRO-CHEMICAL

American Instrument Co., Inc.
Analyticol Instruments, Inc.
R. B. Annis Co.
Beckman-Scientific & Process Instruments Div.
Bendix Aviation Corp., York Div.
Bergen Labs., Inc.
Bristal Co., The
Consolidated Electrodynamics Corp.
Delsen Corp.
Fisher Scientific Co.
Furane Plastics, Inc.
General Electric Co., X-Ray Dept.
Hughes Tool Co., Aircraft Div.
Industrial Instruments Inc.
Jarrell-Ash Co.
Harold Kruger Instruments
Leeds & Northrup Co.
Notionol Spectrographic Lobs., Inc.
New England Scientific Instruments Co.
Perkin-Elmer Corp.
Milton Roy Co.

ANALYSIS EQUIPMENT, MAGNETIC
See MAGNETIC ANALYSIS EQUIPMENT

ANALYZERS

a. Antenna Pattern
b. Audio Amplifier
c. Cable
d. Capacitor
e. Circuit
f. Coincidence
g. Crystal
h. Differential
i. Differential Computer
j. Digital
k. Dimensional
l. Distortion
m. Electro-Chemical
n. Engine
o. Flight
p. Frequency
q. Gas
r. Ignition
s. Infrared
t. Intermodulation
u. Internal Combustion
v. Magnetic
w. Microwave
x. Neutron Absorption
y. Noise
z. Phase
a1. Radar
b1. Servo
c1. Spectrum
d1. Spectrum, nuclear
e1. Stress Surface
f1. Transducer
g1. Transistor
h1. Ultrasonic
i1. Vibration
j1. Wave
k1. Waveform

Advanced Electronics, Inc., i-1.
Aeroflex Corp., The, Aeroflex Labs. Div., a.
Aetna Electronics Corp., b-1.
Air Logistics Corp., d, e, j, z, b-1.
Airborne Instruments Lab., Div.-Cutler-Hammer, Ir a.
Aircom Inc. of New Jersey, w.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., n, e-1.
Airpax Electronics Inc., Seminole Div., p.
Amelco, Inc., e, c-1.
American Electronic Labs., Inc., c-1, g-1.
American Electronics, Inc., Americon Nuclear Div d-1.
American Electronics, Inc., Taller & Cooper Div., m, q.
American Machine & Foundry Co., Government Products Group, a, b, p, a-1, b-1.
Americon Mochine & Foundry Co., Greenwich, s, v w, z, a-1, b-1.
Americon Research & Mfg. Corp., l, p, c-1, i-1.
Analyticol Instruments, Inc., m.
Antlob Inc., a.
Applied Rodiation Corp., v.
Applied Research Lobs., Inc., c-1.
Applied Science Corp. of Princeton, p, y, b-1, i-1.
Audio Instrument Co., Inc., l.
Automotion Dynomics Corp., c.
Avien, Inc., n, i-1.
Axler Associates Inc., q, s.
B & H Instrument Co., Inc., n, p.
B & K Instruments, Inc., b, l, p, y, c-1, i-1.
Boird-Atomic, Inc., q, s, d-1, g-1.
Borker & Williamson Inc., l.
*BAUSCH & LOMB OPTICAL CO., s, c-1.
Beckmon-Scientific & Process Instruments Div., m q, s.
Bendix Aviation Corp., York Div., a, p, w, z, j-1, i

Bdix Computer, Div.-Bendix Aviation Corp., i, j.
*NDIX PRODUCTS DIV., BENDIX AVIATION ORP., n, s.
Bdix Radio Div., Bendix Aviation Corp., a, a-1.
Bjen Labs., Inc., m, t, h-1.
Bo Lab., Inc., f, h, d-1, k-1.
Bder-Tongue Lobs., Inc., l, j-1, k-1.
Bue Electric Mfg., Co., c, n, a.
Bgs Associotes, Inc., f-1, k-1.
Brol Co., The, e, m.
Baswick Instruments, z.
Bth Instruments, Div.-Clevite Corp., h, i, j, l thru s, v, w, a-1, b-1, d-1, e-1, f-1, h-1, j-1.
Bow Electric Co., j, p, w, b-1.
Cal Lobs., Inc., c-1.
Cifornia Technical Industries, Div.-Textron Inc., a, d, e, w, g-1.
Cdl Electronics Corp., k-1.
Ceranix Inc., b, h thru l, a-1, g-1.
Chesapeake Instrument Corp., a, j, f-1.
Clago Aerial Industries, Inc., d.
Clesler Corp., Defense Operations Div., p.
Cly Dynamics, j, b-1, f-1.
Cleland Instrument Co., k.
Cins Microflat Co.
Colidated Avionics Corp., g-1.
Colidated Diesel Electric Corp., c, e, i, j, f-1, l.
Colidated Diesel Electric Corp., Western Div., n.
Colidated Electrodynamics Corp., m, q, e-1, f-1, .
Coell-Dubilier Electric Corp., d.
Jas Cunningham Son & Co., Inc., e.
Cuss-Wright Electronics Div., IMI Branch, f-1, g-1.
Cuss-Wright Corp., Research Div., y.
Dalotor Div., Yuba Consolidated Industries, Inc., i.
Dds Instruments, q.
Dcon Aviation Radio & Equipment Corp., b, e.
Debarn Electronic Labs., d.
Deer Corp., The, p, c-1, i-1.
Dornay-Bonardi, p, w, c-1.
Din Controls, Inc., j, v.
W. L. Dillon & Co., Inc., f-1.
DiCO, Inc., Electronics Div., c, e.
Dip-Wayne Electronics, Div.-Divco-Wayne Corp., a.
Diver Scientific Co., h, i, t, b-1, f-1, j-1, k-1.
Dallas Microwave Co., Inc., w, a-1.
Dreser Industries, Inc., b, j, p, f-1, i-1.
Dyne Inc., v.
Dynics Co., y.
E Div.-Epsco, Inc., c-1, k-1.
Thas A. Edison Ind. Instrument Div.-Mc Grawison Co., b-1.
Elrado Electronics, f, d-1.
Elro Instruments, Inc., d, j.
Elro Products Laboratories, Inc., e-1, i-1.
Elronic Applications, Inc., l, t.
Elronic Communications, Inc., e, p, s, w, z, a-1.
Elronic Reseorch Associates, Inc., g-1.
Elronic Tube Corp., a-1.
Elro-Tech Equipment Co., c, d, e, y, i-1.
Ely Micronics, West Coast Div.-Elgin Nationol tch Co., f-1.
Elsy Motor Co., Inc., c.
Emson Electric Mfg. Co., The, Electronics & lonics Div., a.
Emson Radio & Phonograph Corp., j, w, z, a-1, g-1.
Emre Products Sales Corp., a, l, w, y, a-1, k-1.
Envco Corp., f-1, i-1.
Enlhard Industries, Inc., q.
Epl Inc., i-1.
EX Inc., a, w, y, c-1, k-1.
Fachild Astrionics Div., Fairchild Engine & plane Corp., g-1.
Feral Products Corp., k.
Feral Scientific Corp., c-1.
Ferran Electronics Co., Inc., y, g-1.
Fiey Co., The, a.
Fier Scientific Co., m, q.
Foss, George F., Industrial Mathematician, h, i, j.
Fra Transformer Co. Inc., l.
Fune Plastics, Inc., l, m.
Gerol Communication Co., w, c-1.
Geral Electric Co., Apparatus Sales Div., h.
Geral Electric Co., X-Ray Dept., m, c-1, d-1.
Geral Electrodynomics Corp., c-1.
Geral Scientific Equipment Co., k-1.
Grex Inc., b, a-1.
Gulh Industries, Inc., h-1, i-1.
Har, Raymond & Brown Inc. Div., Singer Mfg. Co., c-1.
Hacrafters, a, t, a-1.
Hakainen Instruments, q.
Halton Standard, Div.-United Aircraft Corp.
Hahy-Wells Electronics Inc., j, v, b-1.
Hal Corp., The., q.
Haline Electronics Div.-Hazeltine Corp., c-1.
Hewett-Packard Co., l, y, j-1, k-1.
Hinp Wires Inc., c.
Hohan Electronics Corp., Semiconductor Div., s, , g-1.
Hoer Electric Co., g-1.
Hues Tool Co., Aircraft Div.
Wair J. Hyatt Co., The, a, v, w, a-1, b-1, j-1, k-1.
ITT Federal Div., International Telephone & Telegph Corp., a, d, e, f, h, j, l, n, a, p, s, t, v thru y-1, c-1, e-1 thru i-1, k-1.
Indrial Control Co., b-1.
Indrial Instruments Inc., c, m, q.
Indrial Test Equipment Co., l, p, z, b-1, k-1.
Ins Co., Div.-Barry Controls Inc., i-1.
Insment Labs., e.
International Research & Development Corp., i-1.
International Wire & Cable Co., c.
Interstate Electronics Corp., f, d-1.
Itek Corp., w, c-1.
Jansky & Bailey, Inc., a, p.
Jarrell-Ash Co., m, c-1.
Jefferson Electronic Products Corp., c.
Johnson-Williams, Inc., q.
Kahn & Co., Inc., i-1.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., c, a, w.
Kay Electric Co., a thru e, g, p, y, c-1, g-1, i-1, j-1.
*KEARFOTT CO., INC., j, w, z, b-1, g-1, j-1, k-1.
Kingston Electronics-Div.-Kingston Industries Inc., e.
Harold Kruger Instruments, q.
Land-Air Inc., j, n, o, u, v, x, f-1, i-1.
La Roe Instruments, Inc., j.
Lavoie Laboratories Inc., e, c-1.
Leeds & Northrup Co., m, q, s.
Ling Electronics, Inc., c-1.
Lockheed Aircraft Corp., Missiles & Space Div., a.
MB Mfg. Co., i-1.
Magnaflux Corp., v, e-1.
Marconi Instruments, l, t, c-1, j-1.
Measurements Div., McGraw Edison Co., t.
J. E. Menaugh Co., r.
Micrometrical Mfg. Co., b, k, p, f-1, g-1, i-1.
Mine Safety Appliances Co., m, q, s, y.
Minneapolis-Honeywell Regulator Co.-Davies Labs. Div., p, c-1, i-1, j-1.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, p, q, c-1, k-1.
Missouri Research Labs., Inc., a-1.
Monogram Precision Industries, a, b, d, k, s, v, w, a-1, m-1, j-1.
Motorola Inc., Military Electronics Div., g thru j, p, t, w, y, z, a-1, b-1, g-1, h-1, k-1.
NRC Equipment Corp., q.
George L Nankervis Co., n, r, b-1.
Narda Microwave Corp., The, u.
National Instrument Laboratories, Inc., q.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., b-1.
National Spectrographic Labs., Inc., b-1, c-1.
North Atlantic Industries, Inc., z.
Northeastern Engrg. Inc., c-1.
Northrop Corp., i, j.
Northrop Corp., The, Nortronics Div., d, e, i, s, w.
Norton Co., New Products Dept., m.
Optimized Devices, Inc., c, d.
Pacific Scientific Co., i-1.
Paco Electronics Co., Inc., d, e, g-1.
Paramount Designs Co., i, j, l.
Perkin-Elmer Corp., m, s, c-1.
Peschel Electronics, Inc., c, e.
Philco Corp., Government & Industrial Div., e, j, s, w, a-1, g-1.
Physics Research Laboratories, Inc., e.
Pioneer Industries Div., Almar-York Co. Inc., q, s, e-1, h-1.
Polarad Electronics Corp., p, w, a-1, b-1, c-1.
Polytechnic Research & Development Co., Inc., w, c-1.
Power-Tronic Systems Inc., v, b-1, f-1, g-1.
Precise Development Corp., b, d, l.
Precision Apparatus Co., Inc., e, g-1.
Probescope Co. Inc., l, p, c-1, k-1.
Process & Instruments, q.
Projects Unlimited Inc., c.
Quan-Tech Labs., t, y, c-1, j-1, k-1.
Radiation, Inc.
Radiation Instrument Development Lab., Inc., f, h, d-1.
Radionics, Inc., h-1.
Railway Communications Inc., j-1.
Raytheon Mfg. Co., c-1, i-1, j-1, k-1.
Edw. Renneburg & Sons Co., u.
Republic Aviation Corp., e.
Rese Engrg., Inc., v.
Milton Roy Co., m.
Scientific-Atlanta, Inc., a.
H. H. Scott, Inc., p, y, i-1.
Servo Corp. of America, b-1.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., k.
Singer Mfg. Co., The, Military Products Div.
Snap-on Tools Corp., n.
Solartron Inc., e, l, y, z, b-1, i-1, j-1.
Space Corp., g-1, i-1, k-1.
Sperry Gyroscope Co., Morine Div., Div.-Sperry Rand Corp., j, n.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., p, w, a-1, c-1.
Sperry Piedmont Co.-Div.-Sperry Rand Corp., n.
Sun Electric Corp., Aeronautical Div., n, p, q, r, i-1.
Superior Cable Corp., c.
Systems Inc., a-1, b-1, c-1, k-1.
Technical Apparatus Builders, e.
Telechrome Mfg. Corp., f, h, i, j, t, w, z, k-1.
Telectro Industries Corp., b, c, d, f, i, j, a, p, r, s, t, z, a-1, b-1, i-1, j-1.
Tele-Dynamics Inc., t, z.
Telerad Mfg. Corp., p, w, a-1.
Tel-Instrument Electronics Corp., i-1.
Theta Instrument Corp., y, z, a-1.
Towaco Electronics, l, p.
Turbo Machine Co., a, b, e, f, w.
United Electrodynamics, Inc., f-1.
U. S. Industries, Inc.
Varian Associates, v, a-1, c-1.
Victor R. F. & Microwave Co., w.
Victory Engrg. Corp., q.
Virginia Electronics Co., Inc., b, e.
Woldorf Electronics. Div.-F.C. Huyck & Sons, a-1, b-1.
Wang Labs., Inc., f, j.
Waste King Corp., Technical Products Div., o.
Waterman Products Co., Inc., z, k-1.
Waveline, Inc., w.
Weinschel Engrg., a, w.
Western Internotionol Co., c.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp., b-1.
Weston Instruments, Div.-Daystrom, Inc., j, p.
Wintronics, z.
Wright Engrg. Co., a, p, t, y, c-1, i-1.
Wye Industries, h-1.

ANEMOMETERS

Aero Research Instrument Co. Inc.
Beckman & Whitley, Inc., Missile Products Div.
Bendix Aviation Corp., Friez Instrument Div.
Epic, Inc.
Flow Corp.
E. Vernon Hill & Co.
Illinois Testing Laboratories, Inc.
Instruments Corp., The
M. C. Stewart
Strong Scott Mfg. Co., The
Victory Engrg. Corp.
Westberg Mfg. Co.
Wilks Precision Instrument Co., Inc.

ANGLE DRIVES

Acton Labs. Inc.
Actuator Products Div., Geortronics Corp.
Airborne Accessories Corp.
Curtiss-Wright Corp.-Wright Aeronauticol Div.
Electronic Communications, Inc.
Foote Bros. Gear & Machine Corp.
Hoover Electric Co.
Interstote Engrg. Corp.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Machinery Sales & Engrg. Co.
Metron Instrument Co.
Robot Industries Inc.
Sargent Engrg. Corp.
F. W. Stewart Corp.
Talley Corp., The
George A. Terry Co.
Vord Inc.
Waste King Corp., Technical Products Div.
Western Gear Corp.

ANNUNICATORS

Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
*ETS-HOKIN & GALVAN
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co.
Litton Industries, Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Scam Instrument Corp., The
Stackpole Carbon Co.
Technicol Apparotus Builders

ANODES, GRAPHITE

Belmont Smelting & Refining Works, Inc.
J. Bishop & Co., Platinum Works
Division Lead Co.
Engelhard Industries, Inc.
Helwig Carbon Products, Inc.
Ohio Carbon Co., The
Squiers Gage Co.
Wallace & Tiernan Inc.

ANODES, METAL

Allied Research Products, Inc.
Alpha Metals, Inc.
Aluminum Co. of America
American Brass Co., The
American Silver Co.
American Smelting & Refining Co.
Attleboro Refining Co., Inc.
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Chase Brass & Copper Co., Inc.
Dayton Aircraft Products, Inc.
Division Lead Co.
Eastern Smelting & Refining Corp.
Giannini Plasmadyne Corp.
Handy & Harman
I-T-E Circuit Breaker Co.
Kolcast Industries-Div.-Thompson Ramo Wooldridge Inc.
W. L. Maxson Corp., The
Metals & Controls Corp., General Plate Div.
Mueller Brass Co.
Research Development Mfg. Inc.
Sel-Rex Corp.
Standard Metals Corp.
Waldom Electronics Inc.
Wildberg Bros. Smelting & Refining Co.

ANTENNA FEED SYSTEMS

Ainslie Corp.
All Products Co.
American Aeroparts
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Coaxial Connector Co. Inc.
Collins Radio Co.

Cooper Development Corp., Sub.-Marquardt Aircraft Co.
DBM Research Corp.
Dayton Aircraft Products, Inc.
Douglas Microwave Co., Inc.
Emersan Electric Mfg. Co., The, Electronics & Avianics Div.
*ETS-HOKIN & GALVAN
Gabriel Co., The, Gabriel Electronics Div.
Goodyear Aircraft Corp.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co.
Hallicrafters
Instruments For Industry, Inc.
Jansky & Bailey, Inc.
E. F. Johnson Co.
*KEARFOTT CO., INC.
*KEARFOTT CO., INC., MICROWAVE DIV.
D. S. Kennedy & Co.
Meridion Metalcraft, Inc.
Microwave Associates, Inc.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
N. R. K. Mfg. & Engrg. Co.
National Pneumatic Co., Inc., Haltzer-Cabot Divs.
Philco Corp., Government & Industrial Div.
Pradelin Inc.
Radiation, Inc.
Royal Industries, Inc.
Scientific-Atlanta, Inc.
Shaw Metal Products Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Stavid Engrg., Inc.
Technical Appliance Corp.
Teiner Engrg. Corp.
Telerad Mfg. Corp.
Thermal Refractories Corp.
Transca Products, Inc.
Turbo Machine Co.
U. S. Science Corp., Div.-Topp Industries, Inc.
Washington Aluminum Co., Inc.
Webcor, Inc., Government Div.
Wilcox-Crittenden Div., North & Judd Mfg. Co.
Wind Turbine Co.
Z & W Mfg. Corp.

ANTENNA FITTINGS & ACCESSORIES

Ainslie Corp.
Aircam Inc. of New Jersey
All Products Co.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Anchor Metal Spinning Co., The
Basco Metal Products, Inc.
Beaver Precision Products Inc.
Blaco Mfg. Co.
CGS Labs., Inc.
Capital City Mfg. Co.
Coaxial Connector Co. Inc.
Collins Radio Co.
Daytan Aircraft Products, Inc.
Douglas Microwave Co., Inc.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
Elsin Electronics Corp.
Emersan Electric Mfg. Co., The, Electronics & Avionics Div.
Empire Products Sales Corp.
Finney Co., The
Ford Instrument Co., Div.-Sperry Rand Corp.
GAR Mfg. Corp.
Gabriel Co., The, Gabriel Electronics Div.
General Electric Co., Missile & Space Vehicle Dept.
General R-F Fittings, Inc.
Gladding, McBean & Co.
Highland Rim Machine Works Inc.
Hi-Lo Manufacturing Corp.
*HOUDAILLE INDUSTRIES, INC., BUFFALO HYDRAULICS DIV.
Walter J. Hyatt Co., The
Isalantite Mfg. Corp.
E. F. Johnson Co.
K-W Engrg. Works
*KEARFOTT CO., INC.
D. S. Kennedy & Co.
Lamtex Industries, Inc.
La Pointe Industries Inc.
Mercury Tool & Mfg. Corp.
Meridian Metalcraft, Inc.
Monogram Precision Industries
Matarala Inc., Military Electronics Div.
National Beryllio Corp.
National Pneumotic Co., Inc., Holtzer-Cabot Divs.
Precision Shapes, Inc.
Prodelin Inc.
Radiatronics, Inc.
Scientific-Atlanta, Inc.
Shollcrass Mfg. Co.
Stainless Inc.
Stanley-Judd Div.-The Stanley Works
Talley Corp., The
Tapco Group, Thompson Rama Woaldridge Inc.
Technical Appliance Corp.
Teiner Engrg. Corp.
Telectra Industries Corp.
Telerad Mfg. Corp.
Transca Products, Inc.
Tricraft Products Corp.
Turba Machine Co.
U. S. Science Corp.
U. S. Industries, Inc.
Wilks Precision Instrument Co., Inc.
Wind Turbine Co.
Z & W Mfg. Corp.

ANTENNA FORMS
See FORMS, ANTENNA

ANTENNA LINKS
See LINKS, ANTENNA

ANTENNA OUTLETS
See OUTLETS, ANTENNA

ANTENNA SWITCHING EQUIPMENT
See SWITCHING EQUIPMENT, ANTENNA

ANTENNA TOWER LIGHTING

Allied International Co.
Anchar Metal Spinning Co., The
Barker & Williamsan Inc.
Collins Radia Co.
Douglas Microwave Co., Inc.
Dresser-Ideca Co., Div.-Dresser Industries, Inc.
Stainless Inc.
Teiner Engrg. Corp.
Telectra Industries Carp.
Wind Turbine Co.

ANTENNA TUNING UNITS

American Machine & Faundry Co., Government Products Group
Callins Radia Co.
Electronic Communications, Inc.
Ford Instrument Co., Div.-Sperry Rand Carp.
General Electric Co., Missile & Space Vehicle Dept.
Walter J. Hyatt Co., The
I-T-E Circuit Breaker Co.
ITT Federal Div., Internatianal Telephane & Telegraph Corp.
E. F. Jahnson Co.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
W. L. Maxson Corp., The
Meridian Metalcraft, Inc.
Managram Precision Industries
National Pneumatic Co., Inc., Holtzer-Cabat Divs.
Philca Carp., Government & Industrial Div.
Radiation, Inc.
Radiatranics, Inc.
Sage-Craft, Inc.
Seiscor Mfg. Co.
Teiner Engrg. Corp.
Telectra Industries Carp.
Turba Machine Co.

ANTENNAS

a. Direction Finding
b. Fixed Station
c. High Frequency
d. Laap-Direction Finder
e. Law Frequency
f. Micrawave-Radar
g. Mobile Commercial
h. Mobile Communication
i. Radar
j. Radiation Test
k. Rotary Beam
l. Slatted Line
m. Ultra High Frequency
n. Very High Frequency

ACF Industries Inc., e, m, n.
Adler Electronics, Inc., f, h, m, n.
Aeradex, Inc., i.
Aeronca Mfg. Corp., i.
Ainslie Carp., c, f, i, m, n.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., j.
Aircam Inc., f, i, j, l, m, n.
Aircom Inc. af New Jersey, f, i.
Airtron Inc., Div.-Litton Industries, f.
Alford Mfg. Ca., m, n.
All Products Co., a, b, c, e thru i, k, m, n.
Allied International Co., b, c, d, g, h, n.
Allied Research & Engrg., Div.-Allied Record Mfg. Co.
Allisan Steel Mfg. Ca., b, f, i.
Alpar Mfg. Carp., b, e.
American Aeroparts, a.
American Aerophysics Corp.
American Aluminum Ca., i.
American Electronic Labs., Inc., f, i, l, m, n.
American Machine & Foundry Co., Government Products Graup, b, c, e, f, g, i thru n.
American Machine & Faundry Co., Greenwich, a, b, c, e, f, h, i, k, l, m, n.
Andrew Carp., b, f, h, l, m, n.
Antenna & Radome Research Associates, f, l, m, n.
Antenna Specialists Co., The, a, c, e, g, h, m, n.
Atlas Precision Products, Co., a, f, i.
Autamatian Dynamics Corp., a, f, l, m.
*AVCO MFG. CORP., CROSLEY DIV., i.
Basco Metal Products, Inc., l.
Rex Bassett, Inc., g, h, k.
Beaver Precision Products Inc., i.
Bell Aircraft Corp., Niagara Frantier Div., c, f, i, m.
Belack Instrument Corp., i.
Bendix Aviation Corp., Eclipse-Pianeer Div., i.
Bendix Aviation Corp., Yark Div., f, j, l.
Bendix Radio Div., Bendix Aviatian Corp., a, d, f, n.
Blaw-Knax Equipment, Div.-Blaw-Knax Co., f, i, m, n.
E. W. Bliss Co., i.
Bagart Mfg. Carp., f, m, n.
Bowser, Inc., Defense Dept., e, i.
Brach Mfg. Corp., Div.-General Branze, h.
Braaks & Perkins, Inc., f, i.
Budd Stanley Co. Inc., f, i, l.
Bulow Electric Ca., a, c, d, f, i, k thru n.
California Technicol Industries, Div.-Textron Inc j, l.
Canoga Div., Underwood Corp., f, i, j, m, n.
Chemald Ca., a thru e.
Coaxiol Cannector Co. Inc., h, i.
Collins Radio Co., a, b, c, e thru k, m, n.
Columbia Products Co., c, e, g, h, m, n.
Communications Ca., b, g, h.
Communications Reseorch Co., h, n.
Caaper Development Corp., Sub.-Marquardt Aircra Co., c, h, m, n.
DBM Research Corp., f, i.
Daytan Aircraft Products, Inc., a, c, e, m, n.
Dayton Aviatian Radio & Equipment Carp., a, c, d, e, n.
Demornay-Bonardi, f.
Diamond Antenna & Microwave Corp., c, e, f, i, l, l, m, n.
Diversey Engrg. Ca., i.
Dorne & Margolin, Inc., a, c, d, f, l, m, n.
Douglas Microwave Co., Inc., f, i, l.
Dresser Industries, Inc., f, i.
Dresser-Ideco Ca., Div.-Dresser Industries, Inc., a, b, c, e, f, i.
Electra-Mechanical Products Co., f, i, m, n.
Electronic Specialty Ca., c, l, m, n.
Emersan Electric Mfg. Co., The, Electranics & Avianics Div., f, i, j, l.
Emerson Radia & Phonograph Carp., f, m, n.
FXR, Inc., f, l.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., a, b, c, f, l, m.
Finney Ca., The, a, c, e, m, n.
Ford Instrument Ca., Div.-Sperry Rand Corp., i.
Freeman Ca., The, a, f, g, n.
Furane Plastics, Inc., i.
GAR Precisian Parts, Inc., f, m.
Gabriel Ca., The, Gabriel Electronics Div., a thru i, k thru n.
General Communicatian Ca., f.
General Precision Lab. Inc., f.
Gladding, McBean & Ca., f, i.
John Gambos Co., Inc., f.
Goodyear Aircraft Corp., a, b, c, e, f, i, m, n.
Gulton Industries, Inc., a, b, c, f, i, k thru n.
Haller, Raymand & Brawn Inc. Div., Singer Mfg. C c, f, l, m, n.
Hallicrafters, c, f, h, i, l, m.
Hozeltine Electronics Div.-Hazeltine Carp., f, i, j, m, n.
Hi-Lo Manufacturing Carp., a thru n.
Haustan Fearless Corp., f, g.
Hughes Aircraft Ca., f, h, i.
Hughes Tool Co., Aircraft Div., c, e, f, i, j, l, m,
Walter J. Hyatt Ca., The, a, b, f, i, k, l.
I.D.E.A., Inc., h.
I-T-E Circuit Breaker Co., a thru n.
ITT Federal Div., International Telephane & Telegraph Corp., d, f, i, k.
ITT Labs., a thru f, h thru n.
Indusl. Prad.-Danbury Knudsen Div. Amphenol-B Electranics Corp., g.
Intercantinental Mfg. Ca., Inc., f, i.
JFD Electranics Corp., m.
J-V-M Micrawave Co., f, i.
Jansky & Boiley, Inc., a thru e, h, j.
E. F. Johnson Co., b, k.
K-W Engrg. Works, g, h.
Kaiser Aircroft & Electronics, Div.-Kaiser Indust Corp., j.
*KEARFOTT CO., a, d, f, i, j.
*KEARFOTT CO., INC., MICROWAVE DIV., f.
Kelsey-Hayes Ca., f, i.
D. S. Kennedy & Ca., f, i, m, n.
Herb Kreckman Ca., b, h, n.
La Painte Industries Inc., a, c thru f, i.
Lear, Inc., a, d, n.
Lear, Inc., Grand Rapids Div., a, d, n.
Leitch-Huard Corp., g, h, m, n.
Lieco, Inc., f, h.
Litton Industries, Inc., f, i.
Litton Industries, Marylond Div., a, thru n.
Lackheed Aircraft Corp., Missiles & Space Div., c, f, i, l, m, n.
Langren Aircraft Ca., Inc., i.
Lundy Mfg. Carp., e.
Magnavax Co., The, d, i.
Mark Products Ca., b, c, g, h, j, m, n.
W. L. Maxson Corp., The, a, c, f, i, l, m, n.
Meridian Metalcraft, Inc., a, f, i, j, l, m, n.
Minnesata Mining & Mfg. Co., i.
*MIRAX CHEMICAL PRODUCTS CORP., ELEC MECHANICAL PRODUCTS DIV., e.
Managram Precision Industries, a thru i, k, l, m,
Masley Electranics, Inc., b, c, h, k, n.
Matarala Inc., Military Electronics Div., a thru d f thru i, l, m, n.
N. R. K. Mfg. & Engrg. Ca., f, i.
Narmco Mfg. Ca., a thru f, h thru n.
National Pneumatic Co., Inc., Haltzer-Cabot Divs., a thru e, g, h, l, m, n.
Nuclear Products-Erca Div.-ACF Industries, Inc.
Ralph M. Parsons Co., The, Electranics Div., m,
Permax Products Div., Chisholm-Ryder Co., Inc. b, c, g, h, m, n.
Philca Carp., Government & Industrial Div., a, b, c, f thru n.

hoto-Crystals, Inc., f.
lastic Age Sales, Inc.
olarad Electronics Corp., f.
ortchester Instrument Corp., e.
adelin Inc., f, h.
adiation, Inc.
adiatronics, Inc., a thru f, i thru n.
aytheon Mfg. Co.
aytheon Mfg. Co., Government Equipment Div., f, i.
epublic Aviation Corp., a thru f, i, j, m, n.
esdel Engrg. Corp., f.
xan Electronics Inc.
oyal Industries, Inc., a thru e.
an Aeronautical Co., a, f, i.
nders Associates, Inc., f, i, l.
ala Radio Co., a thru d, m, n.
ientific-Atlanta, Inc., c, f, i, j.
eburg Corp., The
iscor Mfg. Co., b.
quaia Wire & Cable Co.-Div.-Mandrel Industries, Inc., i.
rvo Corp. of America
ger Mfg. Co., The, Military Products Div., b, e, i.
iatron Electronics & Television Corp., i.
erry Microwave Electronics Co., Div.-Sperry Rand Corp., f, i, j.
erry Piedmont Co. - Div.-Sperry Rond Corp., i, m, n.
ainless Inc., b, f, i, k, l.
avid Engrg., Inc., c, f, i, m, n.
erling Precision Corp., Instrument Div., a, f, n.
and Engrg. Co., f, i, l.
edlow Inc., i.
stems Inc., a, c, f, i, m, n.
mar Electronics, Inc., a, f, h, i, m, n.
pco Group, Thompson Romo Wooldridge Inc., f.
chnical Appliance Corp., b, c, e, f, h, i, m, n.
lectra Industries Corp., a thru n.
lerad Mfg. Corp., f, i.
W. Torngren Co., Inc., i.
nsco Products, Inc., a, c, e, f, i, m, n.
craft Products Corp., a thru n.
rbo Machine Co., b, c, e, f, i, l.
S. Science Corp., Div.-Topp Industries, Inc.
ited States Chemical Milling Corp., i.
tar R. F. & Microwave Co., f.
ginia Electronics Co., Inc., h.
thom Horological Corp., e.
worth Co. Electronics Div., f.
hington Aluminum Co., Inc., b, h, i.
veline, Inc., f.
cor, Inc., Government Div., a, c, d, f, i, m, n.
tbury Electronics Inc., f.
stern Gear Corp., a, b.
stinghouse Electric Corp., f, i.
eeler Laboratories, Inc., f, h, i, m, n.
ks Precision Instrument Co., Inc., a, b, e, f, i, l.
d Turbine Co., k, m, n.
k W Mfg. Corp., l, m.

AN- VIBRATION EQUIPMENT

erican Aeroparts
erican Latex Products Corp.
conda Metal Hose Div., The American Brass Co.
hings, Inc.
veland Pneumatic Industries, Inc.
necticut Hard Rubber Co., The
n Aeronautical Div., T. R. Finn & Co., Inc.
F. Goodrich Industrial Products Co.
ton Industries, Inc.
tt-Robins, Inc.
UDAILLE INDUSTRIES, INC., BUFFALO HYDRAULICS DIV.
. Johnson & Co., Inc.
on Industries, Inc.
on Industries, Morylond Div.
d Mfg. Co.
Mfg. Co.
RAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
ific Scientific Co.
mount Designs Co.
s Engrg. Co., Inc.
inson Technicol Products, Inc.
bercroft Corp. of California
. Stevens Co.
lor Devices, Inc.
ctro Industries Corp.
hite Co., The, Div.-United-Corr Fostener Corp.
. Industries, Inc.
hington Technological Associotes Inc.

APETURE TUBE MASKS
See MASKS, APERTURE, TUBE

ARSHIC

urate Specialties Co. Inc.
rican Dptical Co., Instrument Div.
rican Smelting & Refining Co.
ont Smelting & Refining Works, Inc.
n Metallurgical & Chemicol Co.
ision Lead Co.
Semiconductors, Inc.
ed Minerol & Chemicol Corp.

ASSEMBLERS, FEEDERS

erican Mochine & Foundry Co., Government Products Group
tol Co., The
tronics Div., Von Normon Industries Inc.
***ETS-HOKIN & GALVAN**
Li-Belt Co.
Monogram Precision Industries
Printronics Corp.
Teiner Engrg. Corp.
Walworth Co. Electronics Div.

ASSEMBLIES, EMBEDDED
See EMBEDDED ASSEMBLIES

ASSEMBLIES, MICROWAVE

Adler Electronics, Inc.
Ainslie Carp.
Aircom Inc.
Aircom Inc. of New Jersey
American Machine & Foundry Co., Government Products Group
Antenno & Rodome Research Associotes
Applied Rodiation Carp.
Atlontic Instrument Corp., Sub.-American Electronics, Inc.
Atlas Precision Products, Co.
Bendix Aviation Corp., York Div.
Bristol Co., The
Budd Stonley Co. Inc.
Bulow Electric Co.
Coaxial Connector Co. Inc.
Consolidated Diesel Electric Corp.
Cooper Development Carp., Sub.-Marquordt Aircroft Co.
Demornay-Banardi
Douglas Microwave Co., Inc.
Electrical Insulotion Co., Inc.
Electro-Mechanical Products Co.
Electronic Communicotions, Inc.
Eljoy Corp.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Empire Products Soles Corp.
***ETS-HOKIN & GALVAN**
FXR, Inc.
Gabriel Co., The, Gabriel Electronics Div.
Generol Communication Co.
John Gombos Co., Inc.
Gunnor Loboratories
Walter J. Hyott Co., The
Indusl. Prod.-Danbury Knudsen Div. Amphenal-Borg Electronics Corp.
J-V-M- Microwave Co.
***KEARFOTT CO., INC., MICROWAVE DIV.**
Lemert Engrg. Co., Inc.
Litton Industries, Inc.
W. L. Moxsan Corp., The
Mercury Taal & Mfg. Carp.
Meridion Metalcraft, Inc.
Microlab
Microwave Associates, Inc.
Monogrom Precision Industries
Motorola Inc., Military Electronics Div.
Mutron Corp.
N. R. K. Mfg. & Engrg. Co.
Notional Pneumatic Co., Inc., Holtzer-Cabot Divs.
Omega Labs., Inc.
Philco Carp., Government & Industrial Div.
Polarad Electronics Corp.
Radiatronics, Inc.
Ryan Aeronautical Co.
Scientific-Atlanta, Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Sterling Precision Corp., Instrument Div.
Topco Group, Thompson Romo Wooldridge Inc.
Telectro Industries Corp.
Telerad Mfg. Corp.
Tronsco Products, Inc.
Turbo Machine Co.
Voriety Aircraft Corp.
Victor R. F. & Microwove Co.
Woltham Horological Corp.
Woveline, Inc.
Westinghouse Electric Corp.
Wheeler Loborotories, Inc.
Wilks Precision Instrument Co., Inc.

ASSEMBLIES, NOZZLE
See NOZZLE ASSEMBLIES

ASSEMBLIES, PILOT LIGHT
See PILOT LIGHT ASSEMBLIES

ASSEMBLIES, REDUCTION, GEAR
See GEAR ASSEMBLIES REDUCTION

ASSEMBLIES, SLIP RING
See SLIP RING ASSEMBLIES

ASSEMBLIES, TUBULAR FABRICATIONS
See TUBULAR FABRICATIONS & ASSEMBLIES

ASSEMBLIES, TURBINE
See TURBINE ASSEMBLIES

ASSEMBLY EQUIPMENT, AUTOMATIC

American Mochine & Foundry Co., Government Products Group
Associoted Engineers, Inc.
Atlos Precision Products, Co.
Burklyn Co.
Continentol Technicol Service, Inc.
Diversey Engrg. Co.
Eisler Engrg. Co., Inc.
Koiser Aircroft & Electronics, Div.-Koiser Industries Corp.
Kenhos Corp., Div.
Link-Belt Co.
Philco Corp., Government & Industrial Div.
Pioneer Tool & Engrg. Co.
Printronics Corp.
Robot Industries Inc.
Sheffield Corp., The, Sub.-Bendix Aviotion Corp.
United Shoe Machinery Corp., Drdnonce Dept.

ASSEMBLY SHIELD, NUCLEAR

ACF Industries Inc.
Alpitec, Inc.
Bar-Ray Products, Inc.
Brooks & Perkins, Inc.
Forrel Birmingham Co. Inc.
Generol Electric Co., Missile & Space Vehicle Dept.
Hallett Mfg., Co.
Nuclear Products-Erco Div.-ACF Industries, Inc.
R & R Engrg. Co.
Ryon Aeronautical Co.
Zippertubing Co., The

ATTENUATORS
a. Audio
b. Lagarithmic
c. Microwave
d. Precision
e. RF & IF

Adler Electronics, Inc., e.
Aero Electronics Corp., a.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Aircom Inc., c.
Aircom Inc. of New Jersey, c.
Airtron Inc., Div.-Litton Industries, c.
Alford Mfg. Co., c.
American Machine & Foundry Co., Government Products Graup, c.
Americon Machine & Foundry Co., Greenwich, c, e.
Antenno & Rodome Research Associotes, c, e.
Arenberg Ultrasonic Lab., Inc., b.
Belock Instrument Corp., b.
Blonder-Tongue Labs., Inc., a, e.
Bogart Mfg. Corp., c.
Budd Stonley Co. Inc., c, e.
Centronix Inc., e.
Cinema Engrg., a.
Clippard Instrument Lab., Inc., e.
Coaxiol Connector Co. Inc., c, e.
Cooper Development Corp., Sub.-Morquardt Aircroft Co., c.
Daven Co., The, a, d, e.
Demornay-Bonardi, c, d.
Device Development Corp., e.
Diamand Antenna & Microwave Corp., c, e.
Double E Products Co., e.
Douglos Microwove Co., Inc., c, d.
Dymec Inc., c.
Edgerton, Germeshausen & Grier, Inc., c.
Electronic Applications, Inc., a.
Electron-Radar Products, c.
Elsin Electronics Carp., c, d, e
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., c, d, e.
Empire Products Sales Corp., c, d, e.
Entron, Inc., e.
FXR, Inc., c, d, e.
Filmohm Corp., c.
General Communication Co., c, e.
Groflex Inc., a.
Holler, Roymond & Brown Inc. Div., Singer Mfg. Co., b, e.
Hozeltine Electronics Div.-Hazeltine Corp., c, d, e.
Hewlett-Pockord Co., c, d, e.
Wolter J. Hyott Co., The, c, e.
ITT Federol Div., Internotionol Telephone & Telegroph Corp., a, b, c, e.
ITT Labs., a thru e.
Instruments for Industry, Inc., e.
J-V-M Microwove Co., c, e.
Jovex Electronics, a.
E. F. Johnson Co., e.
Julie Research Labs., Inc., d.
Koy Electric Co., a, d, e.
***KEARFOTT CO., INC., c.**
***KEARFOTT CO., INC., MICROWAVE DIV., c, d, e.**
Lieco, Inc., c, d.
Lockheed Aircraft Corp., Missiles & Spoce Div., c.
W. L. Moxson Corp., The, a, c, e.
Mc Millon Industrial Corp., c.
Meosurements Div., McGraw Edison Co., e.
Meridion Metolcraft, Inc., c, d.
Microlob, c, e.
Microwove Associotes, Inc., c.
Microwove Development Labs., Inc.
Minneapolis-Honeywell Regulotor Co., Industriol Product Group, d.
***MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV., a.**
Monogram Precision Industries, a, c, d, e.
Motorolo Inc., Military Electronics Div., a, c.
NYT Electronics, Inc., a, e.
Nordo Microwove Corp., The, c.
Notionol Pneumatic Co., Inc., Holtzer-Cobot Divs., a, b, d, e.
Dmega Lobs., Inc., c.
Ortho Filter Corp., a, b, e.
Poramount Designs Co,, b, c.
Photo-Crystals, Inc., c.
Polorod Electronics Corp., c.
Portchester Instrument Corp., c.
Precise Development Corp., a, e.
Pyrofilm Resistor Co., Inc., c.
Rodor Design Corp., c.

Resdel Engrg. Corp., e.
Rixon Electronics Inc., d, e.
Sage Labs., Inc., c.
Sage-Craft, Inc., e.
Shallcross Mfg. Co., a, d.
Special Instruments Div., British Industries Corp., c.
Specialty Engrg. & Electronics Co., a.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., c, d.
Sterling Precision Corp., Instrument Div., c.
Stoddart Aircraft Radio Co., Inc., c, d, e.
Suffolk Products Corp., c, e.
H. W. Sullivan Ltd., b, d, e.
Systems Inc., a thru e.
Tapco Group, Thompson Ramo Wooldridge Inc., c.
Telectro Industries Corp., a thru e.
Telerad Mfg. Corp., c.
Telonic Industries, Inc., c, d, e.
Turbo Machine Co., c, e.
University Laudspeakers, Inc., a.
Victor R. F. & Microwave Co., c.
Walworth Co. Electronics Div., e.
Waveline, Inc., c.
Weinschel Engrg., a, c, d, e.
Wilks Precision Instrument Co., Inc., c.
Wright Engrg. Co., c, d, e.
Zenith Optical Laboratory, c, e.

ATTITUDE

Aeronca Mfg. Corp.
American Felt Co.
Cleveland Pneumatic Industries, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Daystrom Pacific Div.-Daystrom, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
*KEARFOTT CO., INC.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Paramount Designs Co.
*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.
Research Controls
Summers Gyroscope Co.
Waldorf Electronics, Div.-F. C. Huyck & Sons

AUDIO CONSOLES
See CONSOLES, AUDIO

AUDIO REMOTE PICKUP
See REMOTE PICKUP, AUDIO

AUTO ALARMS
See ALARMS, AUTO

AUTOMATIC ASSEMBLY EQUIPMENT
See ASSEMBLY EQUIPMENT, AUTOMATIC

AUTOMATIC DEHYDRATORS
See DEHYDRATORS, AUTOMATIC

AUTOMATIC ENGINE CONTROL SYSTEMS
See ENGINE CONTROL SYSTEMS, AUTOMATIC

AUTOMATIC PILOT CONTROL VALVES

Aero Supply Mfg. Inc.
American Measurement & Control, Inc.
*AVCO MFG. CORP., CROSLEY DIV.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix-Pacific Div., Bendix Aviation Corp.
Cadillac Gage Co.
Clary Dynamics
Cleveland Pneumatic Industries, Inc.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Fisher Governor Co.
Futurecraft Corp.
Hamilton Standard, Div.-United Aircraft Corp.
Hydra-Power Corp.
*HYDRO-AIRE CO., DIV.-CRANE CO.
Integral Corp.
Javelin Aircraft Co. Inc.
*KEARFOTT CO., INC.
Kemp Aero Products
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Northrop Corp.
DPW-Jordan
Dzone Metal Products Corp.
Paramount Designs Co.
Pneu-Hydro Valve Corp.
Sargent Engrg. Corp.
Sperry Piedmont Co. - Div.-Sperry Rand Corp.
Summers Gyroscope Co.
Tactair Valve Div.-Aircraft Products Co.
United Aircraft Products, Inc.
Vinson Mfg. Co. Inc.
Waldorf Fluid Systems, Div.-F. C. Huyck & Sons
Westinghouse Electric Corp.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp.

AUTOMATIC PILOTS
See PILOTS, AUTOMATIC

AUTOMATIC PILOTS, ELECTRONIC

*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Atlas Precision Products, Co.
*AVCO MFG. CORP., CROSLEY DIV.
Bendix Aviotion Corp., Eclipse-Pioneer Div.
Cleveland Pneumatic Industries, Inc.
Collins Radio Co.
Daystrom Pacific Div.-Daystram, Inc.
Diversey Engrg. Co.
Donner Scientific Carp.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
ITT Labs.
Javelin Aircraft Co. Inc.
*KEARFOTT CO., INC.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Monogram Precision Industries
Northrop Corp.
Northrop Corp., The, Nortronics Div.
Philco Corp., Government & Industrial Div.
Radiation, Inc.
Ryan Aeronautical Co.
Sanders Associates, Inc.
Servomechanisms, Inc.
Sperry Farragut Co., Div.-Sperry Rand Corp.
Sperry Piedmont Co.-Div.-Sperry Rand Corp.
Summers Gyroscope Co.
Thiokol Chemical Corp.
Westinghouse Electric Corp.
Whittaker Gyro. Div.-Telecomputing Corp.

AUTOMATIC PILOTS, HYDRAULIC

Aerolab Development Co.
American Rocket Co.
Astronautics Engrg. Co.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix Products Div.-Missiles, Bendix Aviation Corp.
Bogue Electric Mfg., Co.
Collins Engrg. Corp.
Consolidated Diesel Electric Corp.
Curtiss-Wright Corp., Research Div.
Diversey Engrg. Co.
Dumont Aircraft Fitting Co.
Eastern Industries Inc.
General Electric Co., Apparatus Sales Div.
Gilfillan Bros. Inc.
Green Rectifier Co.
Hydra-Power Corp.
*KEARFOTT CO., INC.
Land-Air Inc.
Lear, Inc.
Leland Airborne Products, Div.-American Machine & Foundry Co.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Dil-Dyne, Inc.
Pacific Scientific Co.
Pesco Products Div.-Borg-Warner Corp.
Philco Corp., Government & Industrial Div.
Power Supplies Inc.
Ryan Aeronautical Co.
Sargent Engrg. Corp.
Safety Electrical Equipment Corp.
Servomechanisms, Inc.
Sperry Piedmont Co. - Div.-Sperry Rand Corp.
Summers Gyroscope Co.
Turbo Products, Inc.
Washington Technological Associates Inc.
Westinghouse Electric Corp.

AUTOMATIC RESISTANCE COMPARATORS
See COMPARATORS, AUTOMATIC RESISTANCE

AUXILIARY POWER SOURCES

Adel Precision Products of California, Div.-General Metals Corp.
Aeronutronic Systems, Inc., Sub.-Ford Motor Co.
Air Logistics Corp.
*AIRESEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-GARRETT CORP.
Allied International Co.
Amoco Chemicals Corp.
Associated Engineers, Inc.
Astrodyne, Inc.
Atlantic Research Corp.
*BENDIX AVIATION CORP.-HAMILTON DIV.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bendix Utica Div., Bendix Aviation Corp.
Chrysler Corp., Defense Operations Div.
Consolidated Diesel Electric Corp., Western Div.
Cummins Engine Co., Inc.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Utica Div.
Delco-Remy Div., General Motors Corp.
Diversey Engrg. Co.
Eagle-Picher Co., The
Electro Development Corp.
Electro-Mechanical Products Co.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
*ETS-HOKIN & GALVAN
Gearator Corp.
Guided Missile Div.-De Havilland Aircraft of Canada, Ltd.
Gulton Industries, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Hoover Electric Co.
*HYDRO-AIRE CO., DIV.-CRANE CO.
International Fermont Machinery Co., Inc.
Jack & Heintz, Inc.
Jeta, Inc.
Kemp Aero Products
Walter Kidde & Co., Inc., Aviation Div.
Leach Corp.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Leland Airborne Products, Div.-American Machine Foundry Co.
Marquardt Aircraft Co.
*MC CORMICK SELPH ASSOCIATES
Minnesota Mining & Mfg. Co.
Heinz Mueller Eng. Co. Inc.
Motoresearch Co.
National Spectrographic Labs., Inc.
D. W. Dnan & Sons Inc.
Drdnance Div.-Food Machinery & Chemical Corp.
Patterson, Moos Div. - Universal Winding Co., Inc
Perkin Engrg. Corp.
Power Designs Inc.
Power Sources, Inc.
Radiation Research Corp.
Reaction Motors Div., Thiokol Chem. Corp.
Reinhald Engrg. & Plastics Co.
Sargent Engrg. Corp.
Solar Aircraft Co.
Speciol Projects Lab., Food Machinery & Chemic Corp.
Standard Dil Co. of Indiana
Stratos, Div.-Fairchild Engine & Airplane Corp.
Sun Electric Corp., Aeronauticol Div.
Talley Corp., The
Tapco Group, Thompson Ramo Wooldridge Inc.
Technical Apparatus Builders
Thiokol Chemical Corp., Hunter-Bristol Div.
Turbo Products, Inc.
Varo Mfg. Co., Inc.
Vickers Inc., Div.-Sperry Rand
Watertown Div., The New York Air Brake Co.
Western Design, Div.-U. S. Industries, Inc., Sant Barbara Div.
Western Gear Corp.
Winchorger Corp., Sub.-Zenith Radio Corp.

AXIAL FLOW COMPRESSOR ASSEMBLIES
See COMPRESSOR ASSEMBLIES, AXIAL FLOW

AXIAL FLOW MIDFRAME SECTIONS
See MIDFRAME SECTIONS, AXIAL FLOW

BADGES, RADIATION

Acromark Co., The
Adept Industries Inc.
American Electronics, Inc.
*BAUSCH & LOMB OPTICAL CO.
Eastman Kodak Co.
Nuclear-Chicago Corp.
St. John X-Ray Lab.
Specialty Engrg. & Electronics Co.

BAFFLES, AIR

Allied Witan Co. Inc.
Anchor Metal Spinning Co., The
Curtiss-Wright Corp.-Wright Aeronautical Div.
Elzee Metal Products Co., Inc.
Ludwig Honold Mfg. Co.
Kentucky Metal Products Co.
*LAVELLE AIRCRAFT CORP.
Lofstrand Co., The
Mercury Tool & Mfg. Corp.
Monogram Precision Industries
Smith-Morris Corp.
Stanley-Judd Div.-The Stanley Works
Variety Aircraft Corp.

BALANCING EQUIPMENT

American Machine & Foundry Co., Government Products Group
R. B. Annis Co.
Avien, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Dean & Benson Research, Inc.
Decker Corp., The
Dynametrics Corp.
Ensco, Inc.
International Reseorch & Development Corp.
Micro Balancing, Inc.
Pic Design Corp., Sub.-Benrus Watch Co., Inc
Telectro Industries Corp.
Westinghouse Electric Corp.

BALL JOINTS

Allegany Instrument Co., Inc.
American Aeroparts
Amplex Div.-Chrysler Corp.
Barco Mfg. Co.
Capital City Mfg. Co.
Corbin Products Div.
Crystal-X Corp.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Dunbar-Kapple Inc.-Aircraft Components Div.
Flight Refueling, Inc.
Industrial Tectonics, Inc.
Kaydon Engrg. Corp., The
Mercury Air Parts Co., Inc.
Monogram Precision Industries
DPW-Jordan
Radial Bearing Corp.
Rohr Aircraft Corp.

Ryan Aeronouticol Co.
Southwest Products Co.
Stainless Steel Products, Inc.
United Mfg. Co., The
Waste King Corp., Technicol Products Div.

LL LATCHES

Burklyn Co.
Capital City Mfg. Co.
Flight Refueling, Inc.
On Mark Couplings, Inc.

LLISTOCARDIOGRAPHS

Sulton Industries, Inc.
Poce Engrg. Co.

ROGRAPHS

Americon Paulin System
Bendix Aviation Corp., Friez Instrument Div.
Instruments Corp., The
Scientific Instrument Co.

ROMETERS

Airguide Instrument Co.
Americon Paulin System
Bendix Aviation Corp., Friez Instrument Div.
J. Biederman, Inc.
Bristol Co., The
Daystrom Pacific Div.-Daystrom, Inc.
Dynametrics Corp.
Fisher Scientific Co.
Instruments Corp., The
Precision Thermometer & Instrument Co.
Scientific Instrument Co.
Sohling Instrument Co.
Talloce & Tiernon Inc.
Waltham Engrg. Corp.

BAROMETRIC PRESSURE ALTIMETERS
See ALTIMETERS, BAROMETRIC PRESSURE

BASES

a. Antenna
b. Diode
c. Relay
d. Transistor

Aronco Mfg. Corp., a.
Arslie Corp., a.
Allied International Co., a.
Alloys Unlimited Inc., d.
American Car & Foundry, Div.-ACF Industries, Inc., a.
American Machine & Foundry Co., Government Products Group, a.
American Machine & Foundry Co., Greenwich, a.
Anchor Metal Spinning Co., The, a.
Angel Electronics, Inc., c.
Associated Engrg. & Mfg. Corp., d.
Atlas Precision Products, Co., a.
Atlo Seal Co., c.
Automatic Electric Sales Corp., c, d.
Basic Metal Products, Inc., a.
Basic Tool Industries, Inc.
Bendix Aviation Corp., Eclipse-Pioneer Div., a.
Bev. Bliss Co., a.
Bisser Inc., Defense Dept., a.
Boks & Perkins, Inc., a.
Brady Corp., Omoton Div., c.
Cargo Div., Underwood Corp., a.
Capital City Mfg. Co., a.
Chemold Co., a.
Columbia Products Co., a.
Frank R. Cook Co.
Diamond Antenna & Microwave Corp., a.
Electricol Insulation Co., Inc., a, d.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., a.
Fidel Birmingham Co. Inc., a.
Ferrol Machine Co. Inc., j.
Gabriel Co., The, Gobriel Electronics Div.
Hercrafters, a.
Holden Mfg. Co., Inc.
Hilo Manufacturing Corp., a.
Holon Brothers, Inc., b.
Holton Fearless Corp., a.
Homer J. Hyatt Co., The, a.
I-T-E Circuit Breaker Co., a.
ITT Federal Div., International Telephone & Telegraph Corp., a.
Intercontinental Mfg. Co., Inc., a.
Kelay-Hayes Co., a.
Keystone Electronics Corp., b.
Kidde Metal Spinning & Stamping Co., a.
Lenz Inc., a.
Metron Metalcraft, Inc., a, d.
Mel Fabricators Corp., a.
*MAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV., a
Molgram Precision Industries, a, b, c.
Motorola Inc., Military Electronics Div., a, b, d.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., a, b, d.
Norberg Mfg. Co., a.
Perfix Products Div., Chisholm-Ryder Co., Inc., a.
Piasecki Aircraft Corp., a.
Pneumofil Corp., a.
Products Unlimited Inc., a.
Electronics, Inc., a.
Royeon Mfg. Co., Government Equipment Div., a.
Rees Instrument Corp., a.
Riff Ross Metals Co., The, c.
Roy Industries, Inc., a.
Scientific-Atlanta, Inc., a.
Show Metal Products Corp., a.
Sinclair Mfg. Co., b, d.
Smith-Morris Corp.
Specialty Engrg. & Electronics Co., a.
Squiers Gage Co.
Stackpole Carbon Co., a.
Stainless Inc., a.
Stanley-Judd Div.-The Stanley Works, a.
Talley Corp., The, a, b.
Technical Appliance Corp., a.
Teiner Engrg. Corp., a.
Telectro Industries Corp., a.
Tronsco Products, Inc., a.
Tricroft Products Corp., a.
Warren Components, Div. El-Tronics, Inc., b.
Western Gear Corp., a.

BATTERIES

a. Atomic
b. Dry Cell
c. Lead-Acid
d. Mercury
e. Nickel Alkaline
f. Nickel-Cadmium
g. Nuclear
h. Silver
i. Silver Zinc
j. Transistor

Aerojet-General Corp., i.
Allied International Co., b, e.
Bio-Rad Labs., a.
Bowers Battery & Spark Plug Co., c.
Bright Star Industries, b, j.
Burgess Battery Co., b, d, f, j.
Carbone Corp., The, b.
Communications Research Co., f.
Frank R. Cook Co., h. i.
Cooper Industries, Inc.
Delco-Remy Div., General Motors Corp., c, f, i.
Delta Products Div.-Air Accessories, Inc., j.
De Witt Development Co., c.
Eagle-Picher Co., The, e, f, h, i.
Electric Auto-Lite Co., The, c.
Exide Industrial Div.-The Electric Storage Battery Co., b, c, f, m, i.
General American Transportation Corp., j.
General Electric Co., Apparatus Sales Div., g.
Gill Electric Mfg. Corp., c, e.
Greenbrier Instruments Inc., j.
Gulton Industries, Inc., e, f.
Hamilton Watch Co.-Industrial Div., d, f.
Hoffman Electronics Corp., Semiconductor Div., j.
Ludwig Honold Mfg. Co., j.
Internotional Rectifier Corp., f.
Magnovox Co., The, d.
P. R. Mallory & Co. Inc., b, d, i, j.
Morathon Battery Co., b, j.
Meteor Production Engrg., Inc., c.
Minneapolis-Honeywell Regulotor Co., Ordnance Div., b.
National Lead Co.
Nicad Div., Gould-Nationol Batteries, Inc., d, e.
Potterson, Moos Div. - Universal Winding Co., Inc., a, b, g.
Prewitt Aircroft Co., j.
Radiation Reseorch Corp., a, g.
Ray-O-Vac Co., Div.-Electric Storage Bottery Co., a, d, i.
Sonotone Corp., f.
Standard Electric Co., Inc., c.
Turbo Machine Co., j.
United States Chemical Milling Corp., j.
Universal Moulded Products Corp., j.
Whittaker Controls, Div.-Telecomputing Corp., f, i.
Willord Storage Bottery Div., c, h, i.
Yardney Electric Corp., h, i.

BATTERY BOXES, CRADLES, ETC.

Abolon Precision Mfg. Corp.
Aerolite Electronics Corp.
Anchor Metal Spinning Co., The
Cambridge Thermionic Corp.
Chemold Co.
Frank R. Cook Co.
Cooper Industries, Inc.
Crystal-X Corp.
Dayton Rubber Co., The
Elzee Metal Products Co., Inc.
Forwell Metal Fabricating
General American Transportation Corp.
General Scientific Equipment Co.
C. B. Kaupp & Sons, Inc.
Keystone Electronics Corp.
Kirk & Blum Mfg. Co., The
Lofstrond Co., The
Mercury Tool & Mfg. Corp.
Meteor Production Engrg., Inc.
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Piasecki Aircraft Corp.
Plostic Age Sales, Inc.
Pneumafil Corp.
Prereg Mfg. Inc.
Russell Reinforced Plastics Corp.
Scientific-Atlanta, Inc.
Seamless Products Co., Inc.
Shaw Metal Products Corp.
Skyline Products, Inc.
Stanley Aviation Corp.
Vitro Labs.
Vlchek Tool Co., The
Welded Construction Inc.
Winder Aircraft Corp. of Florida
Young Development Div., Hercules Powder Co.

BATTERY CHARGERS
See CHARGERS, BATTERY

BATTERY CHARGING & SERVICING EQUIPMENT

Acme Electric Corp.
Amelco, Inc.
Automatic Switch Co.
Bogue Electric Mfg., Co.
Corol Electronics Corp.
Christie Electric Corp.
Consolidated Diesel Electric Corp., Western Div.
*ETS-HOKIN & GALVAN
Exide Industriol Div.-The Electric Storage Battery Co.
Generol Electric Co., Apparatus Soles Div.
Green Rectifier Co.
Guided Missile Div.-De Havilland Aircroft of Canada, Ltd.
Gulton Industries, Inc.
Hertner Electric Co., The
Homelite, Div.-Textron Inc.
*KEARFOTT CO., INC.
Leitch-Huord Corp.
Leland Airborne Products, Div.-American Machine & Foundry Co.
P. R. Mallory & Co. Inc.
Meteor Production Engrg., Inc.
Sonford Miller Co.
Model Rectifier Corp.
Motor Appliance Corp.
*MOTOR GENERATOR CORP.
Motoresearch Co.
D. W. Onqn & Sons Inc.
Perkin Engrg. Corp.
Power Supplies Inc.
Precise Development Corp.
Radiaphone Co. Inc.
Republic Aviation Corp.
Safety Electricol Equipment Corp.
Schauer Mfg. Corp.
Sel-Rex Corp.
Sun Electric Corp., Aeronouticol Div.
Technical Apparatus Builders
Telectro Industries Corp.
Terado Co.
Westinghouse Electric Corp.
Wincharger Corp., Sub.-Zenith Radio Corp.
Yardney Electric Corp.

BATTERY SERVICING EQUIPMENT

Amelco, Inc.
Bogue Electric Mfg., Co.
Christie Electric Corp.
Frank R. Cook Co.
Electronic Applications, Inc.
*ETS-HOKIN & GALVAN
General Scientific Equipment Co.
Green Rectifier Co.
*KEARFOTT CO., INC.
Meteor Production Engrg., Inc.
Orchard Industries, Inc., Actionflex Div.
Snap-On-Tools Corp.
Technical Apparatus Builders
Winder Aircraft Corp. of Florida

BEACONS, CRASH LOCATOR

ACF Industries Inc.
Aerolab Development Co.
American Aeroports
American Machine & Foundry Co., Government Products Group
American Missile Products Co., Inc.
*AVCO MFG. CORP., CROSLEY DIV.
Bulow Electric Co.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Gilfillon Bros. Inc.
Greer Hydroulics, Inc.
Grimes Mfg. Co.
Hycon Mfg. Co.
ITT Labs.
Lear, Inc.
L E L, Inc.
Litton Industries, Maryland Div.
W. L. Maxson Corp., The
Julion A. Mc Dermott Corp.
Motorola Inc., Military Electronics Div.
*PACKARD-BELL ELECTRONICS CORP.
Philco Corp., Government Industrial Div.
Radiation, Inc.
Raytheon Mfg. Co., Government Equipment Div.
Simmonds Aerocessories, Inc.
Stavid Engrg., Inc.
Telectro Industries Corp.
Telerad Mfg. Corp.

BEACONS, RADAR
See RADAR BEACONS

BEARINGS

a. Ball
b. Ball Miniature
c. Jewel
d. Needle
e. Oiless
f. Rod End

g. Roller
h. Roller Taper
i. Self Aligning
j. Special Purpose

Acorn Bearing Co., a, g, i.
Advance Carbon & Electric Mfg. Co., e.
Allegany Instrument Co., Inc., j.
Alloys Unlimited Inc., b.
Aluminum Co. of America
American Aeroparts, a thru i.
American Machine & Foundry Co., Greenwich, j.
American Standard Products, Inc., i.
Amplex Div.-Chrysler Corp., e, i, j.
Borden Corp., The, a, b, j.
Bearing Inspectian, Inc., a, b, d, f thru j.
Beorium Metals Corp., e.
Beemer Engrg. Co., e.
Bergen Carbide Co., c.
A. Biederman, Inc., a.
Richard H. Bird & Co., Inc., c.
Bonny Mfg. Corp., d, j.
Booker-Cooper, Inc., e, j.
Boston Gear Works, a, e.
Bound Brook Oil-Less Bearing Co., e, i.
Bushings, Inc., e, i, j.
Capital City Mfg. Co., j.
Carbone Corp., The, e, j.
Century Fasteners Corp., a, b, d thru i.
Choin Belt Co., f, g, i, j.
Chemplost, Inc., e.
Chrysler Corp., Defense Operations Div., e, i.
Clevelond Graphite Bronze, Div.-Clevite Corp., f, j.
Collins Engrg. Corp., f.
Corning Glass Works, a.
Crone Pocking Co., d.
Curtiss-Wright Corp.-Wright Aeronautical Div., j.
Dixon Corp., e.
Dodge Mfg. Corp., a, g, h, i.
Dresser Mfg. Div., Dresser Industries, Inc., g, j.
Duotone Co., Inc., d.
Fafnir Bearing Co., The, a, b, f, i, j.
Federal Bearings Co. Inc., The, a, b, i, j.
Fluorocarbon Co., The, e.
Fluorulon Labs., Inc., d, i.
Ford Instrument Co., Div.-Sperry Rand Corp., j.
Freemon Co., The, f.
General Electric Co., Apporatus Soles Div., c.
Gits Brothers Mfg. Co., j.
Graphite Metallizing Corp., e, i, j.
Gwilliam Co., The, a, g, j.
Hamilton Watch Co.-Industrial Div., c, e.
Haveg Industries, Inc., j.
Helwig Carbon Products, Inc., e.
Highland Rim Machine Works Inc., j.
Hyott Bearings Div., Generol Motors Corp., g, i.
Industrial Tectonics, Inc., a, d, f, g, i, j.
Joclin Mfg. Co., e, j.
Kaydon Engrg. Corp., The, a, d, g thru j.
Hugo P. Keller, Jr., c.
Korda Industries, a, b, j.
Landis & Gyr Inc., a, b, f, j.
Link-Belt Co., a, g, i.
Morlin-Rockwell Corp., a, b, f, g, j.
Marman Div., Aeroquip Corp., j.
Mc Gill Mfg. Co. Inc., Bearing Div., d, g, j.
Microtech Corp., Sub.-Federol-Mogul-Bower Bearings, Inc., b, j.
Minioture Precision Beorings, Inc., b, j.
Monarch Beoring Co. Inc., a thru d, f thru i.
Morgonite, Inc., e, j.
Moser Jewel Co., c.
Notionol Beryllio Corp., e, f, g, j.
Notionol Lead Co., i.
New Deporture Div., Generol Motors Corp., a, b, j.
New Hompshire Boll Bearings, Inc., b.
Nice Boll Bearing Co., a, i, j.
Ohio Corbon Co., The, e, j.
Oronge Roller Bearing Co., Inc., d, g, j.
Pic Design Corp., Sub.-Benrus Wotch Co., Inc., a, b, d.
Polymer Corp., The, e, j.
Rodiol Beoring Corp., i.
Rondoll Grophite Beorings, Inc., i, j.
Rawoy Bearing Co., Inc., a, b, d, f, g, i, j.
Reseorch Development Mfg. Inc., j.
Roller Beoring Co. of Americo, d, g, j.
SKF Industries, Inc., a, b, g, h, i.
St. Morys Corbon Co., e, i, j.
Seolmoster Beoring Div., Stephens-Adomson Mfg. Co., a, f, i, j.
Shofer Beorings, Choin Belt Co., e, f, i, j.
Southwest Products Co., e, f, i, j.
Sporto Mfg. Co., Div.-U. S. Ceromic Tile Co., i.
Sphinx-Americon Co., c.
Squiers Goge Co., i, j.
Stockpole Corbon Co., d.
Stein Seol Co., e, j.
Stephens Adomson Mfg. Co., Seol Moster Beoring Div., a, f, i, j.
Sterling Precision Corp., Instrument Div., j.
Swiss Jewel Co., b.
Thermol Refroctories Corp., d, g.
Thermech Engrg. Corp., j.
Timken Roller Beoring Co., The, g.
Torrington Co., The, d, g thru j.
United Stotes Chemicol Milling Corp., j.
United Supply Co., a, e thru h.
Walthom Precision Instrument Co., c.

BELLOW ASSEMBLIES

Accessory Products Co., Div.-Textron Inc.
Aircroft Precision Products, Inc.
Allied Plastics Supply Corp.
Alloy Bellows Inc.
Anaconda Metal Hose Div., The American Brass Co.
Avica Corp.
Bodger Mfg. Co.
***BEATON & CORBIN MFG. CO., THE**
Belfab Corp., The
***BENDIX AVIATION CORP.-HAMILTON DIV.**
Breeze Corporations, Inc.
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co.
Bristol Co., The
California Aircraft Products
Carmac Aviation
Chandler Evans Corp.
Components Corp.
D K Mfg. Co.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Dumont Aircraft Fitting Co.
Dunbar-Kapple Inc.-Aircraft Components Div.
Flexible Metol Hose Mfg. Co.
***FLEXONICS CORP., AERONAUTICAL DIV.**
Flight Refueling, Inc.
Gits Brothers Mfg. Co.
B. F. Goodrich Aviotion Products
Graflex Inc.
Hallett Mfg., Co.
Halley Carburetor Co.
Hydrodyne Corp., Skinner Seal Div.
Internotional Pump & Machine Works
Joclin Mfg. Co.
Korda Industries
Marman Div., Aeroquip Corp.
Mercury Tool & Mfg. Corp.
Drchord Industries, Inc., Actianflex Div.
Parts Engrg. Co., Inc.
Piasecki Aircroft Corp.
Precision Sheet Metal, Inc.
Roymond Engrg. Lab., Inc.
Reflectane Corp., The
Reseorch Appliance Co.
Resistoflex Corp.
C. F. Roark Welding & Engrg, Co., Inc.
Royal Industries, Inc.
Sealol Corp.
Smith-Morris Corp.
Solor Aircroft Co.
Stainless Steel Products, Inc.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Sterling Precision Corp., Instrument Div.
Teiner Engrg. Corp.
Tube-Turns Div., Chemetran Corp.
Turbo Products, Inc.
United Electric Controls Co.
U. S. Flexible Metallic Tubing Co.
United States Chemical Milling Corp.
Variety Aircraft Corp.
Woste King Corp., Technical Products Div.
Wilks Precision Instrument Co., Inc.
Zolleo Brothers

BELLOWS

Accessory Products Co., Div.-Textron Inc.
Aircroft Precision Products, Inc.
Allied Plostics Supply Corp.
Alloy Bellows Inc.
Anocondo Metol Hose Div., The Americon Bross Co.
Bodger Mfg. Co.
Belfob Corp., The
***BENDIX AVIATION CORP.-HAMILTON DIV.**
Breeze Corporotions, Inc.
Bridgeport Thermostot Div., Robertshaw-Fulton Controls Co.
Bristol Co., The
Californio Aircroft Products
Chicogo Gosket Co.
Clevelond Grophite Bronze, Div.-Clevite Corp.
Coloniol Rubber Co.
Components Corp.
Continentol Rubber Works
Diversey Engrg. Co.
Dunbor-Kopple Inc.-Aircroft Components Div.
Eagle Electric Mfg. Co. Inc.
Emerson Plostics Corp.
Engrg. Developments, Inc.
Flexible Metol Hose Mfg. Co.
***FLEXONICS CORP., AERONAUTICAL DIV.**
Flight Refueling, Inc.
Fluorocorbon Co., The
B. F. Goodrich Aviotion Products
Groflex Inc.
Hydrodyne Corp., Skinner Seol Div.
Joclin Mfg. Co.
Drchord Industries, Inc., Actionflex Div.
Pic Design Corp., Sub.-Benrus Wotch Co., Inc.
Ports Engrg. Co., Inc.
Precision Sheet Metol, Inc.
Resistoflex Corp.
C. F. Roork Welding & Engrg. Co., Inc.
Fred T. Roberts & Co.
Royal Industries, Inc.
Rubbercroft Corp. of Colifornio
Seolol Corp.
Smith-Morris Corp.
Solor Aircroft Co.
Stainless Steel Products, Inc.
Standard-Thamson Corp., Clifford Mfg. Co. Div.
Teiner Engrg. Corp.
Turbo Products, Inc.
United Electric Controls Co.
U. S. Flexible Metollic Tubing Co.
United States Rubber Co.
Walthom Engrg. Corp.
Waste King Corp., Technical Products Div.
Zolleo Brothers

BELLS & BUZZERS

Automatic Electric Sales Corp.
Coble Electric Products Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.

BELTS, DIAL DRIVE

General Americon Transportation Corp.
Gerierol Plostics Corp. of New Jersey
Miltan Ross Metals Co., The
A. T. Stevens Co.
United States Rubber Co.

BENCHES & STOOLS
See STOOLS & BENCHES

BEZELS

Adept Industries Inc.
Aerolite Electronics Corp.
Allied Plastics Supply Corp.
Capitol City Mfg. Co.
Carmody Corp.
Craname Inc.
Diversey Engrg. Co.
Elzee Metal Products Co., Inc.
Etched Products Corp.
Hamilton Watch Co.-Industrial Div.
Jon Hardware Mfg. Co., Inc.
Kling Metal Spinning & Stamping Co.
Kollmorgen Optical Corp.
Maryland Etching Co. Inc.
Sterling Glass Corp.
Wilks Preciston Instrument Co., Inc.

BIMETAL, THERMOSTATIC

Americon Silver Co.
Bram Metallurgical & Chemical Co.
Bridgepart Bross Co.
Carpenter Steel Co., The
Components Corp.
Engelhord Industries, Inc.
Metals & Controls Corp., General Plote Div.
Scoico Controls, Inc.
United Aircroft Products, Inc.

BINDERS, LIQUID

Grant Chemical Co., Inc.
Monogram Precision Industries
United Stotes Rubber Co.

BINDING POSTS

Accurate Electronics Corp., Dept. D
Aerolite Electronics Corp.
Amotom Electronic Hordwore Co. Inc.
Boldwin Mfg. Co. Inc., The
Double E Products Co.
Eastern Speciolty Co., The
Elco Corp.
Electro-Tech Equipment Co.
GAR Mfg. Corp.
Grophite Metollizing Corp.
Hewlett-Pockord Co.
E. F. Johnson Co.
Litton Industries, U. S. Engrg. Co., Div.
Molco Mfg. Co.
Minnesoto Mining & Mfg. Co.
Notionol Pneumatic Co., Inc., Holtzer-Cabot Divs
Notionol Tel-Tronics Corp.
North Electric Co.
Milton Ross Metols Co., The
Standord Electric Time Co., The
Superior Electric Co., The
Technicol Apporotus Builders
Telectro Industries Corp.
Woldom Electronics Inc.

BINS

Anchor Metol Spinning Co., The
Chemold Co.
Elzee Metol Products Co., Inc.
Frick Gollogher Mfg. Co., The
Generol Box Co.
Hewitt-Robins, Inc.
Kirk & Blum Mfg. Co., The
Mid-West Metol Products, Inc.
R & R Engrg. Co.
Richordson Scole Co.
Stoinless Inc.

BLADDERS, FUEL

Allied Plostics Supply Corp.
Aviators Equipment Corp.
Berger Brothers Co., The
Dresser Mfg. Div., Dresser Industries, Inc.
Fluorulon Labs., Inc.
B. F. Goodrich Aviotion Products
Goodyeor Tire & Rubber Co., The, Aviotion Pro Div.
Joclin Mfg. Co.

Minnesota Mining & Mfg. Co.
United States Rubber Co.
Wolbar Machine Products Inc.

LADES
a. Compressor
b. Hacksaw
c. Stator
d. Turbine

Allen Tool Corp., a, c.
Allis-Chalmers, a, d.
Aluminum Co. of America, d.
Astronautics Engrg. Co., d.
Austenal Co., Div.-Howe Sound Co., Micracast Products, a, c, d.
Barrett-Christie Co., b.
Capewell Mfg. Co., b.
Christie Machine Works, d.
Curtiss-Wright Corp.-Propeller Div., a, c, d.
Dresser Industries, Inc., a, d.
Eotan Mfg. Co., Aircroft Div., a thru d.
Engelhard Industries Inc., D. E. Makepeace Div., a, c, d.
Ferrotherm Co., The, c.
Fletcher Mfg. Co., Inc., The, a, c, d.
Forsberg Mfg., Co., The, a.
Haynes Stellite Co., Div.-Union Corbide Carp., a, c, d.
Houston Fearless Corp., c, d.
Jorvis Carp., a, c, d.
Kelsey-Hayes Co., a, c, d.
Kolcost Industries-Div. Thampson Romo Wooldridge Inc., a, c, d.
Ladish Co., a thru d.
Lopointe Machine Tool Co., The, a, c, d.
Marman Div., Aeroquip Carp., d.
Mercury Tool & Mfg. Corp., a, d.
Misco Precision Casting Co., a, c, d.
Heinz Mueller Eng. Co. Inc., c.
National Beryllio Carp., a, d.
Parker-Hartford Corp., The, a, c, d.
Precision Castparts Carp., a, c, d.
Precision Shapes, Inc., a, c, d.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV., a, c, d.**
Schellens-True Corp., a, c, d.
Simonds Saw & Steel Co., b.
Snap-On-Tools Corp., b.
Solar Aircraft Co., a, c, d.
Stalker Corp., The, a, c, d.
Steel Impravement & Forge, The, a, c, d.
Talley Carp., The, a, c, d.
Tapco Group, Thompson Ramo Wooldridge Inc., a, c, d.
Therm, Inc., a, c, d.
Thermal Refractories Carp., a, d.
Transmares Corp., b.
Turba Products, Inc., a, c, d.
Universal-Cyclops Steel Corp., a, d.
Veet Industries, a, c, d.
Valbar Machine Products Inc., b, c.
Westinghouse Electric Corp., a, c, d.

LAST DEFLECTOR, PADS & TUBES

Air Logistics Corp.
American Machine & Foundry Co., Government Products Group
American Machine & Faundry Co., Greenwich
Bil-Jax Inc.
Cleveland Pneumatic Industries, Inc.
Curtiss-Wright Corp.-Utica Div.
Deon Products, Inc.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Dynamic Devices, Inc.
Dyno-Therm Chemical Corp.
E. W. Gallaway Co.
Haveg Industries, Inc.
Harquardt Aircraft Co.
Mercury Tool & Mfg. Corp.
Minnesato Mining & Mfg. Co.
Monogram Precision Industries
National Beryllia Corp.
Newbrook Machine Carp.
Norton Co., New Products Dept.
Opeliko Welding, Mochine & Supply Inc.
Ordnance Div.-Food Mochinery & Chemical Corp.
Portland Capper & Tank Works Inc.
Raybestas-Manhattan, Inc., Pa.
Schw. Renneburg & Sons Co.
Tyon Aeranautical Co.
Space Corp.
Stainless Inc.
Swedlow Inc.
Thermal Refractaries Corp.
Ward Inc.
Washington Technalogical Associates Inc.
Wayne Pump Co., The, Div.-Symington Wayne Carp.
Zippertubing Co., The

END RIVETS
See RIVETS, BLIND

ESTERS

Adept Industries Inc.
Flowers Inc.
Gamalite Corp., The
Gamtex Industries, Inc.
Mercury Tool & Mfg. Carp.
Minnesata Mining & Mfg. Ca.
National Pneumatic Co., Inc., Haltzer-Cabot Divs.
Plastic Age Sales, Inc.
Swedlow Inc.
Tel-Labs, Inc.

BLOCKS, TERMINAL
See TERMINAL BLOCKS

BLOWERS, MOTOR & GENERATOR

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
American Aeroparts
American Electranics, Inc.
Bendix-Pacific Div., Bendix Aviation Corp.
Blowers Inc.
Bogue Electric Mfg., Co.
Clarage Fan Co.
Curtiss-Wright Corp., Santa Barbora Div.
Dalmator Div., Yubo Consolidated Industries, Inc.
Eastern Industries Inc.
Globe Industries, Inc.
Hoover Electric Co.
***HYDRO-AIRE CO., DIV.-CRANE CO.**
ILG Electric Ventiloting Co.
Instrument Mators
Joy Mfg. Co.
Leiman Brathers, Inc.
Lundy Mfg. Carp.
McLeon Engrg. Labaratories
Monagram Precision Industries
Heinz Mueller Eng. Ca. Inc.
National Pneumatic Ca., Inc., Holtzer-Cabat Divs.
Redmond Co., Inc.
Ripley Co., Inc.
Ratan Mfg. Ca.
Small Mators Inc.
Talley Corp., The
Task Corp.
Thompsan Engrg. Ca., The, Missile Products Div.
Torrington Mfg. Co. Inc., The, Specialty Blower Div.
United Aircraft Products, Inc.
Western Design, Div.-U.S. Industries, Inc.; Sonto Barbara Div.
Western Gear Carp.

BLOWERS, SMALL

Air Logistics Corp.
***AIRESEARCH MFG. CO., DIV., THE GARRETT CORP.**
Air-Marine Motors, Inc.
American Aeroparts
American Electronics, Inc.
Ashland Electric Products, Inc.
Barber-Colmon Co.
Bendix-Pacific Div., Bendix Aviotion Corp.
Blowers Inc.
Chicogo Aerial Industries, Inc.
Clorage Fan Ca.
Coppus Engrg. Carp.
Curtiss-Wright Carp., Santa Barbora Div.
Dalmotar Div., Yuba Consalidated Industries, Inc.
Dean & Benson Research, Inc.
Eastern Industries Inc.
Eicor Div.-Scranton
El Ray Motor Co., Inc.
Fuller Co.
Gorden City Fan Co.
Glabe Industries, Inc.
Hoover Electric Co.
ILG Electric Ventiloting Co.
Induction Motors Carp.
JEM Electronics Corp.
Joy Mfg. Ca.
Lundy Mfg. Corp.
McLean Engrg. Labaratories
Heinz Mueller Eng. Ca. Inc.
Natianal Pneumatic Co., Inc., Haltzer-Cabot Divs.
Natianal Spectragraphic Labs., Inc.
Peerless Electric Ca., The
Redmand Ca., Inc.
Ripley Co., Inc.
Rotron Mfg. Co.
Sanders Associates, Inc.
Talley Corp., The
Task Corp.
Technical Apparatus Builders
Teiner Engrg. Carp.
Thampson Engrg. Ca., The, Missile Products Div.
Torringtan Mfg. Co. Inc., The, Specialty Blower Div.
Turbo Products, Inc.
Universal Dynomics Corp.
Wenzlau Engrg. Co.
Western Design, Div.-U.S. Industries, Inc.; Santa Barbara Div.
Western Geor Corp.

BLOWERS, TRANSMITTER

Air-Marine Matars, Inc.
Bendix-Pacific Div., Bendix Aviation Carp.
Bud Radia Inc.
Dean & Bensan Research, Inc.
Haaver Electric Co.
ILG Electric Ventilating Co.
Joy Mfg. Co.
Heinz Mueller Eng. Ca. Inc.
Redmond Ca., Inc.
Ripley Ca., Inc.
Rotron Mfg. Co.
Talley Corp., The
Technical Apparatus Builders
Torringtan Mfg. Co. Inc., The, Specialty Blower Div.
Western Gear Carp.

BOARDS, CAPACITOR OR RESISTOR

Accurote Electronics Corp., Dept. D
Adept Industries Inc.
Aerolite Electranics Corp.
Airtranics Internationol Corp.
Corl H. Biggs Co.
Centralab, Div.-Glabe-Unian
Dalmare Carp.
Detronic Industries
Daty Acaustica Electronic Labs.
Double E Products Co.
Dresser Industries, Inc.
Electrical Insulation Ca., Inc.
Electro-Mechanical Products Co.
Gladding, McBean & Co.
Ludwig Honald Mfg. Co.
Julie Research Labs., Inc.
Littan Industries, U.S. Engrg. Co., Div.
Minnesota Mining & Mfg. Co.
Notional Beryllia Carp.
National Pneumatic Ca., Inc., Haltzer-Cobot Divs.
Notionol Tel-Tronics Corp.
Projects Unlimited Inc.
Q-Circuits, Div.-Etching Co. of Calif.
Tri-Dex Co.

BOARDS, PLOTTING

Accurate Electronics Corp., Dept. D
Adept Industries Inc.
Allied Plastics Supply Corp.
Bensan-Lehner Corp.
Braaks & Perkins, Inc.
Carmody Carp.
Double E Products Co.
Durolith Corp.
Electro Instruments, Inc.
Electromath Corp.
Eljay Corp.
Emeloid Ca., Inc., The
Hamalite Carp., The
ITT Labs.
Milgo Electronic Carp.
F. L. Mosley Co.
Motorola Inc., Military Electranics Div.
Nuclear Products-Erco Div.-ACF Industries, Inc.
Seiscar Mfg. Ca.
Serva Corp. of America
Skiatron Electronics & Televisian Corp.
Specialty Engrg. & Electranics Ca.
Virginia Plak Co.

BOARDS, PLUG

Accurate Electranics Corp., Dept. D
Aeralite Electranics Corp.
Anton Electronic Labs., Inc.
Automatic Electric Sales Corp.
Danner Scientific Co.
Eastern Specialty Co., The
Electrical Insulotion Ca., Inc.
Electromath Carp.
***ETS-HOKIN & GALVAN**
Hamolite Corp., The
Hydra Molding Ca., Inc.
Manogram Precision Industries
National Pneumatic Co., Inc., Holtzer-Cabat Divs.
National Tel-Tranics Corp.
Pilgrim Products Inc.
Projects Unlimited Inc.
Spaulding Fibre Co., Inc.
Virginia Electronics Co., Inc.

BOARDS, TERMINAL
See TERMINAL BOARDS

BOBBINS, COIL WINDING

Advanced Electronics, Inc.
Alden Products Co.
American Molded Products Co.
Automatic Electric Sales Corp.
Banny Mfg. Corp.
Centralab, Div.-Globe-Unian
Chemplast, Inc.
Coil Co. of America
Cantinental Diamand Fibre Carp.
Electro-Mechanicol Products Co.
Emersan Plastics Carp.
Form-It Products, Inc.
Franklin Fibre-Lamitex Carp.
Garde Mfg. Co.
Gladding, McBean & Co.
Hays Mfg. Ca.
Hamalite Corp., The
Hydra Malding Co., Inc.
Isalantite Mfg. Carp.
Knopp Inc.
Lamtex Industries, Inc.
Lane Star Plastics Ca. Inc.
Maryland Lava Ca.
Minneapalis-Honeywell Regulatar Co., Boston Div.
Molding Carp. of America
National Cail Co.
National Pneumatic Co., Inc., Haltzer-Cabot Divs.
Peerless Products Industries
Penn Fibre & Specialty Co., Inc.
Perry Plastics, Inc.
Pilgrim Products Inc.
Q. O. S. Corp.
Rallan Electric Co.
Miltan Ross Metals Ca., The
Sanford Plastics Carp.
Silicane Insulation, Inc.

Slip Ring Co. of America
Stanley-Judd Div.-The Stanley Works
Stevens Products, Inc.
Tapper Mfg. Co., Inc.

BOBBINS, TRANSFORMER WINDING

American Molded Products Co.
Bonny Mfg. Corp.
Coil Co. of America
Continental Diamond Fibre Corp.
Emerson Plastics Corp.
Franklin Fibre-Lamitex Corp.
Homalite Corp., The
Hydra Molding Co., Inc.
Knapp Inc.
Lamtex Industries, Inc.
Lone Star Plastics Co. Inc.
Maryland Lava Co.
Molding Corp. of America
National Coil Co.
National Pneumatic Co., Inc., Haltzer-Cabat Divs.
Milton Ross Metals Co., The
Silicane Insulation, Inc.
Slip Ring Co. of America
Stevens Products, Inc.
Topper Mfg. Co., Inc.

BOLT CARTRIDGES, EXPLOSIVE

Aero Bolt & Screw Co., Inc.
American Standard Products, Inc.
Atlantic Research Corp.
Beckman & Whitley, Inc., Missile Products Div.
Components Corp.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Horkey-Moore Associates
***MC CORMICK SELPH ASSOCIATES**
Olin Mathieson Chemical Corp., Energy Div.
***PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.**
Thiokol Chemical Corp., Hunter-Bristol Div.

BOLTS, EXPLOSIVE

***MC CORMICK SELPH ASSOCIATES**

BOLTS, LOCK

Abbott Screw & Mfg. Co.
Aero Bolt & Screw Co., Inc.
American Aeroparts
American Standard Products, Inc.
Bland Burner Co., The
Capital City Mfg. Co.
Century Fasteners Corp.
Chandler Products Corp.
Corbin Products Div.
Eaton Mfg. Co., Reliance Div.
Highland Rim Machine Works Inc.
Hi-Shear Rivet Tool Co.
Huck Mfg. Co.
Lomson & Sessions Co., The
Lucas Aircraft Supply Co.
Mercury Air Parts Co., Inc.
Monogram Precision Industries
National Screw & Mfg. Co., The
Republic Steel Corp.
Standard Pressed Steel Co.
Stanley-Judd Div.-The Stanley Works
***TOWNSEND CO., CHERRY RIVET DIV.**
Western Automatic Machine Screw Co., Div.-Standard Screw Co.

BOLTS, SPADE

Abbott Screw & Mfg. Co.
Amatom Electronic Hardware Co. Inc.
American Aeroparts
Atlas Screw & Specialty Co.
Capital City Mfg. Co.
Century Fasteners Corp.
Corbin Products Div.
H. M. Harper Co.
Lucas Aircraft Supply Co.
Monogram Precision Industries
National Screw & Mfg. Co., The
Stanley-Judd Div.-The Stanley Works
Teiner Engrg. Corp.

BOLTS, TOGGLE OR EXPANSION

Abbott Screw & Mfg. Co.
Ackerman Johnson Co.
Allmetal Screw Products Co., Inc.
American Aeroparts
Anchor Metal Spinning Co., The
Arro Expansion Bolt Co.
Atlas Screw & Specialty Co.
Barrett-Christie Co.
Chase Brass & Copper Co., Inc.
Highland Rim Machine Works Inc.
Hi-Shear Rivet Tool Co.
Holub Industries, Inc.
Lucas Aircraft Supply Co.
Monogram Precision Industries
National Screw & Mfg. Co., The
Republic Steel Corp.
Stanley-Judd Div.-The Stanley Works
Star Expansion
United Supply Co.

BONDING JUMPERS
See JUMPERS, BONDING

BONDING MATERIALS

American Felt Co.
Carl H. Biggs Co.
Carda Chemical Carp.
Corning Glass Works
***DOW CORNING CORP.**
Dresser Mfg. Div., Dresser Industries, Inc.
Dyna-Therm Chemical Carp.
B. F. Gaadrich Industrial Products Co.
Gaadyear Tire & Rubber Co., The, Aviation Products Div.
Grant Chemical Co., Inc.
Haveg Industries, Inc.
Homalite Carp., The
Kaiser Metal Products, Inc.-Fleetwings Div.
Lamtex Industries, Inc.
Leiman Brothers, Inc.
Lord Mfg. Co.
Minnesata Mining & Mfg. Co.
Managram Precision Industries
National Beryllia Corp.
Shell Chemical Carp., Industrial Chemicals Div.
Silicanes Div.-Unian Carbide Carp.

BOOSTERS, GAS PRESSURE

Accessory Controls & Equipment Corp.
Associated Engineers, Inc.
Astrodyne, Inc.
Dynamic Devices, Inc.
Greer Hydraulics, Inc.
Hannifin Co., Div.-Parker-Hannifin Corp.
Haskel Engrg. & Supply Co.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Intercontinental Mfg. Co., Inc.
Kaiser Metal Products, Inc. - Fleetwings Div.
M. W. Kellogg Co., The
***MC CORMICK SELPH ASSOCIATES**
Newbrook Machine Corp.
Pressed Steel Tank Co.
Reaction Motors Div., Thiokol Chem. Corp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Sargent Engrg. Corp.
Universal Moulded Products Corp.
Wayne Pump Co., The, Div.-Symington Wayne Corp.

BOOSTERS, MISSILE, LIQUID FUELED

Aerojet-General Corp.
Alco Products, Inc.
Associated Engineers, Inc.
Chrysler Corp., Defense Operations Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Dynamic Devices, Inc.
Fulton-Irgon Corp., The
General Electric Co., Apparatus Sales Div.
Hicks Corp., The
Hydrodyne Corp., Skinner Seal Div.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kaiser Metal Products, Inc. - Fleetwings Div.
M. W. Kellogg Co., The
Newbrook Machine Corp.
Pressed Steel Tank Co.
Reaction Motors Div., Thiokol Chem. Corp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Special Projects Lab., Food Machinery & Chemical Corp.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Thiokol Chemical Corp.
Universal Moulded Products Corp.
Wayne Pump Co., The, Div.-Symington Wayne Corp.

BOOSTERS, MISSILE, SOLID FUELED

Aerojet-General Corp.
Aerolab Development Co.
Alco Products, Inc.
American Rocket Co.
Associated Engineers, Inc.
Astrodyne, Inc.
Atlantic Research Corp.
Bridgeport Brass Co.
Chrysler Corp., Defense Operations Div.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Dynamic Devices, Inc.
Dyna-Therm Chemical Corp.
Fulton-Irgon Corp., The
General Box Co.
General Electric Co., Apparatus Sales Div.
Goodyear Aircraft Corp.
Hohn & Clay
Hicks Corp., The
Hinde & Dauch Div.-West Virginia Pulp & Paper Co.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Intercontinental Mfg. Co., Inc.
Kanarr Corp.
M. W. Kellogg Co., The
***MC CORMICK SELPH ASSOCIATES**
Mercury Tool & Mfg. Corp.
Newbrook Machine Corp.
Norris-Thermador Corp.
Oerlikon Tool & Arms Corp. of America
Olin Mathieson Chemical Corp., Energy Div.
Portland Copper & Tank Works Inc.
Pressed Steel Tank Co.
Republic Aviation Corp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Raberts Industries Inc.
Rahm & Haas Co., Redstone Arsenal Research Div.
Spaulding Fibre Co., Inc.
Thiokal Chemical Carp.
Wayne Pump Co., The, Div.-Symington Corp.
Winder Aircraft Corp. of Florida

BOOTHS, DECONTAMINATION

***HAWS DRINKING FAUCET CO.**

BOXES

A&P Metal Products Mfg. Carp.
Abalon Precision Mfg. Corp.
Alpitec, Inc.
Aluminum Co. of America
American Aeraparts
American Aluminum Co.
Anchor Metal Spinning Co., The
Brooks & Perkins, Inc.
Bud Radio Inc.
Carmady Corp.
Albert H. Cayne Equipment Corp.
Champion Co., The
Chemold Co.
Chicago Molded Products Corp.
Eckol Packaging Co.
Electro-Mechanical Products Co.
Elzee Metal Products Co., Inc.
***ETS-HOKIN & GALVAN**
Falstrom Co.
Farwell Metal Fabricating
Ferris-Mfg. Co., The
Fletcher Mfg. Co., Inc., The
General American Transportation Corp.
General Box Co.
Greenbrier Instruments Inc.
Hardman Tool & Engrg. Co.
Hinde & Dauch Div.-West Virginia Pulp & Paper Co.
Kirk & Blum Mfg. Co., The
Ludwig Honold Mfg. Co.
Meridian Metalcraft, Inc.
Mid-West Metal Products, Inc.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
Muckle Mfg. Co.
National Pneumatic Co., Inc., Haltzer-Cabot Divs.
Plastic Age Sales, Inc.
Rimak, Inc.
Seamless Products Co., Inc.
Skydyne, Inc.
Skyline Products, Inc.
Swedlow Inc.
United Supply Co.
Young & Rioux Woodworking Co., Inc.

BOXES, BATTERY, CRADLES, ETC.
See BATTERY BOXES, CRADLES, ETC.

BOXES, JUNCTION

A&P Metal Products Mfg. Corp.
Abalon Precision Mfg. Corp.
Aerolite Electronics Corp.
Anchor Metal Spinning Co., The
Bell & Howell Co.
Brooks & Perkins, Inc.
Bud Radio Inc.
Calfibe Co., Inc.
Chrysler Corp., Defense Operations Div.
Consolidated Productions, Inc.
Crouse-Hinds Co.
Daven Co., The
Dayton Aviation Radio & Equipment Corp.
Electro-Mechanical Products Co.
Elzee Metal Products Co., Inc.
***ETS-HOKIN & GALVAN**
Federal Mfg. & Engrg. Corp.
Ferris-Mfg. Co., The
Firestone Tire & Rubber Co., The, Guided Missile Div.
Fletcher Mfg. Co., Inc., The
General Box Co.
General Electric Co., Apparatus Sales Div.
Hardman Tool & Engrg. Co.
Hoffman Engrg. Corp.
Homalite Corp., The
ITT Federal Div., International Telephone & Telegraph Corp.
Javex Electronics
Kirk & Blum Mfg. Co., The
***LAVELLE AIRCRAFT CORP.**
Litton Industries, Inc.
Ludwig Honold Mfg. Co.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Roberts Industries Inc.
Russell Reinforced Plastics Corp.
Ryan Aeronautical Co.
Sequoia Wire & Cable Co., Div.-Mandrel Industries, Inc.
Skyline Products, Inc.
Swedlow Inc.
Teiner Engrg. Corp.

Telectra Industries Corp.
Twin Coach Co., Aircraft-Missiles
United Supply Co.
Universal Maulded Products Corp.
Variety Aircraft Corp.
Waugh Engrg. Co.

BOXES & PANELS, JUNCTION
See **JUNCTION BOXES & PANELS**

BOXES, STORAGE

A&P Metal Products Mfg. Corp.
Abalan Precision Mfg. Corp.
Aluminum Co. of America
Anchor Metal Spinning Co., The
Brooks & Perkins, Inc.
Cormady Corp.
Albert H. Coyne Equipment Corp.
Champion Co., The
Chemold Co.
Chicago Molded Products Corp.
Continental Diamand Fibre Corp.
Curtiss-Wright Corp., Research Div.
Eckal Packaging Co.
Ecanaweld Corp.
Elzee Metal Products Co., Inc.
Ferris-Mfg. Co., The
Fletcher Mfg. Co., Inc., The
General American Transportation Corp.
Hinde & Dauch Div.-West Virginia Pulp & Paper Co.
Ludwig Honold Mfg. Co.
Intercontinental Mfg. Co., Inc.
M. W. Kellog Co., The
Kirk & Blum Mfg. Co., The
H. Koch & Sons
Lyon Van & Storage Co., Aircraft Div.
Metal-Glass Products Co.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
Muckle Mfg. Co.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Precision Sheet Metal, Inc.
Pry Welding & Mfg., Inc.
Russell Reinforced Plastics Corp.
Skyline Products, Inc.
Swedlow Inc.
Teiner Engrg. Corp.
Texas Metal & Mfg. Co., Inc.
Twin Coach Co., Aircraft-Missiles
United Supply Co.
Washington Aluminum Co., Inc.

RACKETS, HARDWARE

Abalon Precision Mfg. Corp.
Aerolite Electronics Corp.
Aeronca Mfg. Corp.
All Products Co.
Alpitec, Inc.
Amatom Electronic Hardware Co. Inc.
American Aeroparts
Anchor Metal Spinning Co., The
Basic Tool Industries, Inc.
Bud Radio Inc.
Burklyn Co.
Capital City Mfg. Co.
Colonial Aircraft Corp.
Cooper Industries, Inc.
Diversey Engrg. Co.
Double E Products Co.
EMMCO Plastic Fabricators - Div.-E. M. McCarthy Machine Co.
Ferris-Mfg. Co., The
Fletcher Mfg. Co., Inc., The
GAR Mfg. Corp.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
M. W. Kellogg Co., The
Keystone Electronics Corp.
Mercury Tool & Mfg. Corp.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
Piasecki Aircraft Corp.
Raythean Mfg. Co.
C. F. Roark Welding & Engrg. Co., Inc.
Stanley-Judd Div.-The Stanley Works
TA Mfg. Corp.
Teiner Engrg. Corp.
Wind Turbine Co.

RACKETS, MOUNTING

A&P Metal Products Mfg. Corp.
Abalon Precision Mfg. Corp.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Aeroparts
Anchor Metal Spinning Co., The
Automatic Electric Sales Corp.
B. H. Aircraft Co., Inc.
Bruce Engrg. Co.
Bud Radio Inc.
Capitol City Mfg. Co.
Colonial Aircraft Corp.
Detronic Industries
Diversey Engrg. Co.
Electro-Mechanical Products Co.
Elzee Metal Products Co., Inc.
Falstrom Co.
Farwell Metal Fabricating
Ferris-Mfg. Co., The
Firestone Tire & Rubber Co., The, Guided Missile Div.
Gar Mfg. Corp.
Highland Rim Machine Works Inc.
Hobsan Brothers, Inc.
Ingersall Kalamazoo Div., Barg-Worner Corp.
M. W. Kellogg Co., The
Keystone Electronics Corp.
Kirk & Blum Mfg. Co., The
Mercury Tool & Mfg. Carp.
Mid-West Metal Products, Inc.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
Newton Hydraulic Tooling Co.
Piosecki Aircraft Carp.
Pneumafil Corp.
C. F. Raork Welding & Engrg. Co., Inc.
Skinner Precision Products
Smith-Morris Corp.
Stanley-Judd Div.-The Stanley Works
TA Mfg. Corp.
Teiner Engrg. Carp.
Variety Aircraft Corp.
Vectar Electranic Co.
Washington Aluminum Ca., Inc.
Winder Aircraft Corp. af Flarida

BRAKE CONTROL UNITS

B. F. Goodrich Aviation Products
Green Rectifier Co.
Hoover Electric Co.
Hydra-Power Corp.
Sargent Engrg. Corp.
Teiner Engrg. Corp.
Weston Hydroulics Ltd.-Sub., Borg-Warner Corp.

BRAKE DRUM

American Aeroparts
Dresser Mfg. Div., Dresser Industries, Inc.
B. F. Goodrich Aviation Products
Kelsey-Hayes Co.
Mercury Tool & Mfg. Corp.
Rockwell-Standard Corp.

BRAKE LININGS

American Aeroparts
American Brake Shoe Co.
Auto Specialties Mfg. Co., Inc.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Gatke Corp.
B. F. Goodrich Aviation Products
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Johns-Manville
Johns-Manville Sales Corp.
National Beryllia Corp.
Raybestos-Manhattan, Inc.
Raybestos-Manhattan, Inc., Pa.
Thermal Refractories Corp.

BRAKES
a. Electrical
b. Magnetic
c. Mechanical
d. Pneumatic

Airborne Accessories Corp., **b, c.**
All American Engrg. Co., **c.**
American Aeroparts, **c. d.**
American Steel Foundries, Hammond Div., **c.**
Atlantic Instrument Corp., Sub.-American Electronics, Inc., **c, d.**
Auto Specialties Mfg. Co., Inc., **b, c, d.**
Autotronics Inc., **b.**
Beaver Precision Products Inc., **c.**
Belock Instrument Corp., **b.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., c.**
Bowmar Instrument Corp., **c.**
Burton-Rodgers, Inc., **a, b.**
Clark Equipment Co., **d.**
Cornelius Co., The, Aero Div., **d.**
Curtiss-Wright Corp., Marquette Div., **c.**
Cutler-Hammer Inc., **a, b.**
Dial Products Co., **a, b.**
Dresser Mfg. Div., Dresser Industries, Inc.
Eaton Mfg. Co.
Electro-Mechanical Products Co., **b.**
Electro-Tech Equipment Co., **b.**
FAE Instrument Corp., **b.**
General Electric Co., Apparatus Sales Div., **a. b.**
General Electro-Mechanical Corp., **a, b.**
Globe Industries, Inc., **a, b.**
B. F. Goodrich Aviation Products, **c, d.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **a, c, d.**
Haddam Mfg. Co., The, **b.**
Hoover Electric Co., **a, b, c.**
Integral Corp., **c, d.**
Jack & Heintz, Inc., **a, b, c.**
***KEARFOTT CO., INC., a, b.**
Kelsey-Hayes Co., **c.**
Liggett Supply & Equipment Co., **a, c.**
Lundy Mfg. Corp., **a thru d.**
Lyndon Aircraft, Inc., **a, b.**
Magtrol, Inc., **a, b.**
Orbit Instrument Corp., **b.**
Pic Design Corp., Sub.-Benrus Watch Co., Inc., **b, c.**
Pacific Scientific Co., **c.**
Reeves Instrument Corp., **b.**
Robot Industries Inc., **a, b.**
Rockwell-Standard Carp., **c, d.**
Sterling Precision Carp., Instrument Div., **a, b, c.**
Talley Carp., The, **a, b, c.**
Technical Apparatus Builders, **a, b.**
Technology Instrument Carp., **a, b.**
Trambetta Salenaid Corp., **b, d.**
U. S. Science Corp., Div.-Topp Industries, Inc., **b.**
Van Zelm Assaciates, Inc., **c.**
Warner Electric Brake & Clutch Co., **a, b.**
Welded Construction Inc., **c.**
Western Design, Div.-U. S. Industries, Inc.; Santa Barbara Div., **a, b.**
Western Gear Corp., **a, b, c.**
Westinghouse Electric Carp., **a. b.**
Wright Engrg. Co., **a, b.**

BRAKESHOES

ACF Industries Inc.
American Aeroparts
American Brake Shae Co.
American Brazing Alloys Co.
American Car & Foundry, Div.-ACF Industries, Inc.
American Steel Foundries, Hammand Div.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
B. F. Goodrich Aviation Products
Johns-Manville
Metals & Controls Corp., General Plate Div.
Monogram Precision Industries
Raybestos-Manhattan, Inc.
Rockwell-Standard Corp.
Thermal Refractories Corp.

BRAZING
a. Aluminum Dip
b. Dry Hydragen

***BENDIX AVIATION CORP., HAMILTON DIV., a, b.**

BRAZING ALLOYS

Accurate Specialties Co. Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Alloys Unlimited Inc.
All-State Welding Alloys Co., Inc.
Aluminum Co. of America
American Brass Co., The
American Silver Co.
Bridgeport Bras's Co.
Dalweld Co. Inc.
Engelhard Industries, Inc.
Handy & Harman
Metals & Controls Corp., General Plate Div.
Sargent & Wilbur Heat Treating Corp.
Solar Aircraft Co.
United Wire & Supply Corp.
Vanadium-Alloys Steel Co.
***WALL COLMONOY CORP., STAINLESS PROCESSING DIV.**
Wildberg Bros. Smelting & Refining Co.

BRAZING OR SOLDERING FLUX
See **FLUX, BRAZING OR SOLDERING**

BREADBOARD KITS, ELECTRONIC

Aerolite Electronics Corp.
Aeronca Mfg. Corp.
Alden Products Co.
Di-An Controls, Inc.
Good Electronic Corp.
Helipot Div.-Beckman Instruments Inc.
Hicks Corp., The
Paul Nurches Co.
Philco Corp., Government & Industrial Div.
Piasecki Aircraft Corp.
Pomona Electronics Co., Inc.
Raymond Engrg. Lab., Inc.
Rimak, Inc.
Ryan Aeronautical Co.
Servo Corp. of America
Stanley Aviation Corp.
Transistor Electronics Corp.
United Aircraft Products, Inc.
Vector Electronic Co.

BREAK-AWAY MECHANISMS

***AC ELECTRONICS DIV., GENERAL MOTORS CORP.**
Aerolab Development Co.
American Machine & Foundry Co., Government Products Group
Beaver Precision Products Inc.
Benbow Mfg. Corp.
Communications Research Co.
Components Corp.
Cooper Development Corp., Sub.-Morquardt Aircraft Co.
Cutler-Hammer Inc.
Hoover Electric Co.
Horkey-Moore Associates
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
H. Koch & Sons
***MC CORMICK SELPH ASSOCIATES**
Pacific Scientific Co.
Royal Industries, Inc.
Skinner Precision Products
Stanley Aviation Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Wilks Precision Instrument Co., Inc.

BREAKERS, CIRCUIT

Cable Electric Products Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Electric Auto-Lite Co., The
General Electric Co., Apparatus Sales Div.
Heinemann Electric Co.
I-T-E Circuit Breaker Co.
Mechanical Products Inc.
Sangamo Electric Co.
Spencer Div., Metals & Controls Corp.
Westinghouse Electric Corp.

BREATHING EQUIPMENT & OXYGEN APPARATUS
See OXYGEN APPARATUS & BREATHING EQUIPMENT

BREATHERS, ENGINE

Bendix Filter Div., Bendix Aviation Corp.
Curtiss-Wright Corp.-Wright Aeronautical Div.
G. W. Lisk Co. Inc.

BRIDGES

a. Capacitance
b. Cathode Interface Impedance
c. Electrical
d. Impedance
e. Inductance
f. Megohm
g. Resistance
h. RF
i. Self-Balancing
j. Standing Wave
k. Synchro
l. VHF
m. Wheatstone

Acton Labs. Inc., a, d, e.
Aero Electronics Corp., g.
Aeronca Mfg. Corp., a, c, g, h, i, m.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., h, i.
Aircom Inc., j.
Aircom Inc. of New Jersey, j.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., m.**
Airflyte Electronics Co., m.
Alford Mfg. Co., j.
Allegany Instrument Co., Inc., g, m.
American Measurement & Control, Inc., c.
***ARNOUX CORP.**, c, g.
Associated Research, Inc., f, g.
Automation Dynamics Corp., g.
Avien, Inc., a, i.
B & F Instruments, Inc., i.
B & H Instrument Co., Inc., i.
B & K Instruments, Inc., a, e, g.
Bliss Electronic Corp., g.
Boonton Radio Corp., d, g, l.
Bristol Co., The, a, c, d, f thru i, m.
Brunswick Instruments, g.
Cable Electric Products Inc., c.
California Technicol Industries, Div.-Textron Inc., j.
Cambridge Instrument Co., Inc., a, d, e, m.
Cardinal Instrumentation Corp., m.
Centralab, Div.-Globe-Union, a.
Centronix Inc.
Clippard Instrument Lab., Inc., a, g.
Control Circuits Inc., c, d, f, g, i, k, l, m.
Cornell-Dubilier Electric Corp., a.
Curtiss-Wright Corp., Electronics Div., g, m.
Datascan Inc., a, b.
Datran Electronics, Div.-Mid-Continent Mfg., Inc., g, i.
Daven Co., The, c thru g, m.
Daystrom Pacific Div.-Daystrom, Inc., i.
Dayton Aviation Radio & Equipment Corp., l.
J. W. Dice Co., g.
Double E Products Co., h.
Dytronics Co., d.
Electro Instruments, Inc., a, f, g, m.
Electro-Measurements Inc., a, d, e, g, k, m.
Electronic Applications, Inc., a, e, f.
Electronic Instrument Co., Inc. (EICD), f.
Electronic Processes Corp. of California, m.
Electro-Tech Equipment Co., f, g, m.
Engrg. Associates, a, c, d, e, g, h, m.
Epic, Inc., a, c thru g, m.
Eppley Laboratory, Inc., The, l.
FXR, Inc., j.
Freed Transformer Co. Inc., a, e.
General Electric Co., Apparatus Sales Div., c, i.
Gilmore Industries, Inc., i.
Globe Industries, Inc., m.
Good Electronic Corp., c, d, i.
Gray Instrument Co., g, k, m.
Gulton Industries, Inc., a.
Hewlett-Packard Co., l.
Industrial Control Co., a.
Industrial Development Labs., Inc., a, g, m.
Industrial Instruments Inc., c, d, f, g, m.
Industrial Test Equipment Co., a, d, e, g, k.
Industrial Transformer Corp., e.
Javelin Aircraft Co. Inc., m.
E. F. Johnson Co., j.
Julie Research Labs., Inc., g, k, m.
Kahn & Co., Inc., g.
***KEARFOTT CO., INC.**, a, c thru g, i, j, k, m.
Leeds & Northrup Co., a, c thru g, i, m.
Mac Lead & Hanopol, Inc.
Magnetic Controls Co., g.
Marconi Instruments, a, e, g.
Metronix, Inc., Sub.-Assembly Products, Inc., a, e, g.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, a, c thru g, i, m.
Monogram Precision Industries, d, e, g, j, k, l.
Moran Instrument Corp., i.
Narda Microwave Corp., The, c.
New England Scientific Instruments Co., a, c thru g, m.
Paco Electronics Co., Inc., a.
Philco Corp., Government & Industrial Div.
Photobell Co., Inc., a.
Physics Research Laboratories, Inc., g, m.
Precise Development Corp., a, d thru h, m.
Radar Design Corp., h, l.
Radex Corp., d.
Rinco, Inc., a, d thru g, m.
Rixon Electronics Inc., j.
Arthur C. Ruge Associates, Inc., g, m.
Shallcross Mfg. Co., f, g, m.
Southwestern Industrial Electronics Co., a, c thru g, i.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., j.
H. W. Sullivan Ltd., a, c, d, e, g, m.
Talley Corp., The, a thru m.
Telectro Industries Corp., a, b, c, f, i, j.
Tel-Labs, Inc., m.
Thiokol Chemical Corp., h.
Waveline, Inc., j.
Weston Instruments, Div.-Daystrom, Inc., i.
Westronics Inc., i.
Wright Engrg. Co., a, b, d thru h.

BRUSHES, MOTOR

ACF Industries Inc.
Advance Carbon & Electric Mfg. Co.
Eagle Electric Mfg. Co. Inc.
Graphite Metallizing Corp.
Helwig Carbon Products, Inc.
Morganite, Inc.
Heinz Mueller Eng. Co. Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Ohio Carbon Co., The
Pacific Scientific Co.
St. Marys Carbon Co.
Stackpole Carbon Co.
Superior Carbon Products, Inc.
Westinghouse Electric Corp.

BRUSHES, SOUND REPRODUCTION EQUIPMENT

Helwig Carbon Products, Inc.

BUFFERS, ANTENNA

***HOUDAILLE INDUSTRIES, INC., BUFFALO HYDRAULICS DIV.**

BUFFERS & GRINDERS

Barrett-Christie Co.
Black & Decker Mfg. Co., The
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
National Beryllia Corp.
Snap-on-Tools Corp.
Thermal Refractories Corp.
U. S. Electrical Tool Co.
Wyzenbeek & Staff, Inc.

BULBS, RESISTANCE THERMOMETER
See RESISTANCE THERMOMETER BULBS

BULBS, TEMPERATURE RESISTANT

***ARNOUX CORP.**
Colonial Rubber Co.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Hallikainen Instruments
Illinois Testing Laboratories, Inc.
***LEWIS ENGRG. CO., THE**
Norton Co., New Products Dept.
Arthur C. Ruge Associates, Inc.
Thermo Electric Co., Inc.
Trans-Sonic, Inc.
United Control Corp.

BUSHINGS

Ace Drill Bushing Co. Inc.
Aero Bolt & Screw Co., Inc.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Aeroparts
American Brake Shoe Co.
American Standard Products, Inc.
American Steel Foundries, Hammond Div.
Ampco Metal, Inc.
Arnav Aircraft Associates, Inc.
Baldwin Mfg. Co. Inc., The
Bearium Metals Corp.
Beemer Engrg. Co.
Bound Brook Oil-Less Bearing Co.
Capital City Mfg. Co.
Century Fasteners Corp.
Cleveland Graphite Bronze, Div.-Clevite Corp
Corning Glass Works
Curtiss-Wright Corp.-Wright Aeronautical Div.
Division Lead Co.
Eagle Electric Mfg. Co. Inc.
Emerson Plastics Corp.
Federal Machine Co. Inc.
Highland Rim Machine Works Inc.
Isolantite Mfg. Corp.
Joclin Mfg. Co.
Johns-Manville
Keystone Electronics Corp.
Landsverk Electrometer Co., The
Mercury Tool & Mfg. Corp.
Monarch Bearing Co. Inc.
National Beryllia Corp.
National Ceramic Co.
Ohio Carbon Co., The
Pic Design Corp., Sub.-Benrus Watch Co., Inc.
Randall Graphite Bearings, Inc.
Research Development Mfg. Inc.
St. Marys Carbon Co.
Ray A. Scharer & Co.
Seamless Products Co., Inc.
Silicone Insulation, Inc.
Sinclair Mfg. Co.
Skinner Precision Products
Southwest Products Co.
A. T. Stevens Co.
True Alloys Inc.
W-S Fittings Works, Forge & Fittings Div., H. K. Porter Co. Inc.
Wilmington Fibre Specialty Co.

BUSHINGS, HERMETICALLY SEALED

B G Corp., The
Ceramaseal, Inc.
Corning Glass Works
Highland Rim Machine Works Inc.
Joclin Mfg. Co.
Landsverk Electrometer Co., The
Lundey Associates Inc.
Telectro Industries Corp.
Torwico Electronics, Inc.

BUSHINGS, METALLIC

Aero Bolt & Screw Co., Inc.
Aircraft Precision Products, Inc.
Airdome Parts Co.
American Aeroparts
American Brake Shoe Co.
American Standard Products, Inc.
American Steel Foundries, Hammond Div.
Ampco Metal, Inc.
Baldwin Mfg. Co. Inc., The
Bearium Metals Corp.
Beemer Engrg. Co.
Birnbach Radio Co., Inc.
Capital City Mfg. Co.
Century Fasteners Corp.
Chase Brass & Copper Co., Inc.
Cleveland Graphite Bronze, Div.-Clevite Corp.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Division Lead Co.
R. C. Dudek & Co.
Elastic Stop Nut Corp. of America
Federal Machine Co. Inc.
Freeman Co., The
GAR Mfg. Corp.
Graphite Metallizing Corp.
Haynes Stellite Co., Div.-Union Carbide Corp.
Highland Rim Machine Works Inc.
Keystone Electronics Corp.
Landsverk Electrometer Co., The
Litton Industries, U. S. Engrg. Co., Div.
Mercury Tool & Mfg. Corp.
Morganite, Inc.
Pic Design Corp., Sub.-Benrus Watch Co., Inc.
Piasecki Aircraft Corp.
Randall Graphite Bearings, Inc.
Rattan Mfg. Co., The
Research Development Mfg. Inc.
Roller Bearing Co. of America
Ronson Hydraulic Units Corp.
St. Marys Carbon Co.
Ray A. Scharer & Co.
Seamless Products Co., Inc.
Sinclair Mfg. Co.
Skinner Precision Products
Southwest Products Co.
True Alloys Inc.
United Mfg. Co., The
W-S Fittings Works, Forge & Fittings Div., H. K Porter Co. Inc.
Wilks Precision Instrument Co., Inc.
Wrought Washer Mfg., Co.

BUSHINGS, NON METALLIC

Aero Bolt & Screw Co., Inc.
Allied Plastics Supply Corp.
American Aeroparts
American Standard Products, Inc.
Anti-Corrosive Metal Products Co., Inc.
Auburn Mfg. Co., The
Birnbach Radio Co., Inc.
Capital City Mfg. Co.
Centralab, Div.-Globe-Union
Century Fasteners Corp.
Chemplast, Inc.
Chicago Gasket Co.
Colonial Rubber Co.
Continental Diamond Fibre Corp.
Continental Rubber Works
Corning Glass Works
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dixon Corp.
Duramic Products Inc.
Eagle Electric Mfg. Co. Inc.
Electrical Insulation Co., Inc.
Emerson Plastics Corp.

Engineered Plastics, Inc.
Franklin Fibre-Lamitex Corp.
Frenchtown Porcelain Co.
Freemon Co., The
Furone Plastics, Inc.
Gotke Corp.
General Gasket Inc.
Glodding, McBean & Co.
Grophite Metollizing Corp.
Heymon Mfg. Co.
Highland Rim Machine Works Inc.
Hoclin Mfg. Co.
Hohns-Monville
Keystone Electronics Corp.
Kip Electronics Corp.
Lomtex Industries, Inc.
Londsverk Electrometer Co., The
Lundey Associates Inc.
Moryland Lovo Co.
M. E. Menough Co.
Mercury Tool & Mfg. Carp.
Mico Fobricating Co.
Morganite, Inc.
National Beryllio Carp.
Norton Co., New Products Dept.
Ohio Corbon Co., The
Pic Design Corp., Sub.-Benrus Wotch Co., Inc.
Perry Plastics, Inc.
Piosecki Aircraft Corp.
Pilgrim Products Inc.
Polymer Corp., The
Rotton Mfg. Co., The
Roybestos-Manhottan, Inc., Pa.
Fred T. Roberts & Co.
Roberts Toledo Rubber Co., The
Rogers Corp.
St. Morys Carbon Co.
Ray A. Schorer & Co.
Silicone Insulation, Inc.
Sinclair Mfg. Co.
Southwest Products Co.
Sparto Mfg. Co., Div.-U. S. Ceramic Tile Co.
Spaulding Fibre Co., Inc.
Stockpole Carbon Co.
Stein Seal Co.
S. T. Stevens Co.
Superior Steatite & Ceromic Carp.
Telectro Industries Corp.
Thermol Refroctories Corp.
Thermech Engrg. Corp.
Wilks Precision Instrument Co., Inc.
Wilmington Fibre Specialty Co.

BUZZERS & BELLS
See **BELLS & BUZZERS**

CABINET CHASSIS
See **CHASSIS, CABINET**

CABINETS
- a. Metal
- b. Plastic
- c. Speaker
- d. Temperature Test
- e. Wood

Ace Engrg. & Machine Co., Inc., a.
A&P Metal Products Mfg. Carp., a.
Abolon Precision Mfg. Carp., a.
Adept Industries Inc., b, e.
Aerojet-General Carp.
Air Logistics Carp., b.
Aircraft Armaments, Inc.,a .
Alden Products Co., a.
Allied Plastics Supply Carp., b.
Alpitec, Inc., a.
Aluminum Co. of America, a.
Amelco, Inc., a.
American Agile Corp., b.
American Aluminum Co., a.
American Electronics, Inc., Toller & Cooper Div., a.
American Machine & Foundry Co., Gavernment Products Group, a.
American Research Carp., d.
Anchor Metal Spinning Co., The, a.
Anchor Specialty Mfg. Co. Inc., a, b, d, e.
Aristocrat Plastics, Inc., b.
ASSOCIATED TESTING LABS., INC., d.
Astravac Corp., d.
Atlos Engrg. Carp., d.
B. H. Aircraft Co., Inc., a.
Barrett-Christie Co., a.
Basco Metal Products, Inc., a.
Basic Taal Industries, Inc., a.
Bensan Mfg. Co., The, a.
Bil-Jax Inc., a.
Blue M Electric Co., d.
Bogue Electric Mfg., Co., a.
Brooks & Perkins, Inc., a.
Bud Radio Inc., a, c.
Cormady Carp., e.
Chemald Co., b.
C. B. Christiansen Co., a.
Chrysler Carp., Defense Operations Div.
Cole Electric Co., a.
Colaniol Aircraft Carp., a.
Conco Engrg. Works, a.
Cooper Industries, Inc., a.
Cornell Deep Drawing Co., Div.-Lanes Industries Carp., a, b.
Croig Systems, Inc., a.
Cromer Mfg. & Engrg., Inc., a.
Cranome Inc., a.
Curtiss-Wright Carp., Reseorch Div., b.
Cutler Metol Products Co., a.
Dohlstram Metollic Daar Co., a.
Delto Products Div.-Air Accessaries, Inc., b.
Deluxe Metal Products Co., a.
Detranic Industries, a.
Devco Engrg. Inc., a.
Dyno-Therm Chemicol Corp., d.
Eckal Pockoging Co., e.
Electro-Mechanical Products Co., a.
Eljay Corp., a, b.
Elzee Metal Products Co., Inc., a.
Erie Resistar Carp., b.
***ETS-HOKIN & GALVAN, a, i.**
Falstrom Co., a.
Forwell Metal Fobricating, a.
Ferris-Mfg. Co., The, a.
Firestone Tire & Rubber Co., The, Guided Missile Div., a.
Fletcher Mfg. Co., Inc., The, a, b.
Fronklin Fibre-Lamitex Corp., b.
Frick Gollagher Mfg. Co., The, a.
G. W. Golloway Co., d.
Generol American Transportatian Carp., b.
General Testing Labs., Inc., d.
Green Rectifier Co., a.
Greenbrier Instruments Inc., a.
Gremca, Inc., a.
Guardite Co., Div. of Americon Marietta Co., d.
Holliburton, Inc., Mfg. Div., a.
Poul Hordeman, Inc., a.
Hordman Tool & Engrg. Co., a, b.
Harris Refrigerotion Co., d.
Hoveg Industries, Inc., b.
Hicks Corp., The, d.
Haffmon Engrg. Corp., a.
Hamolite Corp., The, b.
Honeycomb Co. of America, Inc., a.
Ludwig Hanald Mfg. Co., a.
Horkey-Moore Associotes, a.
Hughes Tool Co., Aircraft Div., a.
Industrial Engrg. Corp., a.
Industrial Taals Mfg. Carp., Sub.-Pendleton Tool Industries, Inc., a.
International Rodiont Corp., d.
Javelin Aircroft Co. Inc., a thru e.
Jeta, Inc., a.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., a.
Kelsey-Hoyes Co.,a.
Kirk & Blum Mfg. Co., The, a.
H. Kach & Sons, b, i.
Lomtex Industries, Inc., b.
Leitch-Huord Corp., a.
Livingstan Electronic Carp., c.
Lafstrand Co., The, a.
Lone Star Plostics Co. Inc., b.
Langren Aircraft Co., Inc., a.
R. H. Lynch Mfg. Co., a.
Mogee-Bralla & Associotes, c, d.
Mercury Tool & Mfg. Corp., a.
Meridian Metalcroft, Inc., a.
Metol Fabricatars Carp., a.
Metal-Glass Products Co., a.
Mid-West Metol Products, Inc., a, c, d.
Miller Dial & Nomeplate Co., a.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV., a.**
Molding Carp. of America, b.
Monogram Precisian Industries, a, b, d, e.
Manrovia Aviotion Corp., a.
Morse Instrument Co., The, a.
Muckle Mfg. Co., a.
Mullenbach Div.-Electric Machinery Mfg. Co., a.
National Pneumotic Co., Inc., Haltzer-Cabot Divs., a.
National Spectrographic Labs., Inc., a.
Nelson Labs., Inc., e.
Neumade Products Corp., a.
North Electric Co., a.
Northeastern Engrg. Inc., a.
Nutran Mfg. Co. Inc., a.
Oxford Companents, Inc., c.
***PACKARD-BELL ELECTRONICS CORP., e.**
Piasecki Aircraft Corp., a, b, e.
Plostic Age Soles, Inc., b.
Pneumofil Corp., a.
Portland Copper & Tank Works Inc., a.
Precision Sheet Metol, Inc., a.
Premier Metal Products Co., a, c.
Prereg Mfg. Inc., a.
Rodiaphone Co. Inc., a.
Red Lion Cobinet Co., Redco Toal Div., a, e.
Reinhold Engrg. & Plostics Co., b.
Republic Steel Carp., a.
Rimok, Inc., a, c.
Rixon Electronics Inc., a.
Roberts Industries Inc., d.
Milton Rass Metals Co., The, b.
Royal Industries, Inc., a.
Russell Reinfarced Plostics Corp., b.
Santa Anita Engrg. Co., a.
Sequaia Wire & Cable Co.-Div.-Mondrel Industries, Inc., a.
Shaw Metol Products Carp., a, c.
Silicone Insulation, Inc., b.
Skydyne, Inc., a, b.
Skyline Electric & Mfg. Co., a.
Skyline Products, Inc., a.
L. B. Smith Aircraft Carp., a.
Smith-Morris Carp., a, b.
Snap-on-Taals Corp., a.
Sauthwestern Industrial Electranics Co., a.
Space Corp., a.
Specialty Engrg. & Electranics Co., a, b.
Standard Cobinet Co., d.
TA Mfg. Corp., a.
Teiner Engrg. Corp., a.
Telectra Industries Carp., c.
Teletronics Lab. Inc., a.
Temperature Engrg. Corp., d.
Tenney Engrg., Inc., d.
Texas Metal & Mfg. Co., Inc., a.
Topatron, Inc., a.
Twin Cooch Co., Aircraft-Missiles, a.
United Aircroft Products, Inc., a, d.
United States Chemical Milling Carp., a.
United States Plywood Carp.
United Supply Co., a, b.
Universol Maulded Products Corp., e.
Universol Unlimited, Inc., b.
University Loudspeakers, Inc., e.
Waldom Electronics Inc., b.
Woshington Aluminum Co., Inc., a.
Waterbury Companies, Inc., b.
Watson Mfg. Co., Inc., a.
Woyne Pump Co., The, Div.-Symington Wayne Carp.
Welded Construction Inc., a.
Wenzlau Engrg. Co., a.
Westlake Plostics Co., b.
Winder Aircroft Corp. of Florida, a.
Wyco Metal Products, a.
Young & Rioux Woodworking Co., Inc., e.

CABLE
- a. Antenna Transmission
- b. Bonding
- c. Clamps & Clips
- d. Coaxial
- e. Coaxial Flexible
- f. Coaxial Rigid
- g. Contral
- h. Delay
- i. Disconnects
- j. Electric
- k. Flat Woven
- l. Guards
- m. Guillatines
- n. Hangars
- o. Ignition
- p. Markers
- q. Mechanical
- r. Micraphone
- s. Shielded
- t. Solid Dielectric
- u. Splicers
- v. Tensioners
- w. Transmission Lines
- x. Wire

AMP Inc., u.
Abalon Precisian Mfg. Corp., c.
Actuatar Products Div., Geartranics Carp., q.
Adept Industries Inc., p.
Aerojet-General Carp., i.
Aerolite Electronics Carp., c.
Airtron Inc., Div.-Litton Industries, a, w.
Alfard Mfg. Co., d, f.
Allied Plastics Supply Corp., d, e, p.
Aluminum Co. of America, w, x.
American Aeraports, a thru f, h, i, k, o thru r.
American Brass Co., The, j, x.
American Electric Cable Co., a, c, g, j, k, a, r, s, x.
American Insuloted Wire Carp., d thru g, j, a, r, s, x.
American Missile Products Co., Inc., x.
American Super-Temperoture Wires, Inc., a, d, e, j, s, t, x.
Amphenal Cable & Wire Div., Amphenol-Barg Electronics Corp., a, d, e, f, r, s, t, w, x.
Amphenal Connectar Div., Amphenal-Barg Electranics Corp., c, i.
Anaconda Wire & Coble Co., a, d thru g, j, a, r, s, t, w, x.
Anchor Metal Spinning Co., The, c, l, n, p.
Andrew Corp., a, d, e, f, n, t.
Anton Electronic Labs., Inc., i.
Arens Contrals, Inc., g, q.
Borker Sales Co., a, d thru g, j, k, s, t, w.
Belden Mfg. Co., a, b, d, e, g , j, k, a, r, s, t, w, x.
Bendix Aviotion Carp., Scintilla Div., i, a, s.
Bergen Wire Rope Co., g, a, x.
Birnbach Radio Co., Inc., a thru e, j, a, r, s, w, x.
Whitney Blake Co., j, r, s.
Blander-Tongue Labs., Inc., c.
Bobrick Mfg. Corp., v.
Bastan Insuloted Wire & Cable Co., d, e, j, k, a, s, t, x.
William Brand & Co., Inc., a, b, d thru g, j, k, p, r, s, t, w, x.
Breeze Carparations, Inc., c, k, s.
Bridgepart Brass Co., j, x.
Burklyn Co., g.
Coble Electric Products Inc., d, e, j, s, x.
Califarnia Spring Co., Inc., x.
Colinoy-Div.-Illinois Tool Works, c.
Carmady Carp., q.
Century Fasteners Corp., c.
Chase Bross & Capper Co., Inc., j, w, x.
Chemald Co., b.
Chemplost, Inc., c, t.
Clippord Instrument Lab., Inc., j.
Columbia Technical Carp., h.
Consalidoted Wire & Associoted Companies, c thru f, i, j, n, q, r, v, w.
Continental Wire Soles Corp., d thru g, a, r, s.
Co-Operotive Industries, Inc., e, a, s.

Copperweld Steel Co., Wire & Coble Div., a, d, j, k, s, w, x.
Carnish Wire Co. Inc., r, s, v, w.
Dayton Aircraft Products, Inc., a.
Devcon Corp., b.
Dielectric Materials Co., d thru g, j, k, r, s, t.
W. C. Dillon & Co., Inc., v.
Dackendorff & Co. Inc., v.
Durolith Corp., p.
Dynamic Devices, Inc., m.
Eagle Electric Mfg. Co. Inc., x.
Thomas A. Edisan Ind. Instrument Div.-McGraw-Edison Co., a, d, e, j.
Electric Auto-Lite Ca., The, j, o, s.
Electric Cords & Supply Corp., e thru j, s, w.
Electronic Applications, Inc., r.
Electronic Parts Mfg. Co., Inc., j.
Emeloid Co., Inc., The, p.
Emerson Radio & Phonograph Corp., s.
Entron, Inc., a, d, e.
Essex Wire Corp., g, j, o, r, s, x.
First Electronics Corp., The, k.
Flexible Metal Hose Mfg. Co., s.
Furane Plastics, Inc., t.
General Coble Carp., a, b, d thru k, o, r, s, t, w, x.
General Cement Mfg. Co., Div.-Textron, Inc., c, r.
General Electric Co., Wire & Coble Dept., g, j, s, t, w, x.
General Insulated Wire Works, d, e, g, j, r, s, x.
General Laboratary Associates, Inc., o.
Gunnar Laboratories, w.
Hallett Mfg., Co., b, c, e, i, j, k, o, p, s, x.
Hallicrafters, a, w.
Heyman Mfg. Co., c, i.
Hitemp Wires Inc., d, e, f, k, s.
Holub Industries, Inc., c.
Holyoke Wire & Cable Corp., a, d, e, g, j, k, r, s, t, w, x.
Hughes Taal Ca., Aircraft Div.
Walter J. Hyatt Ca., The, a, d.
ITT Labs.
Illumitronic Engrg. Co., c.
International Resistance Co., e, k.
Internatianal Wire & Cable Co., a, b, d thru g, j, r, s, t, w, x.
Interstate Electranics Corp.
Javelin Aircraft Co. Inc., x.
Javex Electronics, i, u.
Jeffersan Electronic Products Corp., b, e, g, o, s.
Jefferson Wire & Cable Corp., a, d, e, r, s, t, w.
Kickhaefer Mfg. Ca., c, n.
Korda Industries, i, j, k.
Lenz Electric Mfg. Co., a, b, d, e, g, k, r, s, t, x.
***LEWIS ENGRG. CO., THE**, d, e, g, j, s, x.
Lieco, Inc., f, h.
Ling Electranics, Inc.
Mac Whyte Wire Rape Ca., c, f, q, x.
Magnetic Shield Div. Perfection Mica Co., s.
***MC CORMICK SELPH ASSOCIATES**, m.
J. E. Menaugh Ca. o, s.
Meridian Metalcraft, Inc., w.
Micradat Inc., d.
Minneapolis-Haneywell Regulatar Ca., Drdnance Div., g, j.
Minnesata Mining & Mfg. Ca., b, u.
Mohawk Wire & Cable Corp., d, e, g, j, r, s, t.
Monogram Precision Industries, a thru f, k.
Natianal Pneumatic Ca., Inc., Haltzer-Cabot Divs., c, g, i, j, o, r.
Nesar Allay Products Co., s.
Networks Electranic Carp., k.
New England Electrical Works, Inc., b, k, x.
M. M. Newman Corp., l.
Okanite Ca., The, Subsidiary of Kennecatt Capper Carp., a, d, e, g, o, r, s, t, w.
On Mark Couplings, Inc., i.
Pacific Scientific Co., i, j, m, v, x.
Packord Electric Div.-General Matars Carp., b, j, o, s, x.
Panduit Carp., c, n.
Phalo Plastics Carp., d, e, j, r, s, t, x.
Phelps Dodge Capper Products Corp., a, d thru h, j, a, s, t, w, x.
Plastoid Corp., a, d, e, f, j, o, r, s, t, w.
Precisian Tube Co., Inc., a, d, f, s, t, w.
Prodelin Inc., c, d, e, t, w.
***PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.**, m.
Radar Design Corp., f, w.
Revere Carp. af America, d, e, j, s, x.
Rex Corp., The, Sub.-American Enka, d, e, g, j, r, s, t, x.
Roanwell Corp., r.
Fred T. Raberts & Ca., c.
Rackbestos Products Corp., d thru g.
Rame Cable Corp., Sub.-Aluminum Ca., of America, g, j, s, x.
Roovers-Latsch Carp., p.
Miltan Ross Metals Ca., The, c.
Royal Electric Corp., d, e, f, h, j, o, r, s, t, x.
Sequaia Wire & Cable Co.-Div.-Mandrel Industries, Inc., a, d, e, g, i, j, k, o, r, s, t, x.
Servwell Products Co., c, g, q.
Simplex Wire & Cable Ca., d, e, g, j, o, r, s, t, w, x.
Sauthwest Products Co., g.
Sauthwire Ca., w, x.
Specialty Engrg. & Electronics Ca.
Spectra-Strip Wire & Cable Corp., b thru g, j, k, p, r, s, x.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp., a.
Sperry Piedmont Co.-Div.-Sperry Rand Corp., a.
Stainless Inc., a.
F. W. Stewart Corp., g.
Stic-Klip Mfg., Co., c, n.
Superior Cable Corp., a, b, d, e, g, j, r, s, t, x.
TA Mfg. Corp., c.
Tomer Electronics, Inc., i, w.
Tope Cable Corp., j, s, w, c, g, i, q.
Tensolite Insulated Wire Co., Inc., a, c thru f, j, k, a, q, r, s, x.
Thermal Wire of Americo, d, e, g, s.
Thermax Wire Corp., d, e, g, j, r, s, t, x.
Times Wire & Cable Co., Inc., a, d, e, g, j, a, r, s, t, w.
Transco Products, Inc., a, d, w.
Turbo Products, Inc., c.
United Supply Co., e, i.
United Wire & Supply Corp., x.
Universal Metal Products Inc., c.
Warren Wire Co., d, e, j, o, s, x.
Washington Aluminum Ca., Inc., l.
Western International Ca., a, d thru j, o, r, s, w, x.
Westwood Cable Corp., b, d, e, g, j, k, o, r, s, t, x.
Whitaker Cable Corp., j, s, x.
Wilcax-Crittenden Div., North & Judd Mfg. Co., b.
Winder Aircraft Corp. of Florida, a, j.
Wire Co. af America, Inc., a, g, i, s, x.
Wirecraft Products, Inc., d, e, s, x.
Zippertubing Co., The, k, l, p, s.

CABLE ASSEMBLIES, ELECTRICAL

ACF Industries Inc.
Advanced Electranics, Inc.
Aerodex, Inc.
Aerolite Electronics Corp.
Aircraft Taals, Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Airtronics International Corp.
Alden Products Ca.
Alta Scientific Ca., Inc.
Amelco, Inc.
American Aeroparts
American Basch Arma Corp.
American Electric Cable Ca.
American Machine & Faundry Co., Government Products Group
Amphenol Connector Div., Amphenal-Borg Electronics Corp.
Anaconda Wire & Cable Co.
Anchor Specialty Mfg. Co. Inc.
Andrew Corp.
Automatic Electric Sales Carp.
Barker & Williamson Inc.
***BEATON & CORBIN MFG. CO., THE**
W. A. Beauchaine & Sons Inc.
Belden Mfg. Co.
Belock Instrument Carp.
Bendix Aviation Carp., Scintilla Div.
Bernco Engrg. Carp.
Birnbach Radio Ca., Inc.
Whitney Blake Ca.
Bliss Electranic Corp.
Brach Mfg. Carp., Div.-General Branze
William Brand & Ca., Inc.
Breeze Carparations, Inc.
Bristol Ca., The
Brown Engrg. Ca., Inc.
Bulaw Electric Ca.
Cable Electric Products Inc.
California Technical Industries, Div.-Textron Inc.
Cameraflex Corp.
***CANNON ELECTRIC CO.**
Carmody Corp.
Centranix Inc.
Chalca Engrg. Carp.
Chrysler Carp., Defense Dperatians Div.
Caaxial Cannectar Ca. Inc.
Cails-Electronics
Consolidated Praductions, Inc.
Continental Technical Service, Inc.
Copper Develapment Carp., Sub.-Marquardt Aircraft Ca.
Co-Dperative Industries, Inc.
Carnish Wire Ca. Inc.
Dale Products, Inc.
Dalmatar Div., Yuba Consalidated Industries, Inc.
Dayton Aviation Radia & Equipment Carp.
Detronic Industries
Dielectric Materials Ca.
Divco-Wayne Electronics, Div.-Divco-Wayne Carp.
Daty Acoustica Electronic Labs.
Double E Praducts Co.
Dresser Industries, Inc.
Du Kane Corp.
Eastern Specialty Co., The
Electric Auto-Lite Co., The
Electric Cords & Supply Corp.
Electramath Carp.
Electra-Mechanical Products Ca.
Electro-Miniatures Corp.
Electronic Assembly Ca., Inc.
Electronic Cammunicatians, Inc.
Emerson Radio & Phonagraph Carp.
Empire Electronics Co., Inc.
Entron, Inc.
Ericsan Mfg. Co., The
***ETS-HOKIN & GALVAN**
Fairchild Astrionics Div., Fairchild Engine & Airplane Carp.
Federal Mfg. & Engrg. Corp.
Firestone Tire & Rubber Ca., The, Guided Missile Div.
First Electronics Carp., The
Fugle-Miller Labs. Inc.
General Cable Corp.
General Laboratory Assaciotes, Inc.
General Products Corp.
General R-F Fittings, Inc.
Geotronic Labs. Inc.
Gilfillon Bros. Inc.
Goad-All Electric Mfg. Co.
Gordan Enterprises
Graflex Inc.
Guardion Electric Mfg. Ca.
Gunnor Laboratories
Hallomare Electronics Co.
Hollett Mfg., Ca.
Hamilton Standard, Div.-United Aircraft Carp.
Horco Labs., Inc.
Poul Hordeman, Inc.
Hi-Lo Manufacturing Corp.
Hitemp Wires Inc.
Holyoke Wire & Cable Corp.
Walter J. Hyott Co., The
Indusl. Prod.-Donbury Knudsen Div., Amphenol-Bar Electronics Carp.
Inland Electronics Corp.
Intercontinental Dynomics Corp.
International Wire & Coble Co.
Interstate Electronics Corp.
ITT-Kellogg
Janco Corp.
Jeffersan Electronic Praducts Carp.
Jeta, Inc.
Jettran Products, Inc.
Kahn & Ca., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Carp.
Kelsey-Hayes Co.
Kalled Kards Inc.
Karda Industries
***LEWIS ENGRG. CO., THE**
Magee-Bralla & Assaciates
Methade Mfg. Carp.
***MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.**
Modelectric Products Corp.
Motorola Inc., Military Electranics Div.
Mutran Corp.
George L. Nankervis Co.
Natianal Pneumatic Co., Inc., Haltzer-Cabat Divs.
North Electric Co.
Paul Nurches Ca.
Pacific Scientific Ca.
Packard Electrid Div.-General Matars Corp.
Paraplegics Mfg. Ca., Inc.
Piasecki Aircraft Carp.
Pamana Electronics Co., Inc.
Precise Development Carp.
Projects Unlimited Inc.
Pyle-National Ca., The
Radiaphane Co. Inc.
Ravenna Metal Products, Div.-Standard Screw Ca.
Renwell Corp.
Revere Corp. af America
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Fred T. Roberts & Ca.
Miltan Ross Metals Ca., The
Rawe Industries
Royal Electric Carp.
Royal Industries, Inc.
Ryan Aeronautical Co.
Schaffer Air Industries, Inc.
Sequaia Wire & Cable Ca.-Div.-Mandrel Industries, Inc.
Sheltered Warkshaps
Sittler Corp.
Sauthwestern Industrial Electronics Ca.
Specialty Engrg. & Electronics Co.
Spectra-Strip Wire & Cable Carp.
Suffalk Products Carp.
Switchcraft, Inc.
T-C Div., Dyna-Empire, Inc.
Telectra Industries Carp.
Thamas Electranics, Inc.
Tower Mfg. Carp.
Tricraft Products Carp.
Tri-Dex Ca.
Tucsan Instrument Corp.
U. S. Relay Ca.
United States Chemical Milling Carp.
Victor Adding Machine Ca.
Victor R. F. & Micrawave Co.
Virginia Electranics Ca., Inc.
Waltham Haralagical Carp.
Webcor, Inc., Government Div.
Western International Ca.
Westwaad Cable Carp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.
Whitaker Cable Carp.
Winder Aircraft Carp. of Florida
Wire Co. of America, Inc.
Wirecraft Products, Inc.
Zippertubing Ca., The

CABLE ASSEMBLIES, MECHANICAL

Actuotor Products Div., Geartranics Corp.
Aircraft Taals, Inc.
American Aeroparts
Amphenal Connector Div., Amphenal-Borg Electranics Carp.
Anchor Specialty Mfg. Co. Inc.
Andrew Corp.
W. A. Beauchaine & Sans Inc.

Bergen Wire Rope Co.
William Brand & Co., Inc.
Burklyn Co.
Carmody Corp.
Century Fasteners Corp.
Coaxial Connector Co. Inc.
Continental Technical Service, Inc.
Dayton Aviation Radio & Equipment Corp.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp.
Electro-Mechanical Products Co.
Electro-Miniatures Corp.
Emerson Radio & Phonograph Corp.
Good-All Electric Mfg. Co.
Hallomore Electronics Co.
Highland Rim Machine Works Inc.
Hi-Lo Manufacturing Corp.
Intercontinental Dynamics Corp.
Jefferson Electronic Products Corp.
Jeta, Inc.
Kennedy Aircraft Supply Co.
Mac Whyte Wire Rope Co.
Magee-Brollo & Associates
Mutron Corp.
Paraplegics Mfg. Co., Inc.
Piasecki Aircraft Corp.
Precision Sheet Metal, Inc.
Projects Unlimited Inc.
Ravenno Metal Products, Div.-Standard Screw Co.
Renwell Corp.
Sequoia Wire & Cable Co., Div.-Mondrel Industries, Inc.
Servwell Products Co.
Southwest Products Co.
Southwestern Industrial Electronics Co.
Specialty Engrg. & Electronics Co.
Spectra-Strip Wire & Cable Corp.
F. W. Stewart Corp.
Teleflex Inc.
Thomas Electronics, Inc.
Tricraft Products Corp.
Virginia Electronics Co., Inc.
Webcor, Inc., Government Div.
Winder Aircraft Corp. of Florida
Zippertubing Co., The

ABLE ASSEMBLIES, THERMO-COUPLES

Advanced Electronics, Inc.
Aero Research Instrument Co. Inc.
Aerolite Electronics Corp.
Aircraft Tools, Inc.
American Electric Cable Co.
Amphenol Connector Div., Amphenol-Borg Electronics Corp.
B G Corp., The
***BEATON & CORBIN MFG. CO., THE**
Bendix Aviation Corp., Scintilla Div.
Bernco Engrg. Corp.
Boston Insulated Wire & Cable Co.
William Brand & Co., Inc.
Bristol Co., The
Dockendorff & Co. Inc.
Electric Cords & Supply Corp.
General Cable Corp.
Cloud S. Gordon Co.
Hallett Mfg., Co.
Harco Labs., Inc.
Illinois Testing Laboratories, Inc.
Jefferson Electronic Products Corp.
***LEWIS ENGRG. CO., THE**
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Mutron Corp.
Nesor Alloy Products Co.
Pacific Scientific Co.
Paraplegics Mfg. Co., Inc.
Projects Unlimited Inc.
Renwell Corp.
Revere Corp. of America
Sequoia Wire & Cable Co.-Div.-Mandrel Industries, Inc.
Spectra-Strip Wire & Cable Corp.
T-C Div., Dyna-Empire, Inc.
Thermal Refractories Corp.
Thermo Electric Co., Inc.
Thomas Electronics, Inc.
Westwood Cable Corp.
Winder Aircraft Corp. of Florida
Wire Co. of America, Inc.

ABLE CHECKER
See CHECKER, CABLE

ABLE-ELECTRIC LUGS
See LUGS, CABLE-ELECTRIC

ALIBRATORS
a. Crystal
b. Frequency
c. Radar Devices
d. Radar Range
e. Sweep
f. Voltage
g. UHF
h. VSWR

Aircom Inc., a, h.
Aircraft Armaments, Inc., d.
Airtron Inc., Div.-Litton Industries, h.
American Machine & Foundry Co., Government Products Group, c, d.
American Machine & Foundry Co., Greenwich, c, d.
Arenberg Ultrasonic Lab., Inc., d.
Ballantine Labs., Inc., f.
Barker Sales Co., a.
Rex Bassett, Inc., a.
Beckman Instruments, Inc., Berkeley Div., b.
Beckman-Systems Div., f.
Blonder-Tongue Labs., Inc., g.
Boonton Radio Corp., f.
Bud Radio Inc., a.
California Technical Industries, Div.-Textron Inc., h.
Centronix Inc., b, c.
Collins Radio Co., a, b.
DBM Research Corp., d.
Dayton Aviation Radio & Equipment Corp., a, b.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp., b, c, g.
Donner Scientific Corp., f.
Du Kane Corp., b.
Edgerton, Germeshousen & Grier, Inc., c.
Electro Instruments, Inc., f.
Electronic Applications, Inc., b, g.
Electronic Communications, Inc., c, g.
Electronics of Cleorfield, Inc., d, e.
Electronics Div., Van Normon Industries Inc., b.
Engrg. Associates, b, c.
FXR, Inc., h.
Federal Mfg. & Engrg. Corp.
John Fluke Mfg. Co., Inc., f.
General Communication Co., b, c.
Gilfillon Bros. Inc., c, d.
Gulton Industries, Inc., a.
Hallicrafters, b, c.
Walter J. Hyatt Co., The, c, d, e.
ITT Federal Div., International Telephone & Telegraph Corp., a thru h.
International Wire & Cable Co., e, g.
E. F. Johnson Co., a, h.
Kay Electric Co., h.
***KEARFOTT CO., INC.**, c, d, h.
Kin Tel Div.-Cohu Electronics, Inc., f.
Lampkin Labs., Inc., M.R. Div., b, g.
Leeds & Northrup Co., f.
Marconi Instruments, b.
Measurements Div., Mc Graw Edison Co., a.
Meridian Metalcraft, Inc., c, h.
Metronix, Inc., Sub.-Assembly Products, Inc., a.
Minneapolis-Honeywell Regulator Co., Industrial Products Group, f.
Miratel, Inc., e, g, h.
Missouri Research Labs., Inc., d.
Monogram Precision Industries, b, d, f, g, h.
Moran Instrument Corp., f.
Motorola Inc., Military Electronics Div., a.
Ernest Norman Laboratories, a.
North Hills Electric Co., Inc., f.
Optimized Devices, Inc., f.
Orbitran Co., Inc., d.
Osborne Electronic Soles Corp., f.
Philco Corp., Government & Industrial Div.
Piosecki Aircraft Corp., b.
Polarad Electronics Corp., h.
Precise Development Corp., e, f.
Probescope Co. Inc., a, b.
Radar Design Corp., b, d.
Radiotion, Inc.
Reeves-Hoffman Div., a, b.
Rese Engrg., Inc., f.
Rixon Electronics Inc., h.
Simpson Electric Co., f.
Specialty Engrg. & Electronics Co., f.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., d.
Systron Corp., b.
Telerad Mfg. Corp., b, c, d.
Tel-Instrument Electronics Corp., d.
Turbo Machine Co., c, d, h.
Universal Unlimited, Inc., c, d, f.
Waveline, Inc., h.
Weinschel Engrg., h.
Weston Instruments, Div.-Daystrom, Inc., f.
Wilks Precision Instrument Co., Inc., h.
Winder Aircraft Corp. of Florida, c.
Wright Engrg. Co., b.

CALLING APPARATUS, SELECTIVE
See SELECTIVE CALLING APPARATUS

CALLING SYSTEMS, SELECTIVE, NAVIGATION

Atlas Precision Products, Co.
Bell & Gossett Co.
Bendix Radio Div., Bendix Aviation Corp.
Collins Radio Co.
***ETS-HOKIN & GALVAN**
ITT Labs.
Jansky & Bailey, Inc.
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp.
Telechrome Mfg. Corp.
Telectro Industries Corp.
Winder Aircraft Corp. of Florida

CAMERA AUXILIARY EQUIPMENT

Abrams Instrument Corp.
Atlas Precision Products, Co.
Beckmon & Whitley, Inc., Missile Products Div.
Bell & Howell Co.
Belock Instrument Corp.
Benson-Lehner Corp.
Bulow Electric Co.
Chemold Co.
Chicago Aerial Industries, Inc.
Christie Machine Works
Eastman Kodak Co.
Flight Research, Inc.
General Electric Co., X-Ray Dept.
Gordon Enterprises
Graflex Inc.
Houston Fearless Corp.
Hycon Mfg. Co.
Instrument Corp. of Fla.
ITT-Kellogg
Mast Development Co., Inc.
Mitchell Camera Corp.
Monogram Precision Industries
Optomechanisms Inc.
Philco Corp., Government & Industrial Div.
Specialties, Inc.
Sterling-Howard Corp.
Television Utilities Corp.
Traid Corp.
Transmores Corp.

CAMERA MOUNTS

Aeroflex Corp., The, Aeroflex Labs. Div.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Anchor Metal Spinning Co., The
Atlas Precision Products, Co.
Bell & Howell Co.
Benson-Lehner Corp.
Burke & James Inc.
Cameraflex Corp.
Capital City Mfg. Co.
Chicago Aerial Industries, Inc.
Christie Machine Works
Flight Research, Inc.
Gordon Enterprises
Graflex Inc.
Ludwig Honold Mfg. Co.
Houston Fearless Corp.
Hycon Mfg. Co.
Instrument Corp. of Fla.
Javelin Aircraft Co. Inc.
Kelsey-Hays Co.
Mast Development Co., Inc.
Mercury Tool & Mfg. Corp.
Monogram Precision Industries
Optomechanisms Inc.
Philco Corp., Government & Industrial Div.
Piasecki Aircraft Corp.
Sterling-Howard Corp.
Traid Corp.
Transmores Corp.

CAMERA SWITCHING EQUIPMENT
See SWITCHING EQUIPMENT, CAMERA

CAMERA TURRETS
See TURRETS, CAMERA

CAMERAS
a. Data Recording
b. High Speed
c. Motion Picture
d. Oscillascope
e. Recording, Radar & Oscillascope
f. Sequence, Pluse
g. Television
h. X-Ray

Abrams Instrument Corp., a, e.
Allegany Instrument Co., Inc., a, b.
American Electronics, Inc., Taller & Cooper Div., a.
American Felt Co., d.
***AVCO MFG. CORP., CROSLEY DIV.**, g.
Beattie-Coleman, Inc., a, d, e, f, h.
Beckman & Whitley, Inc., Missile Products Div., b, d.
Bell & Howell Co.
Bendix Aviation Corp., Friez Instrument Div., g.
Benson-Lehner Corp., a, b.
Ernest E. Blanche & Associates, Inc., a.
Blonder-Tongue Labs., Inc., g.
Bulow Electric Co., f.
Burke & James Inc., a, e, f, h.
Camera Mart Inc., The, a, b, c.
Cameraflex Corp., a, c thru f.
Chadwick-Helmuth Co., b, c.
Chicago Aerial Industries, Inc., a thru f.
Christie Machine Works, b.
Coleman Engrg. Co., Inc., d.
DBM Research Corp., a, c, f.
Dage Television Div., Thompson Ramo Wooldridge, Inc., g.
Eastman Kodak Co., c.
Edgerton, Germeshousen & Grier, Inc., a thru e.
Electro-Medical Lab., Inc., d.
Electronic Tube Corp., d, e.
J. W. Fecker, Inc., a thru f.
Flight Research, Inc., a thru f, h.
Foto-Video Labs., Inc., g.
General Electric Co., Apparatus Sales Div., g, h.
General Electric Co., Technical Products Dept., g.
General Electric Co., X-Ray Dept., a, d, e, f, h.
General Precision Lab. Inc., g.
Giannini Plasmadyne Corp., b.
Gordon Enterprises, a thru g.
Graflex Inc., a, d, e, f.
Hallamore Electronics Co., g.
Hycon Mfg. Co., b, f.
ITT Labs.-Ft. Wayne, b, e, g.
Instrument Corp. of Fla.
Instruments Div.-Philips Electronics, Inc., h.
Jarrell-Ash Co., h.

Kin Tel Div.-Cohu Electronics, Inc., g.
Land-Air Inc., a, b.
Librascope Inc., b.
Lockheed Aircraft Corp., Missiles & Space Div., a, b, g.
Mast Development Co., Inc., a, b.
Micrametricol Mfg. Co., d.
Midwestern Instruments, Inc., a.
Miratel, Inc., d, g.
Mitchell Camera Corp., a, b, c.
Monogram Precision Industries, e, f.
Morse Instrument Co., The, a, c.
Optomechanisms Inc., a, c thru f.
Otis Elevator Co., Electronic Div., a.
Perkin-Elmer Corp., a, g.
Philco Corp., Government & Industrial Div., g.
Picker X-Ray Corp., h.
Rolle Mfg., Co., a thru h.
Royal Industries, Inc., a, b.
St. John X-Ray Lab., h.
Seiscor Mfg. Co., a.
Skiatron Electronics & Television Corp., g.
Southwestern Industrial Electronics Co., a, b, d, e.
Specialties, Inc., e.
Specialty Engrg. & Electronics Co., d.
Sterling Precision Corp., Instrument Div., b.
Sterling-Howard Corp., a, c.
Telechrome Mfg. Corp., d, g.
Traid Corp., a thru f.
Transmares Corp.
Victor Adding Machine Co., a.
Vought Co., a thru f.
Wallensak Optical Co., a thru f.

CANS, HERMETICALLY SEALED

Abalon Precision Mfg. Corp.
American Aluminum Co.
Bolco Research Labs., Inc., Capocitar Div.
A. Biederman, Inc.
Brooks & Perkins, Inc.
Champian Co., The
Conco Engrg. Works
Continental Con Co., Inc.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Double E Products Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Electra-Seal Corp.
Graflex Inc.
Ludwig Honold Mfg. Co.
Intercontinental Mfg. Co., Inc.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
Motarala Inc., Military Electronics Div.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Milton Rass Metals Co., The
Seamless Products Co., Inc.
Silicane Seals, Inc.
Smith-Morris Corp.
Southwestern Industrial Electronics Co.
Telectro Industries Corp.
Triad Transformer Carp.
United Aircraft Products, Inc.
Wesrep Corp.
Winzen Research Inc.

CAPACITOR FILMS
See FILMS, CAPACITOR

CAPACITOR OR RESISTOR BOARDS
See BOARDS, CAPACITOR OR RESISTOR

CAPACITOR SPECIALTIES MEASUREMENT

Basco Metal Products, Inc.
Bliss Electronic Corp.
Double E Products Co.
Electronic Applications, Inc.
New England Scientific Instruments Co.
Photobell Co., Inc.
Pyromid Electric Co.
Telectro Industries Corp.

CAPACITORS

a. Ceramic
b. Ceramic Trimmer
c. Composition
d. Decade
e. Electralytic
f. Feed-Thraugh
g. Fixed
h. Gas-Filled
i. Glass
j. Glass Trimmer
k. Hermetically Sealed
l. High Temperature
m. High Valtage
n. Industrial
o. Metallized Paper
p. Mica
q. Mica Trimmer
r. Miniature
s. Mylar Dielectric
t. Neutralizing
u. Oil
v. Oil Filled
w. Piston
x. Plastic
y. Plastic Dielectric
z. Plug-In
a1. Polystyrene Insulated
b1. Porcelain
c1. Precision
d1. Pressure Types
e1. Printed Circuit
f1. Receiver Tuning
g1. Silicane-Filled
h1. Silvered Mica
i1. Standard
j1. Tantalum
k1. Teflan
l1. Teflan, Dielectric
m1. Temperature Compensated
n1. Transmitter Tuning
o1. Transmitting
p1. Vacuum Types
q1. Variable

ACF Industries Inc., a, s, e-1.
AMP Inc., g, k, l, r, m-1, o-1.
Adept Industries Inc., e-1, k-1, l-1.
Advance Carbon & Electric Mfg. Co., e, k, n, u, v, x.
Aerovox Corp., a, b, d thru g, k thru p, r, s, u, v, x, y, z, o-1, b-1, c-1, e-1 thru n-1.
Airborne Accessories Carp., f, g, l, a, r.
American Aerophysics Carp., w, x.
American Agile Corp., x, y, k-1, l-1.
American Bosch Arma Carp., f.
American Lavo Corp., a, b, f, r, e-1.
Astrovoc Corp., m.
Astron Corp., a, e, f, g, k thru a, r, s, u thru z, e-1, g-1, j-1 thru m-1, o-1.
Atlos E-E Carp., j.
Avnet Carp.
Axel Electronics, f, g, k thru n, s, u, v, x, y, g-1, k-1, l-1.
Balco Research Labs., Inc., Capacitor Div., f, g, k thru n, r, s, x, y, z, a-1, c-1, e-1, g-1, k-1, l-1, p-1, q-1.
Barker & Williamson Inc., n-1, o-1, q-1.
Bendix Aviotion Carp., Scintilla Div., l.
Bradford Components, Inc., a.
Bud Rodio Inc., t, o-1, q-1.
Cambridge Thermianic Carp., a, b, f, i, q-1.
Carborundum Co., Refractaries Div., a, k.
Centralab, Div.-Globe-Union, a, b, f, g, l, m, n, r, w, z, e-1, m-1, o-1.
Chemplast, Inc., l-1.
Chicago Gasket Co., k-1, l-1.
Cornell-Dubilier Electric Carp., a, c thru g, k thru p, r, s, v, x, y, z, o-1, b-1, c-1, e-1, h-1, j-1 thru m-1, o-1.
Carning Glass Works, g, i thru l, n, r, w, c-1, e-1.
Corson Electric Mfg. Corp., k, l, m, s, u, x, o-1, f-1, j-1, k-1.
Dearborn Electronic Labs., g, k thru n, r, s, u, v, x, y, o-1, g-1, k-1, l-1.
Devcon Corp., x.
Dalinko & Wilkens, Inc., p-1.
Danner Scientific Ca., z.
Double E Products Co., e, f, g, k, l, m, a, p, r, s, y, k-1, l-1.
EFCON (Electronic Fabricotors, Inc.), g, i, k, l, m, r, s, x, y, z, o-1, c-1, g-1, i-1 thru l-1.
Eostern Jewel Carp., e, e-1.
Electro Mfg. Co., a, f, g, m, q, r, e-1, m-1.
Electro-Capacitors Ca., e, n.
Electro-Measurements Inc., d, o-1.
Electron Products Co., d, f, g, k thru a, r thru u, x, y, z, o-1, c-1, e-1, g-1, k-1, l-1.
Electronic Applications, Inc., b, q, r, s, w, x, o-1.
El Ray Motar Ca., Inc., a, q.
Erie Resistor Corp., a, b, e, f, g, j thru m, a thru r, x, y, b-1, d-1, e-1, g-1, h-1, j-1, l-1, m-1, q-1.
Filmohm Carp., h-1.
Filtran Co., Inc., e, f, k thru a, r, s, u, v, x, y, o-1, e-1, g-1, k-1, l-1.
Fluaracarban Ca., The, k-1, l-1.
Franklin Fibre-Lamitex Carp., x, y, a-1, k-1, l-1.
Freed Transformer Co. Inc., d.
Furance Plastics, Inc., y.
Gas Appliance Stores, Inc., y.
General Electric Co., Apparotus Soles Div., c, e, f, f, k, m, n, r, s, v, y, l-1, j-1, o-1.
Generol Products Corp., a, s, y, o-1.
Geotronic Labs. Inc., a, r, s, g-1, l-1.
Gionnini Plosmadyne Corp.
John Gombos Co., Inc., q-1.
Good-All Electric Mfg. Co., a, c, e, g, k thru a, r, s, u, v, x, y, z, o-1, c-1, e-1, f-1, g-1, k-1, l-1.
Gulton Industries, Inc., a, i, l, m-1.
Hollett Mfg., Co., f.
Hologen Insulotor & Seal Corp., k-1, l-1.
Hammorlund Mfg. Co., Inc., b, l, m, n, e-1, n-1, o-1, q-1.
Haveg Industries, Inc., g-1, k-1, l-1.
ITT-Kellogg, g.
Illinois Condenser Co., d, e, m, n, r, z, e-1, j-1.
Industriol Instruments Inc., d.
Internotionol Electronic Industries, Inc., e, r, e-1, j-1.
JFD Electronics Corp., b, i thru l, r, t, c-1, f-1, n-1, o-1, q-1.
Jennings Rodio Mfg. Corp., m, p-1, q-1.
E. F. Johnson Co., a, m, n, r, t, e-1, n-1, o-1, q-1.
Kling Metol Spinning & Stomping Co., q-1.
Leeds & Northrup Co., d, p, c-1, h-1.
Ling Electronics, Inc., a, b, g, k, l, n, o-1, p-1, q-1.
Mac Leod & Hanopol, Inc., i-1.
Mognovox Co., The, d, i-1, j-1.
Moido Development Co., a, b, f, g, l, m, r, s, e-1, m-1.
P. R. Mollory & Co. Inc., a, e, f, g, k, l, r, v, e-1, j-1.
Morylond Lovo Co., a, x, y, k-1, l-1.
Mc Coy Electronics Ca., q-1.
Mica Fabricating Co., p, q, q-1.
Milam Electric Mfg. Ca., r, x.
Minneapolis-Honeywell Regulotor Co., Industrial Products Group, e-1.
Minnesota Mining & Mfg. Co., a, b, p, u.
Mitranics Inc., b, j, h-1.
Monogram Precision Industries, a, i, l, m, c-1, p-1.
Mucan Corp., a, r, e-1, m-1.
National Beryllia Corp., a, l.
Naz-Dar Co., e-1.
New England Scientific Instruments Ca., h, i-1.
New York Coil Co., a, s.
Northern Plostics Corp., e-1.
Plostic Age Sales, Inc., w, x.
Potter Co., The, f, g, i, k thru a, r, s, u, v, x, y, o-1, e-1, g-1, k-1, l-1.
Precise Development Carp., d.
Radiation Research Corp., m, y, l-1.
Pyramid Electric Co., e, g, j, m, a, q, r, u thru d-1, g-1, j-1.
Radio Industries, Inc., a, f, g, r, z, e-1, m-1.
Rinca, Inc., d.
San Fernando Electric Mfg., Ca., d, f, g, k, l, m, r, s, u, x, y, o-1, c-1, e-1, g-1, k-1, l-1.
Sangama Electric Co., c, e, f, g, k thru p, r, s, x, y, z, o-1, c-1, e-1, g-1 thru o-1.
Southern Electronics Corp., d, g, k, l, m, s, y, o-1, c-1, l-1, q-1.
H. W. Sullivan Ltd., d, c-1, j-1.
Tansitar Electranics, Inc., j-1.
Technograph Printed Electranics, Inc., e-1.
Teiner Engrg. Corp., q-1.
Telectro Industries Corp., k, c-1, q-1.
Texas Capacitor Co., Div.-K-C-K Corp., g, l, n, x, y, k-1, l-1.
Tabe Deutschmann Corp., e, f, j thru a, r, s, u, y, z, o-1, c-1, e-1, g-1, k-1, l-1, m-1, o-1.
Trionics Carp., a, l, e-1.
Underwaad Electric & Mfg. Ca., Inc., g, p, q, h.
United Mineral & Chemical Carp., a, b.
U. S. Science Corp., Div.-Topp Industries, Inc.
U. S. Semicanductor Products, Inc., j-1.
Vacap Corp., p-1.
Victor R. F. & Micrawave Co., c-1.
Vitro Lobs., q.
Waterbury Companies, Inc., x, z.
Westlake Plastics Ca., k-1.
Zenith Radio Carp., a.

CAPS, TUBE

Aerojet-General Corp.
Alden Products Co.
Anchor Metal Spinning Co., The
Arnav Aircroft Associates, Inc.
Claver Industries, Inc.
Cornell Deep Drawing Co., Div.-Lanes Industri Carp.
Habson Brothers, Inc.
Mercury Tool & Mfg. Carp.
Mueller Brass Co.
Seamless Products Co., Inc.
Stanley-Judd Div.-The Stanley Works
Staver Co., Inc., The
Warren Companents, Div. El-Tranics, Inc.

CARTRIDGES, PRESSURE PRODUCING

***MC CORMICK SELPH ASSOCIATES**

CARTRIDGES, STARTER

***AIRESEARCH MFG. CO., DIV.-THE GARRE CORP.**
American Rocket Co.
Amaco Chemicols Carp.
Astrodyne, Inc.
Atlantic Research Carp.
Dynamic Devices, Inc.
Fulton-Irgon Corp., The
Hercules Powder Co.
***MC CORMICK SELPH ASSOCIATES**
Olin Mathieson Chemicol Corp., Energy Div.
***PROPELLEX CHEMICAL DIV., CHROMALL CORP.**
Stondord Oil Co. of Indiana

CASES

a. Diode & Transistar
b. Instrument & Meter
c. Portable
d. Transformer
e. Tubes

A&P Metol Products Mfg. Corp., b, c.
Abolon Precision Mfg. Corp., b.
Adept Industries Inc., b, c.
American Aluminum Co., a thru d.
Anchor Metal Spinning Co., The, a thru e.
Basco Metol Products, Inc., b, d.
Brooks & Perkins, Inc., b, c.
Bud Radio Inc., b, c.
Cambridge Thermionic Corp., e.
Cormody Corp., b.
Chemold Co., b.
Cornell Deep Drawing Co., Div.-Lones Industri Corp., b, c, e.
Corning Gloss Works, a.
Dohlstrom Metallic Door Co., b.
Dresser Mfg. Div., Dresser Industries, Inc.
Elzee Metol Products Co., Inc., b, c.
Great Eastern Metal Products Co., d.
Ludwig Honold Mfg. Co., c.

Ingersoll Kalamazaa Div., Borg-Warner Corp., e.
Kanarr Corp., e.
Kling Metal Spinning & Stamping Co., c.
H. Kach & Sons, b, c.
Lancaster Gloss Corp., b.
Lafstrand Co., The, c.
Lone Star Plastics Co. Inc., a.
Meridian Metalcraft, Inc., a.
Mid-West Metal Products, Inc., b, c, d.
Mitronics Inc., a.
Monogram Precision Industries, e.
Motorola Inc., Military Electronics Div., a.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., o, b, c.
Osborne Electronic Sales Corp., d.
Pneumafil Corp., b, e.
Precision Sheet Metal, Inc., a thru d.
Premier Metal Products Co., b, c.
Prereg Mfg. Inc., b, c, d.
Radiatronics, Inc., b, c.
Rimok, Inc., a thru e.
Roberts Industries Inc., a, b.
Miltan Ross Metals Co., The, a thru d.
Silicone Insulation, Inc., d, e.
Simpson Electric Co., b.
Sinclair Mfg. Co., a.
Skydyne, Inc., a, b, c.
Southwestern Industrial Electronics Co., b, c, d.
Stanley Aviation Corp., c.
Stover Co., Inc., The, a, e.
TA Mfg. Corp., b, c.
Teiner Engrg. Carp., b.
Universal Unlimited, Inc., b, c.
Waldam Electronics Inc., b.
Warren Components, Div. El-Tronics, Inc.
Young & Rioux Woodworking Co., Inc., c.

ASINGS

American Aeroparts
American Car & Foundry, Div.-ACF Industries, Inc.
B. H. Aircraft Co., Inc.
Baker Perkins Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Ludwig Hanald Mfg. Co.
Ingersoll Kalamazaa Div., Borg-Warner Corp.
Kaiser Metal Products, Inc.-Fleetwings Div.
Kirk & Blum Mfg. Co., The
Minnesata Mining & Mfg. Co.
Managram Precision Industries
Scaife Co.-Div.-Wilson Bros.
Smith-Marris Corp.
Twigg Industries
United Mfg. Co., The
United States Rubber Co
Walbar Machine Products Inc.

ASTERS

Aircraft Toals, Inc.
Albian Industries, Inc.
Anchar Metal Spinning Co., The
Bassick Co., The, Div.-Stewart-Warner
Bud Radio Inc.
Capital City Mfg. Co.
Colson Corp., The
Crawn Controls Co., Inc.
Fairbanks Co., The
Faultless Caster Corp.
National Lock Co.
Nelson Labs., Inc.
Precision Metalsmiths, Inc.
Premier Metal Products Co.
Rapids-Standard Co., Inc., The
Shenango Furnance Co., The, Centrifugally Cost Products Div.
United Supply Co.

ASTINGS

a. Centrifugal, Ferraus
b. Centrifugal, Non-Ferraus
c. Die, Ferraus
d. Die, Nan-Ferraus
e. Precision, Ferraus
f. Precision, Non-Ferraus
g. Sand, Ferraus
h. Sand, Non-Ferraus

ACF Industries Inc., d, g.
Acme Bross Foundry Co. of San Antonio, Inc., h.
Airtron Inc., Div.-Litton Industries, f.
Akron Brass Mfg. Co., Inc., h.
Al-Fin Div., Fairchild Engine & Airplane Corp., b, h.
Allegheny Ludlum Steel Corp., a, e, g.
Alloy Steel Casting Co., e, g.
Alloys Unlimited Inc., f.
Alpha Metals, Inc., d, f.
Aluminum Alloys Corp., h.
Aluminum Co. of America, b, d, f, h.
American Aeroparts, a thru h.
American Agile Corp., b.
American Broke Shoe Co., a, e thru h.
American Car & Foundry, Div.-ACF Industries, Inc., g.
Ampco Metal, Inc., b, h.
Anchor Metal Co. Inc., d, f.
Arrow Tool Co. Inc., a thru h.
Austenal Co., Div.-Howe Sound Co., Microcast Products, e, f.
Auto Specialties Mfg. Co., Inc., e, g.
Avion Foundry Corp., b, f, h.
Basic Tool Industries, Inc., d, h.
Marris Bean & Co., f.
Bearium Metals Corp., h.
Bell & Howell Co., d thru f.
Belmant Smelting & Refining Warks, Inc., c.
Bendix Foundries, Bendix Aviation Corp., b, d, f, h.
Bergen Carbide Co., a, b.
E. W. Bliss Co., g.
Blowers Inc., g.
Bridgepart Brass Co., d, f, h.
Bullard Co., The, h.
Celco (Constantine Engrg. Labs. Co.), b.
Casting Engineers Div., Consolidoted Foundries & Mfg. Carp., e, f.
Choin Belt Co., g.
Chombersburg Engrg. Co., g.
Clark Equipment Co., g, h.
Colonial Aircraft Corp., h.
Consolidated Diesel Electric Corp., h.
C. Lee Cook Co., Airtamic Products Div., g, h.
Cooper-Bessemer Carp., The, g.
Crompton & Knowles Corp., g.
Crouse-Hinds Ca., g, h.
Curtiss-Wright Corp.-Wright Aeronautical Div., c, f, h.
Dirilyte Co. of Americo, Inc., h.
Division Lead Co., b, d, h.
Dodge Steel Co., g.
Dollin Corp., d.
Dow Chemical Ca., The, d, f, h.
Duraloy Co., The, a, g.
Eaton Mfg. Ca., e.
Electric Auto-Lite Co., The, d, g.
Electric Steel Foundry Co., a, e, g.
Electro-Mechanical Products Co., f, h.
Engineered Precision Casting Co., e, f.
FXR, Inc., e, f.
Farrel Birmingham Co. Inc., a, g.
General Alloys Co., a, g.
General Electric Co., Metallurgical Products Dept., e.
Gordan Enterprises, a thru f.
Hamilton Faundry & Machine Co., The, g.
Haynes Stellite Co., Div.-Union Carbide Carp., b, e, f, h.
Hills-Mc Canno Ca., h.
Hitchiner Mfg. Co., Inc., e, f.
Investment Casting Co., e, f.
Jovelin Aircraft Co. Inc., c, g, h.
Kenarr Carp., d, f.
Kolcast Industries-Div. Thampson Rama Wooldridge Inc., a, b, d, e.
Lebanan Steel Foundry, a, e, g.
Light Metals, Inc., h.
Lindgren Foundry Co., g.
Magline Inc., d, h.
Mc Pherson Corp., d, e, f, h.
Mercast Mfg. Corp., d, e.
Minneapolis-Honeywell Regulator Co., Ordnonce Div., d, f.
Misco Precisian Casting Co., e.
Morse Instrument Co., The, f.
Mueller Brass Co., h.
National Lead Ca., c.
National Pneumatic Co., Inc., Holtzer-Cobot Divs., d, f, g, h.
Ohio Precision Castings, Inc., f, h.
Perfecto Cast, e, g.
Piasecki Aircraft Corp., e, f, h.
Precision Castings, Inc., b, f, h.
Precision Castparts Corp., a, e.
Precision Metalsmiths, Inc., d, e.
Randall Graphite Bearings, Inc., b, h.
Rolle Mfg., Co.
Saginow Bearing Co., h.
Roy A. Scharer & Co., a thru d, g, h.
Shenango Furnace Co., The, Centrifugolly Cast Products Div., a.
Sibley Machine & Foundry Corp., g.
Solon Foundry, Inc., f, h.
Stover Co., Inc., The, b, d.
Swoyne, Robinson & Co., e thru h.
Techni-Cost Corp., b.
Teiner Engrg. Corp., d, f, g, h.
Titan Metal Mfg. Co., d.
True Alloys Inc., b, f, h.
U. S. Industries, Inc.
Veet Industries, b, f, h.
Vilter Mfg. Co., The, g.
Watertown Div., The New York Air Broke Co., g, h.
Waukesha Foundry Co., g, h.
Wayne Foundry & Stamping Co., h.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Wellmon Bronze & Aluminum Co., f, h.
Western Automatic Machine Screw Co., Div. Standard Screw Co., g.
Western Iron & Foundry Co., Inc., c, g.
Westinghouse Electric Corp., Metals Plant, e, f.
Wheel Croft Inc., b, f.
Wilcox-Crittenden Div., North & Judd Mfg. Co., g, h.
Wisconsin Aluminum Foundry Co., Inc., h.

CASTINGS, ROTOR
See ROTOR CASTINGS

CATAPULTS

All American Engrg. Co.
Allied International Co.
American Car & Foundry, Div.-ACF Industries, Inc.
Americon Machine & Foundry Co., Greenwich
E. W. Bliss Co.
Breeze Corporations, Inc.
Farrel Birminghom Co. Inc.
Fulton-Irgon Corp., The
Halex, Inc.
Horkey-Moore Associates
Javelin Aircroft Co. Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kemp Aero Products
Longren Aircraft Co., Inc.
*MC CORMICK SELPH ASSOCIATES
Monogram Precision Industries
*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.
Ravenna Metol Products, Div.-Standard Screw Co.
Reaction Motors Div., Thiokol Chem. Corp.
Red Lion Cobinet Co., Redco Tool Div.
Stanley Aviatian Corp.
Talley Carp., The
Thiokol Chemical Corp.
U. S. Industries, Inc.
Van Zelm Associates, Inc.
Woshington Aluminum Co., Inc.

CATHODE RAY TUBE CHECKERS
See CHECKERS, CATHODE RAY TUBE

CATHODES

Associoted Engrg. & Mfg. Corp.
J. Bishop & Co., Platinum Works
Bram Metollurgical & Chemicol Co.
Giannini Plasmodyne Carp.
Philco Corp., Government & Industrial Div.
Thamos Electronics, Inc.

CELLS, PHOTOELECTRIC

Cloirex Corp.
Eastman Kodak Co.
General Electric Co., Apporotus Soles Div.
Haffmon Electronics Corp., Semiconductor Div.
ITT Labs.-Ft. Wayne
Internationol Rectifier Carp.
Philco Corp., Government & Industrial Div.

CELLS, STANDARD

Eppley Laboratory, Inc., The
Hoffman Electronics Corp., Semiconductor Div.
Julie Research Labs., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Philco Carp., Gavernment & Industrial Div.
Weston Instruments, Div.-Daystram, Inc.

CELLS, THERMAL CONDUCTIVITY
See THERMAL CONDUCTIVITY CELLS

CEMENT

a. Asbestos
b. Pipe-Joint
c. Plastic
d. Rivet
e. Rubber
f. Rubber-To-Metal
g. Wood

Allied Plastics Supply Corp., b, c.
Ambroid Co. Inc., c thru g.
American Agile Corp., c.
American Latex Products Carp., c, e, f.
Arco Co., The, b.
Aristocrat Plastics, Inc., c.
Barrett-Christie Co., a, b, c.
Carl H. Biggs Co., c, f, g.
Bloomingdale Rubber Co., a thru g.
Bonny Mfg. Corp., b.
Borden Chemical Co., b thru g.
Colonial Rubber Co., f.
Connecticut Hard Rubber Co., The, e, f.
Cooper Industries, Inc.
Crone Pocking Co., b.
DBM Research Corp., c.
Dayton Rubber Co., The, e, f.
Dennis Chemical Co., b, c, e, g.
Devcon Corp., a, c, e, f, g.
Du-Co Ceramics Co., g.
E. I. Du Pont De Nemours & Co., Inc., e, f.
Eagle-Picher Co., The, a.
Emerson & Cuming, Inc., a, c, e, f, g.
Fisher Scientific Co., a, e.
Furane Plastics, Inc., b, c, f, g.
General Cement Mfg. Co., Div.-Textron, Inc., c, f.
B. F. Goodrich Industriol Products Co., e, f.
Goodyear Tire & Rubber Co., The, Aviation Products Div., e.
Grant Chemical Co., Inc., b, c, e, f, g.
Haveg Industries, Inc., c.
R. M. Hollingshead Corp., c, e.
Homolite Corp., The, c, g.
Huntington Rubber Mills, e, f.
Johns-Manville, a, c, e, f.
Johns-Manville Soles Corp., a.
Lamtex Industries, Inc., c.
Leffingwell Chemical Co., f.
Louthan Mfg. Co., The, Div.-Ferro Corp., g.
Maas & Woldstein Co., a, c, e, f, g.
Morblette Corp., The, a, c.
Minnesota Mining & Mfg. Co., c thru g.
Minnesota Mining & Mfg. Co.-Adhesives, Coating & Sealers Div., e, f.
Monogram Precision Industries, c.
National Ceramic Co., g.

Notionol Engrg. Products, Inc., b, c.
New England Tape Co., Div.-United-Carr Fastener Corp., c.
Permacel, b, c, e, f, g.
Permatex Co., Inc., b, c, e.
Presstite Div., American-Marietta, f.
Protex-A-Cote, Inc., b, c, f, g.
Raybestos-Manhattan, Inc., Pa., f.
Reinhold Engrg. & Plastics Co., a, c.
Rubbercraft Corp. of California, e, f.
Saureisen Cements Co., a, b, e, f.
Ray A. Scharer & Co., e, f.
Smooth-On Mfg. Co., b, c.
Topper Mfg. Co., Inc., a, b, c, e, f, g.
Union Asbestos & Rubber Co., a.
United States Chemical Milling Corp., g.
United States Plywood Corp., g.
United States Rubber Co., e, f.
X-Pando Corp., b, c.

CENTRIFUGAL FLOW COMPRESSOR ASSEMBLIES
See COMPRESSOR ASSEMBLIES, CENTRIFUGAL FLOW

CERAMIC PARTS

Aeronca Mfg. Corp.
American Lava Corp.
American Refractories & Crucible Corp.
Antenna & Radome Research Associates
Auburn Spark Plug Co., Inc.
B G Corp., The
Ball Machine Products Co., The
Bergen Carbide Co.
Birma Mfg. Co. Inc.
Birnbach Radio Co., Inc.
Brush Beryllium Co., The
Cambridge Thermionic Corp.
Carborundum Co., Latrobe Plant, Refractories Div.
Carborundum Co., Refractories Div.
Centrolab, Div.-Globe-Union
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Corning Glass Works
Curtiss-Wright Corp., Reseorch Div.
Curtiss-Wright Corp., Santa Barbara Div.
Delta Chemical Works, Inc.
Diamonite Products Mfg. Co.
Duramic Products Inc.
Electric Auto-Lite Co., The
Electrical Refractories Co., The
Electronic Mechanics, Inc.
Erie Resistor Corp.
Frenchtown Porcelain Co.
General Electric Co., Insulator Dept.
General Electric Co., Metallurgical Products Dept.
Glodding, McBean & Co.
Internotional Resistance Co.
Isolontite Mfg. Corp.
***KEARFOTT CO., INC.**
Kip Electronics Corp.
Lockheed Aircraft Corp., Missiles & Space Div.
Moryland Lava Co.
Metallizing Co. of Los Angeles Inc.
Minneopalis-Honeywell Regulator Co., Ordnance Div.
Minnesoto Mining & Mfg. Co.
Mitronics Inc.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
Normco Mfg. Co.
National Beryllia Corp.
Nationol Ceramic Co.
Norton Co.
Norton Co., New Products Dept.
Superior Steatite & Ceramic Corp.
Therm, Inc.
Thermal Refractories Corp.
Topper Mfg. Co., Inc.
United Mineral & Chemical Corp.
Zirconium Corp. of America

CERAMICS, HIGH TEMPERATURE

Aerojet-General Corp.
Aeronca Mfg. Corp.
American Latex Products Corp.
American Lava Corp.
American Refractories & Crucible Corp.
Auburn Spark Plug Co., Inc.
B G Corp., The
Brush Beryllium Co., The
Carborundum Co., Latrobe Plant, Refractories Div.
Carborundum Co., Refractories Div.
Centrolab, Div.-Globe-Union
Consolidated Electrodynamics Corp.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Corning Glass Works
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Santo Barbara Div.
DBM Research Corp.
Diamonite Products Mfg. Co.
Duramic Products Inc.
Dyno-Therm Chemical Corp.
Electric Auto-Lite Co., The
Electronic Mechanics, Inc.
Erie Resistor Corp.
Frenchtown Porcelain Co.
General Electric Co., Metallurgicol Products Dept.
Glodding, McBean & Co.
Hoveg Industries, Inc.
Haynes Stellite Co., Div.-Union Carbide Corp.
Isolantite Mfg. Corp.
***KEARFOTT CO., INC.**
Lockheed Aircraft Corp., Missiles & Space Div.
Marquardt Aircraft Co.
Maryland Lava Co.
Metollizing Engrg. Co., Inc.
Minneapolis-Honeywell Regulator Co., Ordnance Div.
Minnesota Mining & Mfg. Co.
Mitronics Inc.
Monogram Precision Industries
Morganite, Inc.
Motorola Inc., Military Electronics Div.
National Beryllia Corp.
Norton Co.
Norton Co., New Products Dept.
Plastic Age Sales, Inc.
Thermal Refractories Corp.
Topper Mfg. Co., Inc.
Trionics Corp.
Zirconium Corp. of America

CHAIN, SMALL DRIVE

Atlas Precision Products Co.
Choin Belt Co.
Sierra Engrg. Co.

CHAINS

Atlas Precision Products Co.
Chain Belt Co.
Dodge Mfg. Corp.
Jeffrey Mfg. Co., The
Link-Belt Co.
Newbrook Machine Corp.
Stephens Adamson Mfg. Co., Seal Master Bearing Div.

CHAMBERS

a. Acoustic
b. Alpha, Nuclear
c. Environmental
d. Ionization
e. Shielded Screen
f. Temperature & Humidity
g. Test

***AC ELECTRONICS DIV., GENERAL MOTORS CORP., g.**
Aeronutronic Systems, Inc., Sub.-Ford Motor Co., c.
Aireco, Inc., c, f, g.
American Instrument Co., Inc., c, f, g.
American Research Corp., c, f.
Anchor Specialty Mfg. Co., Inc., c, g.
Anton Electronic Labs., Inc., b, d.
Applied Physics Corp., d.
***ASSOCIATED TESTING LABS., INC., a, c, f, g.**
Astravac Corp., c, d, f, g.
Avtron Mfg., Inc., b.
Bar-Ray Products, Inc., d.
Blue M Electric Co., c, f, g.
Brown Engrg. Co., Inc., g.
Chicago Bridge & Iron Co., c, f, g.
Consolidated Electrodynamics Corp., Rochester Div., c, f.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., d.
DBM Research Corp., g.
Dean Products, Inc., b, c, g.
Delta Design Engineers, Inc., c, f.
Development Engrg. Co., Inc., c, f, g.
Diversey Engrg. Co., g.
Dynamic Devices, Inc., g.
Electronic Instrument Co., Inc. (EICD), g.
Environmental Equipment Co., c, f, g.
Fisher Scientific Co., f.
Gardner Laboratory, Inc., c, f.
General Electric Co., Apparatus Sales Div., d.
General Electric Co., X-Ray Dept., d.
Giannini Plasmadyne Corp., c.
Greenbrier Instruments Inc., f, g.
Grieve-Hendry Co., Inc., e, f.
Guardite Co., Div. of American Marietta Co., c, f, g.
Paul Hardeman, Inc., c, f, g.
Harris Refrigeration Co., c, f, g.
Hicks Corp., The, c.
High Vacuum Equipment Corp., c.
Homalite Corp., The, f.
Industrial Acoustics Co., Inc., a, c, e, g.
Industrial Engrg. Corp., g.
Instruments Div.-Philips Electronics, Inc., c.
International Radiant Corp., c, f, g.
Interstate Electronics Corp., d.
Jamison Cold Storage Door Co., a, c, f, g.
Kahn & Co., Inc., g.
Land-Air Inc., d.
Ling Electronics, Inc., a, g.
Magee-Bralla & Associates, c, g.
Mast Development Co., Inc., c, g.
Mc Millan Industrial Corp., e.
Missimers Inc., c, f, g.
Monogram Precision Industries, c, f, g.
Murphy & Miller Inc., c, f, g.
NRC Equipment Corp., d, g.
Newbrook Machine Corp., a thru f.
Nuclear Corp. of Americo, b, d.
Nuclear-Chicago Corp., d.
Peschel Electronics, Inc., g.
Project Fabricotion Corp., c, f, g.
Rototest Labs., Inc., a.
Shielding Inc., a, c, e, g.
Smith-Morris Corp., b.
Spoce Corp., c, f, g.
Stote Testing Lab. Inc., c, g.
Strond Engrg. Co., b.
Surface Combustion Corp., f.
Temperature Engrg. Corp., c, f, g.
Tenney Engrg., Inc., c, f, g.
Thompson Engrg. Co., The, Missile Products Div. a, f.
Topatron, Inc., e, g.
Universal Dynamics Corp., f, g.
Winder Aircraft Corp. of Florida, g.

CHARGERS, BATTERY

Acme Electric Corp.
Aerolab Development Co.
Allis-Chalmers
Associated Engineers, Inc.
Automatic Switch Co.
Basco Metal Products, Inc.
Bogue Electric Mfg., Co.
Cornell-Dubilier Electric Corp.
Dresser Electric Co.
Electric Auto-Lite Co., The
Electro Products Laboratories, Inc.
***ETS-HOKIN & GALVAN**
Exide Industrial Div.-The Electric Storage Battery Co.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
Green Rectifier Co.
Guided Missile Div.-De Havilland Aircraft of Canada, Ltd.
Knopp Inc.
Leach Corp.
Leland Airborne Products, Div.-American Machine & Foundry Co.
P. R. Mallory & Co. Inc.
Meteor Production Engrg., Inc.
Model Rectifier Corp.
J. J. Monoghan Co., Inc.
Motor Appliance Corp.
***MOTOR GENERATOR CORP.**
Motoresearch Co.
North Electric Co.
Northeastern Engrg. Inc.
D. W. Dnan & Sons Inc.
Paco Electronics Co., Inc.
Peer, Inc.
Perkin Engrg. Corp.
Power Supplies Inc.
Precise Development Corp.
Reflectone Corp., The
Republic Aviation Corp.
Safety Electrical Equipment Corp.
Schauer Mfg. Corp.
Sel-Rex Corp.
Sorensen & Co., Inc.
Southwestern Industrial Electronics Co.
Sun Electric Corp., Aeronautical Div.
Syntron Co.
Technical Apparatus Builders
Telectro Industries Corp.
Terada Co.
United Control Corp.
United States Chemical Milling Corp.
United States Dynamics Corp.
Western Design, Div.-U. S. Industries, Inc.; Santa Barbara Div.
Westinghouse Electric Corp.
Willard Storage Battery Div.
Wincharger Corp., Sub.-Zenith Radio Corp.
Winder Aircraft Corp. of Florida
Winpower Mfg. Co.

CHASSIS, CABINET

Abalon Precision Mfg. Corp.
Aerodex, Inc.
Aircraft Tools, Inc.
Alden Products Co.
Alpitec, Inc.
Aluminum Co. of America
American Aluminum Co.
American Machine & Foundry Co., Government Products Group
Anchor Metal Spinning Co., The
Basco Metal Products, Inc.
Basic Tool Industries, Inc.
Benson Mfg. Co., The
Bergen Carbide Co.
Brooks & Perkins, Inc.
Bud Radio Inc.
Carmody Corp.
Centronix Inc.
Chemold Co.
Chrysler Corp., Defense Dperations Div.
Cole Electric Co.
Colonial Aircraft Corp.
Cutler Metal Products Co.
Detronic Industries
Electro-Mechonical Products Co.
Elzee Metol Products Co., Inc.
Falstrom Co.
Farwell Metol Fobricoting
Fletcher Mfg. Co., Inc., The
Green Rectifier Co.
Greenbrier Instruments Inc.
Hordmon Tool & Engrg. Co.
Ludwig Honold Mfg. Co.
Horkey-Moore Associotes
Hughes Tool Co., Aircraft Div.
Hussmonn Aircroft Div.
Hycon Mfg. Co.

dustrial Tools Mfg. Corp., Sub.-Pendleton Tool
Industries, Inc.
ercontinental Mfg. Co., Inc.
iser Aircraft & Electronics, Div.-Kaiser
Industries Corp.
lsey-Hayes Co.
nnedy Van Saun Mfg. & Engrg. Corp.
k & Blum Mfg. Co., The
itch-Huard Corp.
fstrand Co., The
ngren Aircraft Co., Inc.
H. Lynch Mfg. Co.
rcury Tool & Mfg. Corp.
ridian Metalcraft, Inc.
tal Fabricators Corp.
-West Metal Products, Inc.
IRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
nogram Precision Industries
rse Instrument Co., The
tional Pneumatic Co., Inc., Holtzer-Cabot Divs.
asecki Aircroft Corp.
ecision Sheet Metal, Inc.
emier Metal Products Co.
ereg Mfg. Inc.
d Lion Cabinet Co., Redco Tool Div.
mak, Inc.
kon Electronics Inc.
nta Anita Engrg. Co.
quoia Wire & Cable Co., Div.-Mandrel Industries, Inc.
aw Metal Products Corp.
yline Products, Inc.
ith-Morris Corp.
uthwestern Industrial Electronics Co.
ecialty Engrg. & Electronics Co.
in Coach Co., Aircroft-Missiles
ited Aircraft Products Inc.
S. Industries, Inc.
ited States Chemical Milling Corp.
riety Aircraft Corp.
tson Mfg. Co., Inc.
nder Aircraft Corp. of Florida
co Metal Products

CHASSIS HOLDERS
See HOLDERS, CHASSIS

CHASSIS, METAL
P Metal Products Mfg. Corp.
alon Precision Mfg. Corp.
rodex, Inc.
craft Tools, Inc.
der. Products Co.
bitec, Inc.
uminum Co. of America
erican Aluminum Co.
erican Machine & Foundry Co., Government Products Group
chor Metal Spinning Co., The
rgen Carbide Co.
ooks & Perkins, Inc.
d Radio Inc.
pital City Mfg. Co.
ntronix Inc.
rysler Corp., Defense Operations Div.
ark-Aiken Co., The
lonial Aircraft Corp.
nco Engrg. Works
rnell Deep Drawing Co., Div.-Lanes Industries Corp.
omer Mfg. & Engrg., Inc.
tler Metal Products Co.
hlstrom Metallic Door Co.
tronic Industries
ctra-Mechanical Products Co.
ay Corp.
ee Metal Products Co., Inc.
lstrom Co.
rwell Metal Fabricating
rris-Mfg. Co., The
etcher Mfg. Co., Inc., The
aflex Inc.
gen Rectifier Co.
rdman Tool & Engrg. Co.
dwig Honold Mfg. Co.
ssman Aircraft Div.
can Mfg. Co.
dustrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
ercontinental Mfg. Co., Inc.
ta, Inc.
iser Aircraft & Electronics, Div.-Kaiser Industries Corp.
lsey-Hayes Co.
nnedy Van Saun Mfg. & Engrg. Corp.
k & Blum Mfg. Co., The
itch-Huard Corp.
fstrand Co., The
ngren Aircraft Co., Inc.
H. Lynch Mfg. Co.
rcury Tool & Mfg. Corp.
ridian Metalcraft, Inc.
tal Fabricators Corp.
d-West Metal Products, Inc.
iller Dial & Nameplate Co.
IRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
nogram Precision Industries
rse Instrument Co., The
torola Inc., Military Electronics Div.
elika Welding, Machine & Supply Inc.
*PACKARD-BELL ELECTRONICS CORP.
Piasecki Aircroft Corp.
Precision Sheet Metal, Inc.
Premier Metal Products Co.
Red Lion Cabinet Co., Redco Tool Div.
Rimak, Inc.
Rixon Electronics Inc.
Santa Anita Engrg. Co.
Shaw Metal Products Corp.
Skyline Products, Inc.
Smith-Morris Corp.
Stanley Aviation Corp.
Roland Teiner Co., Inc .
Turbo Machine Co.
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
Variety Aircraft Corp.
Watson Mfg. Co., Inc.
Welded Construction Inc.
Wyco Metal Products

CHECKER, CABLE
Amelco, Inc.
American Bosch Arma Corp.
American Machine & Foundry Co., Government Products Group
Anchor Specialty Mfg. Co. Inc.
Associated Research, Inc.
Bogue Electric Mfg., Co.
California Technical Industries, Div.-Textron Inc.
Consolidated Diesel Electric Corp.
Dit-Mco, Inc., Electronics Div.
Hallamore Electronics Co.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Korda Industries
Land-Air Inc.
Motorola Inc., Military Electronics Div.
Optimized Devices, Inc.
Peschel Electronics, Inc.
Radiophone Co. Inc.
Telectro Industries Corp.
Thomas Electronics, Inc.

CHECKERS, CATHODE RAY TUBE
Hi-Lo Manufacturing Corp.
International Research Associates
Monogram Precision Industries
Paco Electronics Co., Inc.
Precise Development Corp.
Precision Apparatus Co., Inc.
Thomas Electronics, Inc.
Tricraft Products Corp.

CHECKERS, CRYSTAL RECTIFIER
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
Munston Mfg. & Service, Inc.
Paco Electronics Co., Inc.
Precision Apparatus Co., Inc.
Technical Apparatus Builders
Wright Engrg. Co.

CHECKERS, KLYSTRON TUBE
Land-Air Inc.
Philco Corp., Government & Industrial Div.
Polarad Electronics Corp.
Telerad Mfg. Corp.

CHEMICAL DEVELOPERS
See DEVELOPERS, CHEMICAL

CHEMICALS, RADIOACTIVE
*ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.
Bio-Rad Labs.
Bios Labs., Inc.
Curtiss-Wright Corp., Research Div.
Matheson Co., Inc., The
Minnesota Mining & Mfg. Co.
Nuclear-Chicago Corp.
United States Radium Corp.

CHEMICALS, TUBE
*ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.
Barium & Chemicals, Inc.
Bios Labs., Inc.
Borden Chemical Co.
E. I. Du Pont De Nemours & Co. Inc.
Kelite Corp.
Lebec Chemical Corp.
Dakite Products, Inc.
Sylvania Electric Products Inc., Chemical & Metallurgical Div.

CHEMICALS, WIRE STRIPPER
*ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.
Bios Labs., Inc.
Borden Chemical Co.
Division Lead Co.
General Cement Mfg. Co., Div.-Textron, Inc.
Kelite Corp.
London Chemical Co., Inc.
Matheson Co., Inc., The
Dakite Products, Inc.
Wye Industries

CHOKES
Airpax Electronics Inc. Seminole Div.
Ballastron Corp.
Barwood Electronics Inc.
Bud Radio Inc.
Cable Electric Products Inc.
Cambridge Thermionic Corp.
Carol Electronics Corp.
Chicago Standard Transformer Corp.
Clippard Instrument Lab., Inc.
Double E Products Co.
Dresser Industries, Inc.
Electrical Windings, Inc.
Era Electric Corp.
Ferranti Electric Inc.
Ferroxcube Corp. of America
Forbes & Wagner, Inc.
Forest Electric Co., The
Green Rectifier Co.
Hindle Transformer Co. Inc.
International Resistance Co.
E. F. Johnson Co.
Keystone Products Co.
Langevin Div., W. L. Maxson Corp., The
Microtran Co. Inc.
Sanford Miller Co.
Minitran Corp.
Motorola Inc., Military Electronics Div.
NYT Electronics, Inc.
National Coil Co.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
New York Transformer Co. Inc.
North Hills Electric Co., Inc.
Omega Electronic Corp.
Perry Plastics, Inc.
Raytheon Mfg. Co.
Rollan Electric Co.
Rytron Co., Inc.
Soge-Craft, Inc.
Sangamo Electric Co.
Shallcross Mfg. Co.
Signal Transformer Co.
Sterling Transformer Corp.
Technical Apparatus Builders
Torwico Electronics, Inc.
Transformer Design, Inc. of Milwaukee
Transonic, Inc.
Triod Transformer Corp.
Universal Mfg. Co., Inc.
Varo Mfg. Co., Inc.
Virginia Electronics Co., Inc.
Warren Transformer Co., Inc.
Westbury Electronics Inc.

CHROMATOGRAPHS
American Agile Corp.
American Instrument Co., Inc.
Beckman-Scientific & Process Instruments Div.
Bio-Rad Labs.
Bristol Co., The
Consolidated Electrodynamics Corp.
Fisher Scientific Co.
Greenbrier Instruments Inc.
Hallikainen Instruments
Matheson Co., Inc., The
Perkin-Elmer Corp.

CHROMATOGRAPHS, VAPOR PHASE
Beckman-Scientific & Process Instruments Div.
Bio-Rad Labs
Consolidated Electrodynamics Corp.
Fisher Scientific Co.
Hollikainen Instruments
Leeds & Narthrup Co.
Matheson Co., Inc., The
Perkin-Elmer Corp.

CHRONOGRAPHS
Bristol Co., The
M. Ducommun Co.
Electro-Medical Lab., Inc.
Gaertner Scientific Corp., The
Gordon Enterprises
Hamilton Watch Co.
Hamilton Watch Co.,-Industrial Div.
Jardur Aviation Co.
Jardur Import Co.
Ernest Norrman Laboratories
Systron Corp.
Union Switch & Signal, Div.-Westinghouse Air Brake Co.
Wakmann Watch Co. Inc.
Waltham Engrg. Corp.

CHRONOMETERS
Gordon Enterprises
Hamilton Watch Co.
Hamilton Watch Co.-Industrial Div.
Sphinx-American Co.
Wakmann Watch Co. Inc.
Waltham Engrg. Corp.

CHRONOSCOPES
Systron Corp.
Waltham Engrg. Corp.

CIRCUIT BREAKERS
See BREAKERS, CIRCUIT

CIRCUITS
a. Computer, Logic
b. Computer, Packaged
c. Plated
d. Plug-In

*AC ELECTRONICS DIV., GENERAL MOTORS CORP., a, d.
ACF Industries Inc., a.
Accurate Electronics Corp., Dept. D, a, b.
Aeronca Mfg. Corp., Baltimore Facility, b.
Aeronutronic Systems, Inc., Sub.-Ford Motor Co., a thru d.
Air Logistics Corp., d.
Airflyte Electronics Co., c, d.
American Machine & Foundry Co., Greenwich, a, b, d.
American Printed Circuits Co., Inc., c, d.
Arthur Ansley Mfg. Co., d.
Bendix Aviation Corp., York Div., a, d.
Bendix Computer, Div.-Bendix Aviation Corp., a, b, d.
Bendix Radio Div., Bendix Aviation Corp., a, d.
Briggs Associates, Inc., a.
Burr-Brown Research Corp., b, d.
Burroughs Corp., a, b.
Burton-Rodgers, Inc., b, d.
C & K Components, Inc., a, b.
Carmody Corp., b, d.
Centralab, Div.-Globe-Union, b, d.
Centronix Inc., a, b, d.
Cleveland Metal Specialties Co., Electronics Div., a, b, d.
Colorado Reseorch Corp., b.
Computer Control Co., Inc., a, b.
Consolidated Diesel Electric Corp., d.
Control Circuits Inc., b, c, d.
Croname Inc., c.
Curtiss-Wright Electronics Div., IMI Branch, b.
DBM Research Corp., a, d.
Dalmotor Div., Yuba Consolidated Industries, Inc., a thru d.
Daven Co., The, b, d.
Daystrom Pacific Div.-Daystrom, Inc., b, d.
Dayton Aviation Radio & Equipment Corp., d.
Di-An Controls, Inc., a, b, d.
Donner Scientific Co., b.
Doty Acoustica Electronic Labs., c, d.
Double E Products Co., a thru d.
Dresser Industries, Inc., d.
Eaton Electronics Corp., c.
Eldorado Electronics, d.
Electro Precision Corp., b, d.
Electronic Communications, Inc., b.
Electronic Engrg. Co. of California, a, b, d.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., a thru d.
Erie Resistor Corp., a, d.
Federal Mfg. & Engrg. Corp., a, d.
Ferranti Electric Inc., a, b.
Ferris-Mfg. Co., The, b,
Ferrotran Electronics Co., Inc., d.
Forbes & Wagner, Inc., a.
General Electric Co., Apparatus Sales Div., a.
Gilfillan Bros. Inc., a, b.
Gladding, McBean & Co., c.
Good Electronic Corp., d.
Hallicrafters, a, b.
Hamilton Standard, Div.-United Aircraft Corp., a thru d.
Harvey-Wells Electronics Inc., a, b.
Hoffman Electronics Corp., Semiconductor Div., a, d.
Walter J. Hyatt Co., The, b.
*KEARFOTT CO., INC., b.
Lamtex Industries, Inc.,c.
Land-Air Inc., d.
La Roe Instruments, Inc., a, b, d.
Librascope Inc., a, b.
Litton Industries, U. S. Engrg. Co., Div., a thru d.
Lockheed Aircraft Corp., Missiles & Space Div., a.
MF Electronics Co., b, d.
Milgo Electronic Corp., a, b, d.
Motorola Inc., Military Electronics Div., a thru d.
NYT Electronics, Inc., d.
National Pneumotic Co., Inc., Holtzer-Cabot Divs., d.
Navigation Computer Corp., a thru d.
North Electric Co., a, d.
Northrop Corp., a thru d.
Ohio Semiconductors, Inc., a, b.
*PACKARD-BELL ELECTRONICS CORP., a thru d.
George A. Philbrick Researches, Inc., b, d.
Philco Corp., Government & Industrial Div., a, b, d.
Power-Tronic Systems Inc., a thru d.
Precise Development Corp., d.
Printed Electronics Corp., c, d.
Printronics Corp., c, d.
Projects Unlimited Inc., d.
RS Electronics Corp., d.
Radiaphone Co. Inc., d.
Radiation, Inc., a, b.
Raytheon Mfg. Co., a.
Rese Engrg., Inc., a thru d.
Rixon Electronics Inc., a, b, d.
Milton Ross Metals Co., The, c, d.
Servomechanisms, Inc.
Singer Mfg. Co., The, Military Products Div., a.
Slip Ring Co. of America, c.
Soroban Engrg., Inc., a.
Southwestern Industrial Electronics Co., a thru d.
Sterling Precision Corp., Instrument Div., a, b.
Superex Electronics Corp., d.
Tapco Group, Thompson Ramo Wooldridge Inc., a.
Technitrol Engrg. Co., a, b, d.
Telechrome Mfg. Corp., a thru d.
Telectro Industries Corp., a thru d.
Tapper Mfg. Co., Inc., d.
Transistor Electronics Corp., a, b.
Transonic, Inc., d.
Trionics Corp., a, d.
Vitro Labs., a thru d.
Walkirt Co., a, b, d.
Webcor, Inc., Government Div., a, d.

CIRCUITS-PRINTED, STAMPED, ETCHED
ACF Industries Inc.
Adept Industried Inc.
Aerolite Electronics Corp.
Aeronutronic Systems, Inc., Sub.-Ford Motor Co.
Air Logistics Corp.
Amelco, Inc.
Arthur Ansley Mfg. Co.
Bendix Aviation Corp., York Div.
Bendix Computer, Div.-Bendix Aviation Corp.
Bendix Radio Div., Bendix Aviation Corp.
Best Aircroft Corp.
Whitney Bloke Co.
Brown Engrg. Co., Inc.
Burr-Brown Research Corp.
Burroughs Corp.
Burton-Rodgers, Inc.
Chrysler Corp., Defense Operations Div.
Cleveland Metal Specialties Co., Electronics Div.
Continental Technical Service, Inc.
Corning Glass Works
Croname Inc.
Dale Products, Inc.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Doyton Aviation Rodio & Equipment Corp.
Digitronics Corp.
Dorsett Labs., Inc.
Doty Acoustica Electronic Labs.
Du Kane Corp.
Eaton Electronics Corp.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Electralab Inc.
Electronic Engrg. Co. of California
Emerson Electric Mfg. Co., The Electronics & Avionics Div.
Emerson Radio & Phonograph Corp.
Erie Resistor Corp.
Etched Products Corp.
Gladding, McBean & Co.
Globe Electrical Mfg. Co.
Good Electronic Corp.
B. F. Goodrich Aviation Products
Gulton Industries, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Harvey-Wells Electronics Inc.
Walter J. Hyatt Co., The
ITT Labs.
Land-Air Inc.
Landsverk Electrometer Co., The
La Pointe Industries Inc.
Litton Industries, Maryland Div.
Litton Industries, U. S. Engrg. Co., Div.
MF Electronics Co.
Mansfield Fabricators Inc.
Methode Mfg. Corp.
Miller Dial & Nameplate Co.
Minneapolis-Honeywell Regulator Co., Drdnance Div.
Minnesota Mining & Mfg. Co.
Motorola Inc., Military Electronics Div.
Newton Co., The
Northern Plastics Corp.
Northrop Corp.
*PACKARD-BELL ELECTRONICS CORP.
Philco Corp., Government & Industrial Div.
Piasecki Aircraft Corp.
Power-Tronic Systems Inc.
Precision Circuits, Inc.
Printed Electronics Corp.
Printronics Corp.
Q-Circuits, Div.-Etching Co. of Calif.
RS Electronics Corp.
Rogers Corp.
Milton Ross Metals Co., The
Ryan Aeronautical Co.
St. Regis Paper Co., Panelyte Div.
Southwestern Industrial Electronics Co.
Stanley Aviotion Corp.
Stavid Engrg., Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
Telectro Industries Corp.
Trionics Corp.
Ucinite Co., The, Div.-United-Carr Fastener Corp.
United Electrodynamics, Inc.
United States Chemical Milling Corp.
Webcor, Inc., Government Div.
Wesrep Corp.
Westinghouse Electric Corp.
Zenith Optical Laboratory

CLAMPS
a. Conduit
b. Ground
c. Harness
d. Hose
e. Mechanical Cable
f. Special
g. Tube

Abalon Precision Mfg. Corp., b thru f.
Adel Precision Products, Div.-General Metals Corp., a, b, c, f, g.
Adel Precision Products of California, Div.-General Metals Corp., a, c, f, g.
Aero Gasket Corp., a, b, c, e, f.
Aerolite Electronics Corp., e.
Aeroquip Corp., Jackson Div., d, f, g.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., e.
Alden Products Co., g.
Allenair Corp., f.
American Aeroparts, a thru g.
Amphenol Connector Div., Amphenol-Borg Electronics Corp., e.
Anchor Metal Spinning Co., The, f.
Atlas Precision Products, Co., f.
Augat Brothers, Inc., f, g.
W. L. Barrett Co., The, f.
Barrett-Christie Co., a, d.
Best Aircraft Corp., a thru f.
Birnbach Radio Co., Inc., f, g.
Birtcher Corp., The, f, g.
Blaco Mfg. Co., b.
Breeze Corporations, Inc., d.
Burklyn Co., f.
Cambridge Thermionic Corp., g.
Capwell Mfg. Co., c.
Century Fasterners Corp., a, c, d, e, g.
Continental Rubber Works, d.
Cooper Industries, Inc., d.
Capperweld Steel Co., Wire & Cable Div., b.
Corbin Products Div., c, f.
Crouse-Hinds Co., a.
Dakota Engrg., Inc., b, c, e, f.
Dante Electric Mfg. Co., b.
Diversey Engrg. Co., e, f.
Dresser Mfg. Div., Dresser Industries, Inc., a, b, c, f, g.
Eaton Mfg. Co., Reliance Div., d.
Elzee Metal Products Co., Inc., f.
Erie Resistor Corp., c.
Fidelity Chemical Products Corp., g.
Fisher Scientific Co., g.
Hallett Mfg., Co., a, b, c.
Heyman Mfg. Co., e.
Highland Rim Machine Works Inc., f.
Holub Industries, Inc., a, c, g.
International Electronic Research Corp., f.
Joclin Mfg. Co., c thru g.
Kickhaefer Mfg. Co., a, e, f.
Lucas Aircraft Supply Co.
Marman Div., Aeroquip Corp., d, f, g.
Monogram Precision Industries, a thru g.
Motorola Inc., Military Electronics Div., f.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., e.
National Utilities Corp., d, f, g.
Panduit Corp., c.
Peerless Electronics Inc., f, g.
Rattan Mfg. Co., The, a, b.
Republic Steel Corp., e.
Fred T. Roberts & Co., c, d, g.
Rockwell-Standard Corp., d, f.
Milton Ross Metals Co., The, c.
Ryan Aeronautical Co., f.
Shur-Lok Corp., e.
Skinner Precision Products, a, f.
Smith-Morris Corp., b, d.
Solar Aircraft Co., f.
Specialty Products Corp., d, f, g.
Stanley-Judd Div.-The Stanley Works, a thru g.
Staver Co., Inc., The, g.
Stone City Products Co., f.
Surface Combustion Corp., g.
TA Mfg. Corp., a thru g.
Tinnerman Products, Inc., c thru g.
Titeflex, Inc., d, g.
Turbo Products, Inc., b, c, f, g.
United Supply Co., b, c.
Universal Metal Products Inc., a thru d, f, g.
Webcor, Inc., Government Div., f.
Wetzler Clamp Co. Inc., f.
Wittek Mfg., Co., b thru g.
Wollam Aircraft & Marine Products Co., f.

CLEANERS, CONTACT
*ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.
American Aeroparts
Anderson Dil & Chemical Co., Inc.
George Basch Co., The
Caig Labs.
Cincinnati Cleaning & Finishing Machinery
Clarkson Labs., Inc., The
Cobehn, Inc.
Del's Tumbling Service
Devcon Corp.
Dowell Div.-The Dow Chemical Co.
Fidelity Chemical Products Corp.
Grant Chemical Co., Inc.
R. M. Hollingshead Corp.
Kano Labs.
Kelite Corp.
London Chemical Co., Inc.
Monode Inc.
Neumade Products Corp.
Nu Steel Co.
Penetone Co., The
Protective Coatings, Inc.
Quietrole Co.
Trio Chemical Works, Inc.
Turbo Machine Co.
Vapor Blast Mfg. Co.
Wesrep Corp.

Wheelabrator Corp.
Wye Industries

LEANERS, ULTRASONIC

Assaciated Engineers, Inc.
Bendix Aviation Corp., Pioneer-Central Div.
Bronson Ultrasonic Corp.
Cincinnati Cleaning & Finishing Machinery
Clarkson Labs., Inc., The
Curtiss-Wright Corp.-Princeton Div.
Detrex Chemical Industries, Inc.
Dowell Div.-The Daw Chemical Co.
General Kinetics, Inc.
Grant Chemical Co., Inc.
Kelite Carp.
Landon Chemical Co., Inc.
Mossa Div.-Cohu Electronics, Inc.
Narda Ultrasanics Corp., The
National Ultrasonic Carp.
Dakite Products, Inc.
Penetane Co., The
Pawer Supplies Inc.
Ransahoff, Co.
Tapper Mfg. Co., Inc.
Turco Products, Inc.
Wye Industries

LEANING COMPOUNDS
See COMPOUNDS, CLEANING

LINOMETERS

Airguide Instrument Co.
*ENGIS EQUIPMENT CO.

LIPS

a. Alligator
b. Battery
c. Conduit
d. Crystal Diode
e. Mechanical Cable
f. Spectal
g. Spring
h. Test
i. Tube

AMP Inc., f.
Abalon Precision Mfg. Corp., f.
Adel Precision Products, Div.-General Metals Corp., f.
Adel Precision Products of Californio, Div.-Generol Metals Corp., c.
Aerolite Electronics Corp., a, h.
Amatom Electronic Hordware Co. Inc., a.
American Aeroparts, a, b, e.
Anchor Metal Spinning Co., The, f.
Anchor Specialty Mfg. Co. Inc., g. h.
Associated Engrg. Corp., a.
Astronautics Engrg. Co., f, h, i.
Atlas E-E Corp., d, f, g, i.
Augat Brothers, Inc., d, f, g, i.
W. L. Barrett Co., The, f, g.
Birnbach Radio Co., Inc., a, f, h.
Calinoy-Div.-Illinois Tool Works, f, g, i.
Cambridge Thermionic Corp., g.
Capital City Mfg. Co., f.
Century Fasteners Corp., c, e, g, i.
Carbin Products Div., e, f.
Dotex Corp., i.
E-Z-Hook Test Products, b, f, h.
Electro-Tech Equipment Co., a, b, h.
Federal Screw Products Inc., a, b.
Fisher Scientific Co., a, i.
Gorde Mfg. Co., f, g.
General Cement Mfg. Co., Div.-Textron, Inc., a.
General Scientific Equipment Co., a.
Highland Rim Machine Works Inc., f.
Hobson Brothers, Inc., g.
Industrial Timer Corp., i.
International Electronic Research Corp., i.
Javex Electronics, a, h.
Keystone Electronics Corp., b, d.
Kickhaefer Mfg. Co., c, h.
M & Q Plastic Products, c, l.
Monogram Precision Industries, f, g, i.
Mueller Electric Co., a, b, h.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., a, e.
Pacific Cut Washer Co., e, f.
Reliable Spring & Wire Forms Co., g.
Rockwell-Standard Corp., f.
Milton Ross Metals Co., The, a, g.
Roy A. Scharer & Co., e.
Shur-Lok Corp., f.
C. Sjoberg & Son., c, e, f.
Smith-Morris Corp., e, f, g.
Stanley-Judd Div.-The Stanley Works, a thru i.
Staver Co., Inc., The, g, i.
Stic-Klip Mfg., Co., c, g, l.
Stone City Products Co., h.
Technical Apparatus Builders, a, b.
Teiner Engrg. Corp., e, f.
Tinnermon Products, Inc., f, g, i.
Universal Metol Products Inc., c, f, g.
Vectar Electronic Co., a, h.

LOCKS, TIME

American Aeroparts
Consolidated Productions, Inc.
M. Ducommun Co.
Electro Precision Corp.
Electro-Tech Equipment Co.
Elgin Micronics Div.-Elgin National Watch Co.
Fisher Scientific Co.
Gardner Laboratory, Inc.
Hamiltan Watch Co.-Industrial Div.
*A. W. HAYDON CO., THE
Hewlett-Packard Co.
Lux Clock Mfg. Co., Inc.
Ernest Norman Laboratories
Patterson, Moos Div. - Universal Winding Co., Inc.
Raymand Engrg. Lab., Inc.
Reseorch Contrals
Sangamo Electric Co.
Sphinx-American Co.
Standard Electric Time Co., The
Systron Corp.
Wakmann Watch Co. Inc.
Woltham Engrg. Carp.
Waltham Precision Instrument Co.

CLOTHS, GRILL

Aviation Textile Associates
Chase Bross & Copper Co., Inc.
Durocote Corp.

CLOTHS, SPEAKER GRILLE

Aviation Textile Associates
Cranome Inc.
General Cement Mfg. Co., Div.-Textran, Inc.
Peerless Products Industries
Sterling Precision Corp., Instrument Div.

CLUTCHES, MAGNETIC

Actuator Products Div., Geartronics Corp.
Anologue Controls, Inc.
Autotronics Inc.
Cameraflex Corp.
Cedar Engrg. Div.-Control Data Corp.
Curtiss-Wright Corp., Research Div.
Dial Products Co.
Digitronics Corp.
Dockendorff & Co. Inc.
Dynamic Instrument Corp.
Eaton Mfg. Co.
Exact Engrg. & Mfg. Inc.
FAE Instrument Corp.
General Electric Co., Apparatus Soles Div.
General Electro-Mechonical Corp.
Globe Industries, Inc.
Haddam Mfg. Co., The
Helipot Div.-Beckman Instruments Inc.
Hoover Electric Co.
I-T-E Circuit Breaker Co.
Jock & Heintz, Inc.
Land-Air Inc.
Leor, Inc.
Lear, Inc., Grand Rapids Div.
Lundy Mfg. Corp.
Lyndon Aircraft, Inc.
Magtrol, Inc.
Minneapolis-Honeywell Regulator Co., Ordnance Div.
Nuclear Products-Erco Div.-ACF Industries, Inc.
Poul Nurches Co.
Orbit Instrument Corp.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Precision Methods & Machines Div. - Textron Inc.
Reeves Instrument Corp.
Servomechanisms, Inc., Mechatrol Div.
Standord Electramagnetics, Inc.
Sterling Precision Corp., Instrument Div.
Talley Corp., The
Technology Instrument Corp.
Warner Electric Brake & Clutch Co.
Wesrep Corp.
Westinghouse Electric Corp.
Wright Engrg. Co.

CLUTCHES, MOTOR & GENERATOR

Curtiss-Wright Corp., Marquette Div.
Dockendorff & Co. Inc.
Exact Engrg. & Mfg. Inc.
General Electro-Mechonical Corp.
Globe Industries, Inc.
Grophite Metallizing Corp.
Hoover Electric Co.
Jock & Heintz, Inc.
Land-Air Inc.
Lundy Mfg. Corp.
Magtrol, Inc.
Overload Control Co.
Servomechonisms, Inc., Mechatrol Div.
Talley Corp., The

COAXIAL CABLE FITTINGS
See FITTINGS, COAXIAL CABLE

CODE & TAB MARKERS

Adept Industries Inc.
W. H. Brady Co.
William Brond & Co., Inc.
Miller Dial & Nameplate Co.
Westline Products Div., Western Lithogroph Co.
Zippertubing Co., The

COIL ASSEMBLIES

Ace Coil & Electronics Co.
Advanced Electronics, Inc.
Aerolite Electronics Corp.
American Measurement & Control, Inc.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Atlas Coil Inc.
Barker & Williamson Inc.
Bendix Aviation Corp., York Div.
Brighton Corp.
Bud Radio Inc.
Cambridge Thermionic Corp.
Corruthers & Fernandez, Inc.
Clippard Instrument Lab., Inc.
Coil Co. of America
Coilcraft Inc.
Coils-Electronics
Cato-Coil Co., Inc.
Crown Controls Co., Inc.
Dayton Aviatian Radio & Equipment Corp.
Dean Products, Inc.
Dietz Design & Mfg. Co.
Double E Products Co.
Dresser Industries, Inc.
Electra-Mechanical Products Co.
First Electronics Corp., The
Forbes & Wagner, Inc.
Fugle-Miller Labs. Inc.
General Coil Products Corp.
Genistron, Inc.
Gaslin Electric & Mfg. Co.
Green Rectifier Co.
Hoover Electric Co.
Hussmann Aircroft Div.
Jack & Heintz, Inc.
Jet Electronics Corp.
J. W. Miller Co.
NYT Electronics, Inc.
National Coil Co.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
New York Coil Co.
North Electric Co.
North Hills Electric Co., Inc.
Palo Alto Engrg. Co.
Precision, Inc.
Projects Unlimited Inc.
Rixon Electronics Inc.
Rollan Electric Co.
Milton Ross Metals Co., The
Rytron Co., Inc.
Sage-Craft, Inc.
Signol Transformer Co.
Small Motors Inc.
Stanwyck Winding Co., Inc.
Telectro Industries Corp.
Topper Mfg. Co., Inc.
Tri-Dex Co.
U. S. Relay Co.
Vanguard Electronics Co.
Waldom Electronics Inc.
Warren Transformer Co., Inc.
A. W. Welch Mfg., Co., Inc.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

COIL DOPE

Emerson & Cuming, Inc.
Homalite Corp., The
Liss Products, Inc.
Maos & Waldstein Co.

COIL FORMS

American Molded Products Co.
W. L. Barrett Co., The
Brighton Corp.
Cambridge Thermionic Corp.
Centralab, Div.-Globe-Union
Comco Plastics Inc.
Continental Diomond Fibre Corp.
Corning Glass Works
Dixon Corp.
Electrical Insulation Co., Inc.
Electro-Mechanical Products Co.
Emerson Plastics Corp.
Ferroxcube Corp. of America
Form-It Products, Inc.
Fronklin Fibre-Lamitex Corp.
Garde Mfg. Co.
Hobson Brothers, Inc.
Hydro Molding Co., Inc.
Isolontite Mfg. Corp.
E. F. Johnson Co.
Kip Electronics Corp.
Lamtex Industries, Inc.
Thomas J. Long, Inc.
Minnesota Mining & Mfg. Co.
Molding Corp. of America
National Coil Co.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
North Electric Co.
North Hills Electric Co., Inc.
Peerless Products Industries
Penn Fibre & Specialty Co., Inc.
Pilgrim Products Inc.
Milton Ross Metals Co., The
Sanford Plastics Corp.
Silicone Insulation, Inc.
Slip Ring Co. of Americo
Spaulding Fibre Co., Inc.
Stevens Products, Inc.
Superior Steatite & Ceramic Corp.
Topper Mfg. Co., Inc.

COIL WINDING BOBBINS
See BOBBINS, COIL WINDING

COIL WINDING MACHINES, TOROIDAL

American Machine & Foundry Co., Greenwich
Coil Winding Equipment Co.
Cantinental Technical Service, Inc.
Eisler Engrg. Co., Inc.
Electro Devices Inc.
Gultan Industries, Inc.
Carl Hirschmann Co., Inc.
Industrial Winding Machinery Carp.
Johnson Electronics Inc.
Mico Instrument Co.
Southwestern Industrial Electranics Co.
Universal Mfg. Co., Inc.

COIL WINDING TENSIONS

See TENSIONS, COIL WINDING

COILS

a. AF Choke
b. Choke
c. Booster
d. Filter Choke
e. IF
f. Printed Circuit
g. RF Choke
h. RF Transmitting
i. Solenaid
j. Transducer

AMP Inc., f.
A.P.W. Co., d, l.
Ace Coil & Electronics Co., e thru h.
Acme Wire Co., b, d, l.
Adept Industries Inc., f.
Advanced Electronics, Inc., l.
Aerolite Electranics Carp., a, b, d, e, g, h, i.
Aerovox Corp., d.
Aetna Electronics Corp., h.
Airpox Electronics Inc. Seminole Div.
Aladdin Electronics, Div.-Aladdin Industries Inc., b, d thru g.
Allied Control Co., Inc., l.
All-Tronics, Inc., b, d, e, g, h.
Amelco, Inc.
American Machine & Foundry Co., Greenwich
American Measurement & Control, Inc.
Amplifier Corp. of America, a, b, d.
Artisan Electronics Corp., i.
Atlas Coil Inc.
Audio Development Co., a, d.
Barker & Williamson Inc., a, b, e, g, h, i.
Bel-Tronics Corp., a thru i.
Bendix Aviation Corp., York Div., d, e, f.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., l.
J. Bishop & Co., Platinum Works, j.
Bradford Components, Inc., b, d thru g.
Brighton Corp.
Brown Engrg. Co., Inc.
Bud Radio Inc., g, h.
Burnell & Co., Inc., f.
Cambridge Thermionic Corp., a, b, d thru g, i.
Corol Electronics Corp., a, e thru h.
Carruthers & Fernandez, Inc., a, i.
Cedar Engrg. Div.-Contral Data Corp., l.
Celco (Constantine Engrg. Labs. Co.), a thru j.
Central Transformer Co., a, b, d.
Cinema Engrg.
Cleveland Metal Specialties Co., Electronics Div., f.
Clippard Instrument Lab., Inc., b, d, e, g.
Coil Co. of America, a thru d, f, i.
Coilcraft Inc., b, d thru h.
Coils-Electronics, b, d, f, g, l.
Collins Radio Co.
Comar Electric Co., i.
Control Circuits Inc., l.
Corning Glass Works
Coto-Coil Co., Inc., g thru j.
Crown Controls Co., Inc.
Cycle Transformer Corp., a, b, d, i.
D. & R. Ltd.
Dolmotor Div., Yuba Consolidated Industries, Inc., l, j.
Doyton Aviation Radio & Equipment Corp., a, b, e, f, g.
Deon Products, Inc.
De Witt Development Co., f, g, l.
Dietz Design & Mfg. Co., a, b, d thru i.
Double E Products Co., a, b, d thru h.
Dresser Industries, Inc., a, b, d, l, j.
Edcliff Instruments, l.
Electric Auto-Lite Co., The, i.
Electricol Windings, Inc., a, b, d, l.
Electro-Mechanicol Products Co., b, g, i.
Electronic Coils, Inc., b, d, g, l.
Electronic Transformer Co., Inc., a, b.
Electro-Tech Equipment Co., i.
Electro-Winders Co. Inc., a thru l.
Ferronti Electric Inc., a, b, d.
Ferris Mfg. Co., The, f.
Ferrotran Electronics Co., Inc., b, e, f.
Forbes & Wagner, Inc., b, e, g, l.
Forest Electric Co., The, a, b, d.
Foster Transformer Co., a, b, d, f.
Freed Transformer Co. inc., a, d.
Fugle-Miller Labs. Inc., b, d, e, g, h, l.
General Coil Products Corp., a, b, d thru l.
Genistron, Inc.
Geotronic Labs. Inc., d.
Good Electronic Corp., f.
Good-All Electric Mfg., Co., d, h, l.
Goslin Electric & Mfg. Co., a, b, d.
Green Rectifier Co., b, d.
Guardian Electric Mfg. Co., l.
Homilton Standard, Div.-United Aircraft Corp., i, j.
Hillburn Electronic Products Co., i.
Hindle Transformer Co. Inc., b, c, d.
Hoover Electric Co., i.
T. J. Houlihan Co., b, e thru i.
Illumitronic Engrg. Co., h.
Industriol Winding Machinery Corp.
JFD Electranics Carp., e, g, h.
Jack & Heintz, Inc., l.
Jet Electranics Carp.
E. F. Johnson Co., b, g, h.
Johnsan Electranics Inc., a thru h.
Keystane Products Co., a, b, d.
Knapp Inc., d, i.
*KOONTZ-WAGNER ELECTRIC CO., INC., i.
Langevin Div., W. L. Maxson Carp., The, a, b, d.
La Pointe Industries Inc., f.
Mac Leod & Hanapal, Inc., g.
Magnetica, Inc., a, b, d, g.
Merit Coil & Transformer Corp., a, b, d thru g.
Microtran Co. Inc.
J. W. Miller Co., b, e thru h.
Minitran Corp., a, b, d.
Madelectric Products Corp., a, e, f, i.
Matorala Inc., Military Electronics Div., a, d thru g, j.
NYT Electronics, Inc., a, b, d thru h.
National Cail Co., a thru j.
Nationol Pneumatic Co., Inc., Holtzer-Cabot Divs., a, b, d, e, g, h, i.
Naz-Dar Co., f.
Netwarks Electronic Corp., e, g.
New York Coil Co., a thru j.
New York Transformer Co. Inc., a, b, d.
North Electric Co.
North Hills Electric Co., Inc., b, e thru j.
Omega Electronic Corp., g.
Dpeliko Welding, Machine & Supply Inc., j.
Dsborne Electronic Sales Corp., a, e, g, h, j.
Palo Alto Engrg. Co., a, b, d, f.
Perry Plastics, Inc., a.
Philco Corp., Government & Industrial Div., b, d, e, g.
Pickering & Co., Inc., i, j.
Potter Aeronautical Corp.
Precision, Inc., j.
RS Electronics Corp., e, g, h.
Rodio Industries, Inc., e thru h.
Douglas Randall Inc., i, j.
Redman Electronics Corp., e, g.
Reliable Spring & Wire Forms Co., g.
Research Development Mfg. Inc., g.
Rixon Electronics Inc., f.
Rollan Electric Co.
Milton Ross Metals Co., The
Rytron Co., Inc., a, b, d, e.
Sage-Craft, Inc., b, e thru j.
Sangamo Electric Co., a, b, d.
Signal Transformer Co., a thru d, f, i.
Southwestern Industrial Electronics Co., a thru j.
Standard Electromagnetics, Inc., i.
Stanwyck Winding Co., Inc., b, e thru i.
Superex Electronics Corp., a thru d, f, g.
Technicol Apparatus Builders, a thru d.
Telectro Industries Corp., a thru i.
Topper Mfg. Co., Inc., a thru l.
Transco Products, Inc., l.
Transistor Electronics Corp., b.
Transonic, Inc., a, b, d, f, j.
Tresco, Inc., a, d.
Triod Transformer Corp., a, b, d, i.
Tri-Dex Co., b, i, j.
U. S. Relay Co., a thru j.
United Transformer Co., a, b, d, f, i, j.
Universal Mfg. Co., Inc.
Universol Torold Coil Winding, Inc., a, b, d, g, j.
Vanguard Electronics Co., b, d, e, g.
Virginia Electronics Co., Inc., a, b, d, e, g, h.
Waldom Electronics Inc.
Warren Transformer Co., Inc., a thru j.
A. W. Welch Mfg., Co., Inc., a, b, d, f, g, h.
Westbury Electronics Inc., a, b, d, i.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., a thru g, i, j.
Winatic Corp., The, f, l, j.
Zenith Rodio Corp., e.

COILS, HEATING

Astravac Corp.
Borker & Williomson Inc.
W. L. Barrett Co., The
J. Bishop & Co., Plotinum Works
Blue M Electric Co.
Bradford Components, Inc.
Brighton Corp.
Briscoe Mfg. Co.
Carrier Corp.
Central Transformer Co.
Deon Products, Inc.
Wilbur B. Driver Co.
General Electric Co., Apparotus Sales Div.
Griscom-Russell Co., The
Hevi-Duty Electric Co.
Marlo Coil Co.
Minitran Corp.
NYT Electronics, Inc.
Precision, Inc.
Edw. Renneburg & Sons Co.
Rome-Turney Radiator Co., The
Statikil, Inc., Div.-The J.E. Doyle Co.
Trane Co., The
Tranter Mfg., Inc.
U. S. Reloy Co.
York Corp.

COILS, HIGH TEMPERATURE

A.P.W. Co.
Advanced Electronics, Inc.
American Measurement & Control, Inc.
*BENDIX PRODUCTS DIV., BENDIX AVIATIO CORP.
Blue M. Electric Co.
Corruthers & Fernandez, Inc.
Chemplast, Inc.
Double E Products Co.
Electric Auto-Lite Co., The
Electronic Parts Mfg. Co., Inc.
Engelhard Industries, Inc.
Ferrotran Electronics Co., Inc.
Forbes & Wagner, Inc.
Good-All Electric Mfg. Co.
Griscom-Russell Co., The
Hevi-Duty Electric Co.
Hoover Electric Co.
T. J. Houlihan Co.
Keystane Products Co.
*KOONTZ-WAGNER ELECTRIC CO., INC.
Marlo Coil Co.
National Coil Co.
New York Coil Co.
New York Transformer Co. inc.
North Hills Electric Co., Inc.
Potter Aeronautical Carp.
Precisian, Inc.
Douglas Rondall Inc.
Edw. Renneburg & Sons Co.
Signal Transformer Co.
Thermal Refractories Corp.
Topper Mfg. Co., Inc.
Trone Co., The
Transonic, Inc.
Tranter Mfg., Inc.
U. S. Relay Co.
Warren Transformer Co., Inc.
A. W. Welch Mfg., Co., Inc.

COILS, IGNITION

Acme Wire Co.
American Aeroparts
Coil Co. of Americo
Electric Auto-Lite Co., The
General Products Corp.
Hallett Mfg., Co.
Modelectric Products Corp.
NYT Electronics, Inc.
New York Coil Co.
Warren Transformer Co., Inc.

COILS, INDUCTORS

See INDUCTORS, COILS

COILS, SPEAKER

Aerolite Electronics Corp.
Coil Co. of America
Electrical Windings, Inc.
General Coil Products Corp.
T. J. Houlihan Co.
Magnavox Co., The
Notional Coil Co.
National Pneumatic Co., Inc., Holtzer-Cabot Di
Dsborne Electronic Sales Corp.
Perry Plastics, Inc.
Smith-Morris Corp.
Standord Metals Corp.
U. S. Reloy Co.
Waldom Electronics Inc.
Warren Transformer Co., Inc.

COLD CATHODE LIGHTING

See LIGHTING, COLD CATHODE

COLLECTOR RINGS

American Felt Co.
Buhl Optical Co.
Chicago Aerial Industries, Inc.
Electro-Mechanical Products Co.
Engelhard Industries Inc., D. E. Makepeoce Div
Fletcher Mfg. Co., Inc., The
Industrial-Electrical Works
Mercury Tool & Mfg. Corp.
Metals & Controls Corp., General Plate Div.
Motorola Inc., Military Electronics Div.
Nippert Electric Products Co., The
Portland Copper & Tank Works Inc.
Milton Ross Metals Co., The
Slip Ring Co. of America
Stanley-Judd Div. - The Stanley Works
Twin Coach Co., Aircraft-Missiles

COLLIMATORS

American Optical Co., Instrument Div.
*BAUSCH & LOMB OPTICAL CO.
Chrysler Corp., Defense Operations Div.
Davidson Mfg., Co., Inc.
Edgerton, Germeshausen & Grier, Inc.
*ENGIS EQUIPMENT CO.
Epic, Inc.
J. W. Fecker, Inc.
Gordon Enterprises
Opto-Metric Tools, Inc.
Perkin-Elmer Corp.
Radiation Instrument Development Lab., Inc.

Zenith Optical Laboratary
Zoomar Inc.

OLORIMETERS

*BAUSCH & LOMB OPTICAL CO.
Beckman-Scientific & Process Instruments Div.
Epic, Inc.
FXR, Inc.
Fisher Scientific Co.
Gardner Laboratary, Inc.
Instrument Development Labs., Inc.
National Spectrographic Labs., Inc.
W. A. Taylor & Co.

OLORIMETERS, PHOTOELECTRIC

Axler Associates Inc.
*BAUSCH & LOMB OPTICAL CO.
Central Scientific Co.
Epic, Inc.
Fisher Scientific Co.
Gardner Laboratory, Inc.
Hallikainen Instruments
Instrument Development Labs., Inc.
Harold Kruger Instruments
Minneapolis-Honeywell Regulatar Co., Industrial Products Group
National Spectragraphic Labs., Inc.
Photamotion, Inc.
Photavalt Corp.
Process & Instruments
Telechrame Mfg. Corp.

OLORIMETERS, SPECIAL PURPOSE

*BAUSCH & LOMB OPTICAL CO.
Fisher Scientific Co.
Gardner Laboratory, Inc.
Instrument Development Labs., Inc.
Harold Kruger Instruments
National Spectragraphic Labs., Inc.
Photabell Co., Inc.
Milton Roy Co.
W. A. Taylor & Co.
Telechrame Mfg. Corp.
Turbo Products, Inc.
Universal Moulded Products Corp.

MBUSTION CHAMBER COVERS

Astronautics Engrg. Co.
Christie Machine Works
Curtiss-Wright Corp., Wright Aeronautical Div.
Curtiss-Wright Corp., Santa Barbara Div.
Dyna-Therm Chemical Corp.
Ferris-Mfg. Co., The
Finn Aeronautical Div., T. R. Finn & Co., Inc.
Grieve-Hendry Co., Inc.
Huffard Corp., The
Hupp Aviation Co.
M. W. Kellogg Co., The
*LAVELLE AIRCRAFT CORP.
Mercury Taal & Mfg. Corp.
Minnesata Mining & Mfg. Corp.
Monogram Precision Industries
National Beryllia Carp.
Plastic Age Sales, Inc.
Portland Copper & Tank Warks Inc.
Reinhold Engrg. & Plastics Co.
Edw. Renneburg & Sons Co.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Smith-Morris Carp.
Stainless Inc.
Stainless Steel Products, Inc.
Thermal Refractories Corp.
Turbo Products, Inc.
Twigg Industries

MBUSTION CHAMBERS

American Air Filter Co., Defense Products Div.
Bell Aircraft Carp., Niagara Frontier Div.
Benson Mfg. Co., The
California Aircraft Products
Carborundum Co., Refractaries Div.
Christie Machine Works
Cooper Development Corp., Sub. - Morquardt Aircraft Co.
Cramer Mfg. & Engrg., Inc.
Curtiss-Wright Carp., Research Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Diversey Engrg. Co.
Dynamic Devices, Inc.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
Giannini Plasmadyne Corp.
Haveg Industries, Inc.
Hevi-Duty Electric Co.
Huffard Corp., The
Hupp Aviation Co.
M. W. Kellogg Co., The
Kelsey-Hayes Co.
*LAVELLE AIRCRAFT CORP.
Marquardt Aircraft Co.
Mercury Taal & Mfg. Carp.
Monagram Precision Industries
National Beryllia Carp.
Nartan Co.
Penn-Michigan Mfg. Carp.
Portland Copper & Tank Warks Inc.
Pressed Steel Tank Co.
Reinhold Engrg. & Plastics Co.
Edw. Renneburg & Sons Co.

*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Smith-Morris Carp.
Stainless Inc.
Stainless Steel Products, Inc.
Temperature Engrg. Carp.
Thermal Refractaries Corp.
C. W. Tarngren Co., Inc.
Twigg Industries
Veet Industries
Young Development Div., Hercules Powder Co.

COMBUSTORS

Aeralab Development Co.
American Air Filter Co., Defense Products Div.
Auburn Spark Plug Co., Inc.
Budelman Electronics Carp.
Curtiss-Wright Carp. - Wright Aeronautical Div.
Dynamic Devices, Inc.
Elgin Micranics, West Coast Div. - Elgin National Watch Co.
Hamilton Standard, Div. - United Aircraft Carp.
*LAVELLE AIRCRAFT CORP.
Morquardt Aircraft Co.
Edw. Renneburg & Sons Co.
Singer Mfg. Co., The, Military Products Div.
South Wind Div., Stewart Warner Corp.
Warner Electronic Devices

COMMERCIAL COMMUNICATIONS SYSTEM
See COMMUNICATIONS SYSTEM, COMMERCIAL

COMMUNICATIONS SYSTEM

ACF Industries Inc.
Allied International Co.
Amelco, Inc.
Automation Dynamics Corp.
*AVCO MFG. CORP., CROSLEY DIV.
Barker Sales Co.
Bell & Gossett Co.
Bendix Radio Div., Bendix Aviation Carp.
Bogen-Presto, Div. - Siegler Corp., The
Budelman Electronics Carp.
CGS Labs., Inc.
Centranix Inc.
Chalco Engrg. Corp.
Collins Radio Co.
Communicatians Research Co.
Cooper Development Corp., Sub. - Marquardt Aircraft Co.
Crosby Laboratories, Inc.
Dayton Aviation Radio & Equipment Carp.
Du Kane Carp.
Edgertan, Germeshausen & Grier, Inc.
Electronic Communications, Inc.
Electronics Div., Van Norman Industries Inc.
Entran, Inc.
General Communicatian Co.
General Precision Lab. Inc.
Gilfillan Bros. Inc.
Goodyear Aircraft Carp.
Hallicrafters
Hammarlund Mfg. Co. Inc.
Hazeltine Electronics Div. - Hazeltine Corp.
Haffman Labs. Div., Haffman Electranics Carp.
Hogan Labaratories, Inc.
Hughes Aircraft Co.
ITT Federal Div., International Telephane & Telegraph Carp.
ITT Labs.
ITT-Kellogg
Instruments for Industry, Inc.
Jansky & Bailey, Inc.
Kahn Research Labs., Inc.
Land-Air Inc.
Lear, Inc.
Ling Electronics, Inc.
Littan Industries, Maryland Div.
Livingston Electronic Corp.
Magnavax Co., The
Mansan Labs., Inc.
Minneapalis-Haneywell Regulatar Co., Ordnance Div.
Miratel, Inc.
Monagram Precision Industries
Motorala Inc., Military Electranics Div.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Nems Clarke Co., Div. - Vitro Corp. af Americo
North Electric Co.
*PACKARD-BELL ELECTRONICS CORP.
Perry Plastics, Inc.
Philco Carp., Government & Industriol Div.
Precise Development Corp.
Pradelin Inc.
Radiatian, Inc.
Raythean Mfg. Co., Gavernment Equipment Div.
Seeburg Corp., The
Servo Carp. af America
Singer Mfg. Co., The, Military Products Div.
Skyline Electric & Mfg. Co.
Specialty Engrg. & Electronics Co.
Stromberg-Carlson Div. - General Dynamics Corp.
Telechrame Mfg. Corp.
Telectra Industries Corp.
Telerad Mfg. Corp.
Televisian Utilities Carp.
Thiokal Chemical Carp.
U. S. Industries, Inc.
Virginia Electranics Co., Inc.
Webcor, Inc., Gavernment Div.
Westinghause Electric Carp.
Winzen Research Inc.
Warner Electranic Devices

COMMUNICATIONS SYSTEM, COMMERCIAL

Allied International Co.
Amelco, Inc.
Barker Sales Co.
Bendix Radio Div., Bendix Aviatian Carp.
Bliss Electronic Carp.
Bogen-Presto Co., Div.-Siegler Carp., The
Centronix Inc.
Communicatians Co.
Crosby Laboratories, Inc.
Daytan Aviation Radio & Equipment Corp.
Du Kane Carp.
Entran, Inc.
Fisher Research Lab., Inc.
General Precisian Lab. Inc.
Hammarlund Mfg. Co. Inc.
ITT Labs.
ITT-Kellogg
Jansky & Bailey, Inc.
Kaar Engrg. Carp.
Kahn Research Labs., Inc.
Land-Air Inc.
Ling Electranics, Inc.
Littan Industries, Maryland Div.
Miratel, Inc.
Matarala Inc., Military Electronics Div.
Notianal Pneumatic Co., Inc., Holtzer-Cabot Divs.
Narth Electric Co.
Philca Carp., Government & Industrial Div.
Precise Development Corp.
Raythean Mfg. Co.
Stramberg-Carlsan Div.-General Dynamics Carp.
Telechrame Mfg. Carp.
Telectra Industries Carp.
Tele-Dynamics Inc.
Thiokal Chemical Carp.
U. S. Science Carp., Div.-Tapp Industries, Inc.
Winzen Research Inc.
Warner Electranic Devices

COMMUNICATIONS SYSTEMS, INTERCOM

Barker Sales Ca,
Bliss Electranic Carp.
Blander-Tangue Labs., Inc.
Bogen-Presto Co., Div.-Siegler Carp., The
Bristal Matars Div.-Vocaline Co., af America, Inc.
Centranix Inc.
Chalca Engrg. Corp.
Continental Mfg., Inc.
Cooper Develapment Corp., Sub.-Marquardt Aircraft Co.
Du Kane Carp.
Electranic Communications, Inc.
Executone, Inc.
Federal Mfg. & Engrg. Corp.
Fidelity Amplifier Co.
Graflex Inc.
ITT-Kellogg
Litton Industries, Maryland Div.
Miratel, Inc.
Motarala Inc., Military Electranics Div.
Natianal Pneumatic Co., Inc., Holtzer-Cabot Divs.
Nippert Electric Products Co., The
North Electric Co.
*PACKARD-BELL ELECTRONICS CORP.
Perry Plastics, Inc.
Philca Carp., Government & Industrial Div.
Precise Develapment Carp.
Stromberg-Carlsan Div.-General Dynamics Corp.
Telectra Industries Corp.
Thiakal Chemical Carp.
Unisan Products, Inc.
Virginia Electranics Co., Inc.
Wheeler Electranic Corp., Sub.-Sperry Rand Corp.
Winzen Research Inc.

COMMUTATORS, SWITCHING

Advance Carbon & Electric Mfg. Co.
Aeralab Development Co.
Airflyte Electronics Co.
Alta Scientific Co., Inc.
Applied Science Carp. af Princetan
*ARNOUX CORP.
Callectron Carp.
Computer Instruments Carp.
Cubic Corp.
Cushman Precision Industries
Electra Develapment Co.
Electra Tec Corp.
Electro-Mechanical Products Co.
Electra-Miniatures Carp.
Elgin Micronics Div.-Elgin National Watch Co.
General Devices, Inc.
Genisca, Inc., Instrument Div.
Graphite Metallizing Carp.
Hesca Engrg.
Instrument Development Labs., Inc.
Kauke & Co.
Land-Air Inc.
Minneapolis-Haneywell Regulator Co., Davies Labs. Div.
Minneapalis-Honeywell Regulatar Co., Ordnance Div.
Matarala Inc., Military Electranics Div.
Radiatian, Inc.
Slip Ring Co. af America
Talley Carp., The
Technalagy Instrument Corp.
Tele-Dynamics Inc.
Wang Labs., Inc.

COMPARATORS
a. Capacitance

b. Circuit Linearity
c. Dielectric
d. Iron Core
e. Q
f. Voltage

Alto Scientific Co., Inc., f.
Avien, Inc., f.
B & K Instruments, Inc., a.
Bendix Aviation Corp., York Div.
Boonton Radio Corp., e.
California Technical Industries, Div.-Textron Inc., a, b, f.
Centronix Inc., e.
Davenport Mfg. Co., f.
Delsen Corp., c.
Donner Scientific Corp., f.
Dytronics Co., a.
Electro Instruments, Inc., a, f.
Electronic Applications, Inc., a.
Electronic Instrument Co., Inc. (EICD), a.
Freed Transformer Co. Inc., a.
Graflex Inc.
Hoffman Electronics Corp., Semiconductor Div., f.
Industrial Test Equipment Co., a.
Inland Electronics Corp., a.
Julie Research Labs., Inc., f.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kay Electric Co., e.
Lear, Inc., Grand Rapids Div., f.
Marconi Instruments, e.
Metronix, Inc., Sub.-Assembly Products, Inc., a.
Micrometrical Mfg. Co., b.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, f.
National Spectrographic Labs., Inc.
Non-Linear Systems, Inc., f.
North Hills Electric Co., Inc., e.
*PACKARD-BELL ELECTRONICS CORP., f.
Photobell Co., Inc., a, c.
Precise Development Corp., a, f.
Rese Engrg., Inc., f.
Slaughter Co., Inc., a, b, c, f.
Soroban Engrg., Inc.
Southwestern Industrial Electronics Co., a thru f.
Tempo Instrument Inc., f.
Trio Laboratories, Inc., f.
Weston Instruments, Div.-Daystrom, Inc., f.
Wright Engrg. Co., a.

COMPARATORS, AUTOMATIC RESISTANCE

Amelco, Inc.
California Technical Industries, Div.-Textron Inc.
Centronix Inc.
Clippard Instrument Lab., Inc.
Datran Electronics, Div.-Mid-Continent Mfg., Inc.
Dytronics Co.
Electro Instruments, Inc.
Electronic Applications, Inc.
Industrial Test Equipment Co.
Julie Research Labs., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
*KEARFOTT CO., INC.
Minneapolis-Honeywell Regulator Co., Industrial Products Group
Non-Linear Systems, Inc.
Optimized Devices, Inc.
Precise Development Corp.
Radiaphone Co. Inc.
Slaughter Co., Inc.
Telectro Industries Corp.

COMPASSES

a. Electronic Gyro
b. Gyro
c. Magnetic
d. Radio
e. Remote indicating

Airguide Instrument Co., c.
American Aeroparts, c, e.
American Bosch Arma Corp., b.
Arma Div., American Bosch Arma Corp., b.
Belock Instrument Corp., a, b, c, e.
Bendix Aviation Corp.-Eclipse-Pioneer Div., a, b, e.
Bendix Aviation Corp.-Montrose Div., e.
Bendix Radio Div., Bendix Aviation Corp., d.
Collins Engrg. Corp., b.
Datron Electronics, Div.-Mid-Continent Mfg., Inc.
Daystrom Pacific Div.-Daystrom, Inc., b.
Fisher Research Lab., Inc., d.
General Electric Co., Apparatus Sales Div., a, b, e.
*KEARFOTT CO., INC., a thru e.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., c.
Lear, Inc., a, b, d, e.
Lear, Inc., Grand Rapids Div., a, b, c.
Magnavox Co., The, d.
Motorola Inc., Military Electronics Div., d.
Power-Tronic Systems Inc., a, b, e.
Radiation, Inc., d.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp., b, c, e.
Sperry Piedmont Co.-Div.-Sperry Rand Corp., a, b, c, e.
Zophar Mills Inc., e.

COMPONENTS, EMBEDDED

See EMBEDDED COMPONENTS

COMPOUNDS, CLEANING

Air Logistics Corp.
Allied Chemical Corp., National Aniline Div.
Allied Research Products, Inc.
American Felt Co.
Anderson Oil & Chemical Co., Inc.
Arco Co., The
Armite Labs.
George Basch Co., The
Borden Chemical Co.
Cooper Industries, Inc.
Dels Tumbling Service
Delta Chemical Works, Inc.
Dennis Chemical Co.
Devcon Corp.
Dow Chemical Co., The
Fidelity Chemical Products Corp.
Finnell System, Inc.
Fisher Scientific Co.
Grant Chemical Co., Inc.
E. F. Houghton & Co.
R. M. Hollingshead Corp.
Joy Mfg. Co.
Kelite Corp.
London Chemical Co., Inc.
Monogram Precision Industries
Neumade Products Corp.
Oakite Products, Inc.
Penetone Co., The
Permatex Co., Inc.
Protective Coatings, Inc.
Ransohoff, Co.
Bernard Sirotta Co.
Trio Chemical Works, Inc.
Turco Products, Inc.
Wesrep Corp.
Wye Industries

COMPOUNDS, INSULATING

See INSULATING COMPOUNDS

COMPRESSOR ASSEMBLIES

Air Products, Inc.
Beach-Russ Co.
Carrier Corp.
Centrax Ltd., American Sales Office
Cornelius Co., The, Aero Div.
Cummins Engine Co., Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dresser Industries, Inc.
Dunham-Bush Inc.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
Joy Mfg. Co.
Kelsey-Hayes Co.
Walter Kidde & Co., Inc., Aviation Div.
Lear, Inc.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Scaife Co.- Div.-Wilson Bros.
Smith-Morris Corp.
Solar Aircraft Co.
Stainless Steel Products, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Tosk Corp.
Therm, Inc.
Turbo Products, Inc.

COMPRESSOR ASSEMBLIES, AXIAL FLOW

Air Logistics Corp.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Allis-Cholmers
Carrier Corp.
Centrax Ltd., American Sales Office
Christie Machine Works
Cummins Engine Co., Inc.
Curtiss-Wright Corp.-Research Div.
Curtiss-Wright Corp.-Utica Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dean & Benson Research, Inc.
Dresser Industries, Inc.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
Jorvis Corp.
Joy Mfg. Co.
J. J. Monaghan Co., Inc.
Schellens-True Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Therm, Inc.
Turbo Products, Inc.
Twigg Industries
Veet Industries
Westinghouse Electric Corp.

COMPRESSOR ASSEMBLIES, CENTRIFUGAL FLOW

Air Logistics Corp.
Air Products, Inc.
Allis-Cholmers
American Felt Co.
Centrax Ltd., American Sales Office
Christie Machine Works
Consolidated Diesel Electric Corp.
Cummins Engine Co., Inc.
Curtis-Wright Corp.-Research Div.
Curtiss-Wright Corp.-Utica Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dresser Industries, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Kelsey-Hayes Co.
Jorvis Corp.
Joy Mfg. Co.
Strotos, Div.-Fairchild Engine & Airplane Corp.
Topco Group, Thompson Ramo Wooldridge Inc.
Therm, Inc.
Turbo Products, Inc.
Veet Industries
Wickfield, Inc.
York Corp.

COMPRESSOR ASSEMBLIES, MOBILE

Accessory Controls & Equipment Corp.
Air Logistics Corp.
Air Products, Inc.
*AIRSEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
American Felt Co.
Beach-Russ Co.
Carrier Corp.
Consolidated Diesel Electric Corp.
Cornelius Co., The, Aero Div.
Cummins Engine Co., Inc.
Dresser Industries, Inc.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
Haskel Engrg. & Supply Co.
Joy Mfg. Co.
Kelsey-Hayes Co.
Walter Kidde & Co., Inc., Aviation Div.
Lear, Inc.
United Mfg. Co., Div., The W. L. Maxson Corp.
Wickfield, Inc.

COMPRESSORS, AIR

Accessory Controls & Equipment Corp.
Air Logistics Corp.
Air Products, Inc.
*AIRESEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Allis-Chalmers
American Felt Co.
American Instrument Co., Inc.
Applied Dynamics Corp.
Beach-Russ Co.
Carrier Corp.
Chicago Pneumatic Tool Co.
Cooper-Bessemer Corp., The
Cornelius Co., The, Aero Div.
Cummins Engine Co., Inc.
Curtiss-Wright Corp.-Utica Div.
Dresser Industries, Inc.
Dunham-Bush Inc.
Fuller Co.
Gardner-Denver Co.
Haskel Engrg. & Supply Co.
Hoover Electric Co.
Joy Mfg. Co.
Kahn & Co., Inc.
Walter Kidde & Co., Inc., Aviation Div.
Lear, Inc.
Leiman Brothers' Inc.
M. C. Mfg. Co.
Nash Engrg. Co., The
Pennsylvania Pump & Compressor Co.
Quincy Compressor Co.
Scaife Co.- Div.-Wilson Bros.
Schutte & Koerting Co.
Solar Aircraft Co.
Stainless Steel Products, Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Superior Pneumatic & Mfg., Inc.
Thompson Engrg. Co., The, Missile Products Div.
Trane Co., The
Waldorf Fluid Systems. Div.-F.C. Huyck & Sons
Waste King Corp., Technical Products Div.
Wayne Pump Co., The, Div.-Symington Wayne Corp.

COMPRESSORS, GAS

Air Products, Inc.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Allis-Chalmers
American Felt Co.
American Instrument Co., Inc.
Beach-Russ Co.
Carrier Corp.
Chicago Pneumatic Tool Co.
Christie Machine Works
Cooper-Bessemer Corp., The
Cornelius Co., The, Aero Div.
Dresser Industries, Inc.
Dunham-Bush Inc.
Fuller Co.
Gardner-Denver Co.
Haskel Engrg. & Supply Co.
Hoover Electric Co.
Joy Mfg. Co.
Leiman Brothers, Inc.
M. C. Mfg. Co.
Nash Engrg. Co., The
Pennsylvania Pump & Compressor Co.
Schutte & Koerting Co.
Solar Aircraft Co.
Stainless Steel Products, Inc.
Strotos, Div.-Fairchild Engine & Airplane Corp.
Thompson Engrg. Co., The, Missile Products Div.
Trane Co., The
Vilter Mfg. Co., The
Waldorf Fluid Systems. Div.-F.C. Huyck & Sons
Wayne Pump Co., The, Div.-Symington Wayne Corp.

COMPRESSORS, PORTABLE

Air Products, Inc.

AIRESEARCH MFG. CO. DIV.-THE GARRETT CORP.
Beach-Russ Co.
Chicago Pneumatic Tool Co.
Cornelius Co., The, Aera Div.
Cummins Engine Co., Inc.
Curtiss-Wright Corp.-Utica Div.
Dunham-Bush Inc.
Gardner-Denver Co.
Haskel Engrg. & Supply Co.
Hoover Electric Co.
Joy Mfg. Co.
Kahn & Co., Inc.
Walter Kidde & Co., Inc., Aviation Div.
Lear, Inc.
Solar Aircraft Co.
Turratas, Div.-Fairchild Engine & Airplane Corp.
Thompson Engrg. Co., The, Missile Products Div.
Voyne Pump Co., The, Div.-Symington Wayne Corp.

MPUTER DEMODULATORS
ee DEMODULATORS, COMPUTER

MPUTER, DIAGNOSTIC EQUIPMENT
ee DIAGNOSTIC EQUIPMENT, COMPUTER

MPUTER DISCS
ee DISCS, COMPUTER

MPUTER HEADS
ee HEADS, COMPUTER

MPUTER INPUT EQUIPMENT
eronutronic Systems, Inc., Sub.-Ford Motor Co.
AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Alwoc Corp.
Belock Instrument Corp.
Bendix Aviotion Corp., York Div.
Benson-Lehner Corp.
Ernest E. Blanche & Associates, Inc.
Bogue Electric Mfg., Co.
Bristol Co., The
Burton-Rodgers, Inc.
Cedar Engrg. Div.-Control Dato Corp.
Centronix Inc.
Chicago Aeriol Industries, Inc.
Consolidoted Diesel Electric Corp.
DBM Research Corp.
Dato Instruments Div.-Telecomputing Corp.
Di-An Controls, Inc.
Dresser Industries, Inc.
Electronic Communicotions, Inc.
Electronic Engrg. Co. of California
Ferranti Electric Inc.
General Electric Co., Computer Dept.
General Kinetics, Inc.
Julie Research Lobs., Inc.
KEARFOTT CO., INC.
Land-Air Inc.
Librascope Inc.
Milgo Electronic Corp.
Minneapolis-Honeywell Regulator Co., Dovies Labs. Div.
Minneapolis-Honeywell Regulator Co., Industriol Product Group
Norse Instrument Co., The
P. L. Moseley Co.
Motorolo Inc., Military Electronics Div.
National Cash Register Co., The, Electronics Div.
Philco Corp., Government & Industriol Div.
Radiation, Inc.
Singer Mfg. Co., The, Military Products Div.
Sorobon Engrg., Inc.
Sterling Precision Corp., Instrument Div.
Systron Corp.
Technitrol Engrg. Co.
Thompson-Ramo-Wooldridge Products Co., The
Trio Laboratories, Inc.
United Electrodynomics, Inc.
Victor Adding Machine Co.
Vitro Labs.
Wang Labs., Inc.
Wright Engrg. Co.

CAPUTER MATRIXES
ee MATRIXES COMPUTER

CAPUTER OUTPUT EQUIPMENT
eronutronic Systems, Inc., Sub.-Ford Motor Co.
AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Alwac Corp.
Belock Instrument Corp.
Bendix Aviation Corp., York Div.
Ernest E. Blanche & Associates, Inc.
Bristol Co., The
Burton-Rodgers, Inc.
Cedar Engrg. Div.-Control Dota Corp.
Centronix Inc.
Chicago Aeriol Industries, Inc.
Consolidated Diesel Electric Corp.
IBM Research Corp.
Di-An Controls, Inc.
Dresser Industries, Inc.
Electronic Communicotions, Inc.
Electronic Engrg. Co. of California
General Electric Co., Computer Dept.
Julie Research Labs., Inc.
KEARFOTT CO., INC.
Land-Air Inc.
Librascope Inc.
Milgo Electronic Corp.
Minneapolis-Honeywell Regulator Co., Dovies Labs. Div.
Minneapolis-Honeywell Regulator Co., Industriol Product Group
Norse Instrument Co., The
P. L. Moseley Co.
Motorolo Inc., Military Electronics Div.
National Cash Register Co., The, Electronics Div.
Philco Corp., Government & Industriol Div.
Radiation, Inc.
Singer Mfg. Co., The, Military Products Div.
Sorobon Engrg., Inc.
Sterling Precision Corp., Instrument Div.
Systron Corp.
Technitrol Engrg. Co.
Thompson-Ramo-Wooldridge Products Co., The
Trio Laboratories, Inc.
United Electrodynomics, Inc.
Victor Adding Machine Co.
Vitro Labs.
Wang Labs., Inc.
Wright Engrg. Co.

COMPUTER READOUT DEVICES
See READOUT DEVICES, COMPUTER

COMPUTERS
a. Analog
b. Course Line
c. Data Processing
d. Digital
e. Navigatian
f. Offset Track
g. Storage, Electrastotic
h. Storage, Ferroelectric
i. Storage, Magnetic

*AC ELECTRONICS DIV., GENERAL MOTORS CORP., a, d, e.
ACF Industries Inc., a, d.
Acromog Inc., a, e.
Advanced Electronics Mfg. Corp., i.
Aerojet-Generol Corp., a
Aeronco Mfg. Corp., Boltimore Focility, d.
Aeronutronic Systems, Inc., Sub.-Ford Motor Co., c, d, e, h, i.
Air Logistics Corp.
*AIRESEARCH MFG. CO. OF ARIZ., a, i.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a.
Airpax Electronics Inc. Seminole Div., d.
Allegany Instrument Co., Inc., a
Alwoc Corp., c, d, i.
American Bosch Armo Corp., a, d, e.
Americon Electronics, Inc., c.
Americon Electronics, Inc., Taller & Cooper Div., c, d.
Analogue Controls, Inc., a.
Applied Science Corp. of Princeton, c.
Arma Div., Americon Bosch Armo Corp., a, d.
Atlos Precision Products, Co., a, e.
*AVCO MFG. CORP., CROSLEY DIV., c, e.
Beckman Instruments, Inc., Berkeley Div., a.
Beckman-Systems Div., a, c, d.
Belock Instrument Corp., a, c, d, e.
Bendix Aviation Corp., Eclipse-Pioneer Div., a, b, d, e, f.
Bendix Aviation Corp., York Div., c, d.
Bendix Computer, Div.-Bendix Aviotion Corp., a, c, d.
Ernest E. Blanche & Associates, Inc., c, d.
Bowmar Instrument Corp., d, e.
Briggs Associates, Inc., c, d.
Bristol Co., The, a, d.
Burroughs Corp., a thru h.
Burton-Rodgers, Inc., a, b.
CDC Control Services, Inc., a.
CGS Lobs., Inc., c.
Centronix Inc., a, c, d, e, i.
Chicago Aeriol Industries, Inc., a, e.
Christie Machine Works, c, d.
Clory Dynamics, d, i.
Clifton Precision Products Co., Inc., e.
Collins Radio Co., a, e.
Colorado Reseorch Corp., a, e.
Computer Control Co., Inc., c, d, i.
Computer Engrg. Associotes, Inc., a.
Consolidated Avionics Corp., c, d.
Consolidoted Diesel Electric Corp., a, c, d.
Control Circuits Inc., d.
Control Dota Corp., c, d.
Cooper Industries, Inc., e.
Curtiss-Wright Corp., Electronics Div., a, d.
Dolmotor Div., Yubo Consolidated Industries, Inc., a, c, d.
Datex Corp., c.
Davenport Mfg. Co., a, d.
Daystrom Pacific Div.-Daystrom, Inc., a, b, e.
Device Development Corp., a.
Di-An Controls, Inc., c, d, e, i.
Digitronics Corp., c, d.
Donner Scientific Co., a, c, e.
Dorsett Labs., Inc., a, d.
Dresser Industries, Inc., a, c, d, i.
Eldorado Electronics, a.
Electro Instruments, Inc., c.
Electro Precision Corp.
Electro-Measurements Inc., a.
Electronic Communicotions, Inc., a, c, e, i.
Electronic Engrg. Co. of California, c, d.
Electronic Tube Corp., c.
Emeloid Co., Inc., The, e.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., a, c, d.
Emersan Radio & Phanograph Corp., a, c, e.
Ensco, Inc., a.
Exact Engrg. & Mfg. Inc., e.
Feedback Cantrals, Inc., a, e.
Ferranti Electric Inc., c, d, i.
Flight Research, Inc., e.
Forbes, Geargе F., Industrial Mathematician, a, d.
Ford Instrument Co., Div.-Sperry Rond Corp., a thru e.
General Electric Co., Apparatus Sales Div., a, c, d, i.
General Electric Co., Computer Dept., a, c, d, i.
General Precision Lab. Inc., e, f.
G. M. Giannini & Co., Inc., a, c, d.
Gilfillan Bros. Inc., a thru e, g.
Goodyear Aircraft Corp., a, c, e.
Hagan Chemicals & Controls, Inc., c.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co. d.
Hallicrafters, c, d.
Harvey-Wells Electronics Inc., c, d.
Hazeltine Electronics Div.-Hazeltine Corp., c, e, f.
Hoffman Labs. Div., Hoffman Electronics Corp., e.
Hughes Aircroft Co., d, e.
Hughes Tool Co., Aircroft Div.
Walter J. Hyott Co., The, a, e.
ITT Federol Div., Internotionol Telephone & Telegraph Corp., a, c thru f.
ITT Labs., a, c, d, e, g, h, i.
ITT Lobs.,-Ft. Woyne, g.
Industriol Control Co., a.
Instrument Development Labs., Inc., a.
Instrumentotion Div.-Ampex Corp., i.
International Business Machines Corp.-Military Products Div., b, c, d.
Jonsky & Boiley, Inc., e.
Jordur Aviotion Co., e.
Jardur Import Co., e.
*KEARFOTT CO., INC., a thru f, h, i.
Kelsey-Hayes Co., a.
Kinevox Div.-Electromotion Co., c, e.
Kollsmon Instrument Corp., Sub.-Standard Coil Products Co., Inc., a, e.
Lond-Air Inc., e.
Leor, Inc., a thru f.
Leor, Inc., Grond Rapids Div., a, e.
Leeds & Northrup Co., a.
Libroscope Inc., c, d, e, i.
Litton Industries, Inc., c, d, e, i.
Litton Industries, Morylond Div., a.
Lockheed Aircroft Corp., Missiles & Spoce Div., d, h.
Magnavox Co., The, a.
W. L. Maxson Corp., The, a, b, d, e.
Mergenthaler Linotype Co., a, c.
Mid-Century Instrumatic Corp., a, c.
Milgo Electronic Corp., a.
Minneapolis-Honeywell Regulator Co., Aeronauticol Div., a, c, d, e.
Minneapolis-Honeywell Regulotor Co., Industriol Div., c.
Minneapolis-Honeywell Regulotor Co., Industriol Product Group, c, d.
Minneapolis-Honeywell Regulotor Co., Drdnonce Div., o, d.
Missouri Reseorch Lobs., Inc., e.
Motorolo Inc., Military Electronics Div., a thru f, h, i.
Notionol Cosh Register Co., The, Electronics Div., b, c, d, g, h.
Novigotion Computer Corp., c thru f.
Northrop Corp., a, d, e, i.
Northrop Corp., The, Nortronics Div., o, d, e, h.
Norton Associotes, Inc., i.
Nucleor Products-Erco Div.-ACF Industries, Inc., a.
Dhio Semiconductors, Inc., a.
*PACKARD-BELL ELECTRONICS CORP., c, d.
Perkin-Elmer Corp., a.
George A. Philbrick Reseorches, Inc., a.
Philco Corp., Government & Industrial Div., c, d, e.
Power-Tronic Systems Inc., a, c, e, f.
Radiotion, Inc., a, c, d.
Ramo-Wooldridge Div., Thompson Romo Wooldridge of Calif., a, c, d.
George Rattroy & Co., a.
Raymond Engrg. Lob., Inc., d.
Roytheon Mfg. Co., Government Equipment Div., a, c, d, e, g.
Reeves Instrument Corp., a, e.
Reflectone Corp., The, e.
Remington Rond Univac Div.-Sperry Rand Corp., b, c, d.
Republic Aviotion Corp., c.
Rese Engrg., Inc., i.
Royol Industries, Inc., a, d.
Ryan Aeronouticol Co., e.
Servo Corp. of Americo, d.
Servomechonisms, Inc., a, d.
Singer Mfg. Co., The, Military Products Div., a, b, c, g, h, i.
Skiotron Electronics & Television Corp., a, e.
Solar Aircroft Co., a, d.
Solortron Inc., a, c.
Soroban Engrg., Inc., c, d.
Southwestern Industriol Electronics Co., a thru i.
Sperry Forrogut Co., Div.-Sperry Rand Corp., a, d, e.
Sterling Precision Corp., Instrument Div., e.
Summers Gyroscope Co., e.
Tapco Group, Thompson Romo Wooldridge Inc., c.
Technitrol Engrg. Co., c, d.
Telechrome Mfg. Corp., a, d.
Telectro Industries Corp., a, b, c, i.
Telemeter Magnetics, Inc., c, h, i.
Thompson-Ramo-Wooldridge Products Co., The, c, d.
Transistor Electronics Corp., i.

Trionics Corp., a, d, i.
U. S. Science Corp., Div.-Topp Industries, Inc., a, c, e.
Victor Adding Machine Co., c, d.
Vitro Labs., c, d, h, i.
Waldorf Electronics. Div.-F. C. Huyck & Sons, a, b, d, e.
Waltham Electronics Corp., a, d.
Wang Labs., Inc., b, d, h, i.
Wayne-George Corp., c.
Webcor, Inc., Government Div., a thru i.
Westinghouse Electric Corp., a, d.

COMPUTERS, AIR DATA

Aeronutronics Systems, Inc., Sub-Ford Motor Co.,
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Applied Science Corp. of Princeton
Atlas Precision Products, Co.
*AVCO MFG. CORP., CROSLEY DIV.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Ernest E. Blanche & Associates, Inc.
Centronix Inc.
Consolidated Controls Corp.
Cooper Industries, Inc.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Doystrom Pacific Div.-Daystrom, Inc.
Elgin Micronics Div.-Elgin National Watch Co.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Fairchild Controls Corp., Components Div.
Feedback Controls, Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Precision Lab. Inc.
G. M. Giannini & Co., Inc.
Goodyear Aircraft Corp.
Harvey-Wells Electronics Inc.
Hughes Aircraft Co.
ITT Federal Div., International Telephone & Telegraph Corp.
ITT Labs.
*KEARFOTT CO., INC., LITTLE FALLS, N. J.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Land-Air Inc.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
*WALLACE O. LEONARD, INC.
Librascope Inc.
Litton Industries, Inc.
W. L. Maxson Corp., The
Mergenthaler Linotype Co.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Motorola Inc., Military Electronics Div.
*PACKARD-BELL ELECTRONICS CORP.
Philco Corp., Government & Industrial Div.
Radiation, Inc.
Servomechanisms, Inc.
Southwestern Industrial Electronics Co.
Specialties, Inc.
Summers Gyroscope Co.
United Control Corp.
U. S. Industries, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Vitro Labs.
Waldorf Electronics Div.-F. C. Huyck & Sons
Webcor, Inc., Government Div.

CONDITIONING EQUIPMENT, THERMAL
See THERMAL CONDITIONING EQUIPMENT

CONDUITS
a. Electric
b. Fiber
c. Ignition Wire
d. Metal
e. Metal, Flexible
f. Metal, Non-Flexible

Adam Metal Supply Inc., f.
American Brass Co., The, a, d, e, f.
Anaconda Metal Hose Div., The American Brass Co., a, e.
Breeze Corporations, Inc., e.
Bridgeport Brass Co., a, d, e.
Carrier Corp., f.
Century Fasteners Corp., d, e.
Chase Brass & Copper Co., Inc., a, d.
Collins Engrg. Corp., a.
Continental Diamond Fibre Corp., a, b.
Co-Operative Industries, Inc., a, c, e.
D K Mfg. Co., d, e, f.
*ETS-HOKIN & GALVAN, f.
Federal Metal Hose Corp., e.
Flexaust Co., The, a, d, e.
Flexible Metal Hose Mfg. Co., a, e.
*FLEXONICS CORP., AERONAUTICAL DIV., e.
Fromson Drban Co., Inc., d.
General Cable Corp., a, d, e, f.
General Electric Co., Wire & Cable Dept., a, d.
General Plastics Corp. of New Jersey, b.
Hollett Mfg., Co., a, c thru f.
Haveg Industries, Inc., b.
Johns-Manville, a, b.
Kling Metal Spinning & Stamping Co., f.
Morco Industries Co., e.
Metoplast Corp., c.
Minnesota Mining & Mfg. Co., a thru e.
Newbrook Machine Corp., f.
Panduit Corp., b.
Ravenna Metal Products, Div.-Standard Screw Co., e.
Republic Steel Corp., d, f.
Rome Cable Corp., Sub.-Aluminum Co. of America, a, d, e, f.
Soylor Electric Products Corp., a.
Teleflex Inc., d, e.
United Wire & Supply Corp., d.
Wilmington Fibre Specialty Co., b.
Wiremold Co., The., a.

CONES, EXHAUST

Anchor Metal Spinning Co., The
B. H. Aircraft Co., Inc.
Basic Tool Industries, Inc.
Benson Mfg., Co., The
California Aircraft Products
Chemold Co.
Christie Machine Works
Curtiss-Wright Corp.-South Bend Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dresser Industries, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Fletcher Mfg. Co., Inc., The
Haveg Industries, Inc.
Hufford Corp., The
Hupp Aviation Co.
Ingersoll Kolamazoo Div., Borg-Warner Corp.
Intercontinental Mfg. Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kaiser Metal Products, Inc. - Fleetwings Div.
Kanarr Corp.
M. W. Kellogg Co., The
Kelsey-Hayes Co.
Kling Metal Spinning & Stamping Co.
*LAVELLE AIRCRAFT CORP.
Machine Products Div., New Haven Trap Rock Co.
Mercury Tool & Mfg. Corp.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
National Beryllia Corp.
Norris-Thermador Corp.
Norton Co.
Norton Co., New Products Dept.
Ports Engrg. Co., Inc.
Penn-Michigan Mfg. Corp.
Perry Plastics, Inc.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Portland Copper & Tank Works Inc.
Precision Sheet Metal, Inc.
Pressed Steel Tank Co.
Raybestos-Manhattan, Inc., Pa.
Reinhold Engrg. & Plastics Co.
Edw. Renneburg & Sons Co.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
C. F. Roark Welding & Engrg. Co., Inc.
Rohr Aircraft Corp.
Rolock Inc.
Ryan Aeronautical Co.
Scoife Co.-Div.-Wilson Bros.
Silicone Insulation, Inc.
Smith-Morris Corp.
Stainless Steel Products, Inc.
Swedlow Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Teiner Engrg. Corp.
Thermal Refractories Corp.
C. W. Torngren Co., Inc.
Turbo Products, Inc.
Twigg Industries
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
Waste King Corp., Technical Products Div.
Whelond Co., The
Wilks Precision Instrument Co., Inc.
Young Development Div., Hercules Powder Co.

CONES, SPEAKER

Anchor Metal Spinning Co., The
Chemold Co.
Magnavox Co., The
Perry Plastics, Inc.
Plastic Age Sales, Inc.
Smith-Morris Corp.
Waldom Electronics Inc.

CONNECTOR, OXYGEN EQUIPMENT

American Aeroparts
Aro Equipment Corp.
Carmac Aviation
Dresser Mfg. Div., Dresser Industries, Inc.
Essex Mfg., Co., Inc.
Walter Kidde & Co., Inc., Aviation Div.
H. Koch & Sons
Harold Kruger Instruments
Monogram Precision Industries
Ports Engrg. Co., Inc.
Puritan Compressed Gas Corp., Aviation Div.
Ronon & Kunzl, Inc.

CONNECTORS
a. Electric Subminiature
b. Miniature
c. Printed Circuit
d. Rack & Panel
e. RF

AMP Inc., a thru d.
Abalon Precision Mfg. Corp., d.
Accurate Electronics Corp., Dept. D, a, b, c.
Aerolite Electronics Corp., b.
Aircom Inc., d.
Aircraft Controls Co., Div., Gorn Electric Co., Inc., b, c, d.
Alden Products Co., d.
American Aeroports, a, b, d.
American Standard Products, Inc.
Amphenol Connector Div., Amphenol-Borg Electronics Corp., a thru e.
Amphenol Western Div., Amphenol-Borg Electronics Corp., e.
Anton Electronic Labs., Inc., a thru e.
Armel Electronics, Inc., a thru d.
Avnet Corp., b, d.
W. A. Beauchaine & Sons Inc., d.
Bendix Aviation Corp., Scintilla Div., b, d.
Birnbach Radio Co., Inc., b, c, d.
Burndy Corp., Dmoton Div., b thru e.
Cable Electric Products Inc., a, b.
Cambridge Thermionic Corp., b, c.
*CANNON ELECTRIC CO., a thru e.
Century Fasteners Corp., b.
Chemold Co., d.
Cleveland Metal Specialties Co., Electronics Div., c.
Coaxial Connector Co., Inc., b, e.
Cole Electric Co., d, e.
Connector Corp. of America, e.
Consolidated Electrodynamics Corp., b.
Continental Connector Corp., a thru d.
Dage Electric Co., Inc., a, b, e.
Dialight Corp., b.
R. C. Dudek & Co., a thru d.
E-Z-Hook Test Products
Elco Corp., a thru d.
Electrical Insulation Co., Inc., a, b, c.
Electro Tec Corp., a.
Electrocraft, Inc., b.
Entron, Inc., e.
*ETS-HOKIN & GALVAN, d.
Furane Plastics, Inc., c.
G. W. Galloway Co., b.
Garde Mfg. Co., c, d, e.
General R-F Fittings, Inc., b, e.
Glasseal Products Co., Inc., d.
Good Electronic Corp., c.
Good-All Electric Mfg. Co., a thru e.
Gulton Industries, Inc., a.
Hallett Mfg., Co., e.
Hampden Mfg. Co., Inc., b.
Indusl. Prod.-Danbury Knudsen Div., Amphenol-Borg Electronics Corp., b, d, e.
Javex Electronics, b, d.
Jettron Products, Inc., a, b, c.
Joclin Mfg. Co., b.
E. F. Johnson Co.
Howard B. Jones Div.-Cinch Mfg. Corp., a, b, c.
Korda Industries, a.
Kulka Electric Corp., c.
La Pointe Industries Inc., c.
Malco Mfg. Co., a, b, c.
Meridian Metalcraft, Inc., e.
Methode Mfg. Corp., b, c, d.
Microdot Inc., a, b, c, e.
Microwove Associates, Inc., e.
Minnesota Mining & Mfg. Co.
Molding Corp. of Americo, a, b.
Frank W. Morse Co., b.
Motorola Inc., Military Electronics Div., c.
National Pneumatic Co., Inc., Holtzer-Cabat Divs., d, e.
National Tel-Tronics Corp., a, b.
North Electric Co., a, d.
Nugent Electronics Co., Inc., a, b, c.
Philco Corp., Government & Industriol Div., a, b, c.
Plasteck, Inc., a, b, c.
Radar Design Corp., e.
*REDEL INC., a, b, c.
Edw. Renneburg & Sons Co., d.
Research Development Mfg. Inc., e.
Milton Ross Metals Co., The, a, b, c.
Savage-Rowe Plating Co., Inc.
Shur-Lok Corp.
C. Sjoberg & Son, a, b.
Stanley-Judd Div.-The Stanley Works, a, d.
Tamar Electronics, Inc., e.
Tap-A-Line Mfg. Co., d.
Tapco Group, Thompson Ramo Wooldridge Inc., e.
Titeflex, Inc., b.
Tower Mfg. Corp., d.
Transco Products, Inc., e.
Transistor Electronics Corp., c.
Tru-Connector Corp., e.
Ucinite Co., The, Div.-United-Carr Fastener Corp., c.
U. S. Components, Inc., a thru d.
United States Chemical Milling Corp., c.
United Supply Co., b, e.
Waltham Engrg. Corp., a, b, c.
Waltham Horological Corp., a, b, c, e.
Western International Co., a, b, d, e.
Westwood Cable Corp., e.
E. B. Wiggins Oil Tool Co. Inc., b, d.
Winchester Electronics, Inc., a thru e.

CONNECTORS, ELECTRICAL FIREWALL

*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Amphenol Connector Div., Amphenol-Borg Electronics Corp.
Anton Electronic Labs., Inc.
Bendix Aviation Corp., Scintilla Div.

*CANNON ELECTRIC CO.
Century Fosteners Corp.
Cole Electric Co.
R. C. Dudek & Co.
General R-F Fittings, Inc.
Glodding, McBeon & Co.
Good-All Electric Mfg. Co.
Joy Mfg. Co.
J. S. Industries, Inc.
United Supply Co.
E. B. Wiggins Oil Tool Co., Inc.
Winchester Electronics, Inc.

ONNECTORS, HIGH VOLTAGE

AMP Inc.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Alden Products Co.
Amphenol Connector Div., Amphenol-Borg Electronics Corp.
Anton Electronic Labs., Inc.
Armel Electronics, Inc.
Auburn Spark Plug Co., Inc.
Bendix Aviation Corp., Scintillo Div.
*CANNON ELECTRIC CO.
Coaxial Connector Co., Inc.
Cole Electric Co.
Continental Connector Corp.
Eagle Electric Mfg. Co., Inc.
Elco Corp.
Electro Tec Corp.
Good-All Electric Mfg. Co.
Hobson Brothers, Inc.
Joclin Mfg. Co.
E. F. Johnson Co.
Joy Mfg. Co.
Molding Corp. of Americo
Topco Group, Thompson Romo Wooldridge Inc.
Western Internotionol Co.
Winchester Electronics, Inc.

ONNECTORS, INTER-STAGE BREAKAWAY

*CANNON ELECTRIC CO.

NNECTORS, MICROPHONE

Amphenol Connector Div., Amphenol-Borg Electronics Corp.
Birnboch Rodio Co., Inc.
*CANNON ELECTRIC CO.
Cole Electric Co.
Dialight Corp.
Elco Corp.
Electrocroft, Inc.
Howard B. Jones Div.-Cinch Mfg. Corp.
Notional Tel-Tronics Corp.
Perry Plostics, Inc.
Switchcroft, Inc.
Waltham Horological Corp.
Western Internotionol Co.

NNECTORS, POWER

Accurate Electronics Corp., Dept. D.
AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Amphenol Connector Div., Amphenol-Borg Electronics Corp.
Anton Electronic Labs., Inc.
Armel Electronics, Inc.
W. A. Beauchaine & Sons Inc.
Bendix Aviation Corp., Scintillo Div.
Burndy Corp., Omoton Div.
CANNON ELECTRIC CO.
Cole Electric Co.
Continental Connector Corp.
Elco Corp.
ETS-HOKIN & GALVAN
G. W. Galloway Co.
Jovex Electronics
Howard B. Jones Div.-Cinch Mfg. Corp.
Joy Mfg. Co.
Kyle-Notional Co., The
Loyol Electric Corp.
Specialty Engrg. & Electronics Co.
Superior Electric Co., The
Scinite Co., The, Div.-United-Corr Fostener Corp.
U. S. Components, Inc.
Waltham Horologicol Corp.
Western Internotionol Co.
Winchester Electronics, Inc.

CNNECTORS, PRESSURIZED

Amphenol Connector Div., Amphenol-Borg Electronics Corp.
Bendix Aviation Corp., Scintillo Div.
Burndy Corp., Omoton Div.
CANNON ELECTRIC CO.
Cormac Aviation
Coaxial Connector Co. Inc.
Cole Electric Co.
Continental Connector Corp.
General R-F Fittings, Inc.
Good-All Electric Mfg. Co.
Joclin Mfg. Co.
Joy Mfg. Co.
Microdot Inc.
On Mork Couplings, Inc.
Parts Engrg. Co., Inc.
Kyle-Notional Co., The
Tru-Connector Corp.
Waltham Horological Corp.
Western Internotionol Co.
Winchester Electronics, Inc.

CONNECTORS, PATCH CORDS
See PATCH CORDS, CONNECTORS

CONNECTORS, SKIO & SLED

Amphenol Connector Div., Amphenol-Borg Electronics Corp.
Amphenol Western Div., Amphenol-Borg Electronics Corp.
*CANNON ELECTRIC CO.
Capewell Mfg. Co.
Cormac Aviotion
Cole Electric Co.
Joy Mfg. Co.
On Mork Couplings, Inc.

CONNECTORS, UMBILICAL

*CANNON ELECTRIC CO.

CONSOLES, AUOIO

Brooks & Perkins, Inc.
Bud Rodio Inc.
Du Kane Corp.
*ETS-HOKIN & GALVAN
Fletcher Mfg. Co., Inc., The
Ludwig Honold Mfg. Co.
Kirk & Blum Mfg. Co., The
Litton Industries, Morylond Div.
Livingston Electronic Corp.
*MIRAX CHEMICAL PROOUCTS CORP., ELECTRO-MECHANICAL PROOUCTS OIV.
Motorolo Inc., Military Electronics Div.
Notional Pneumotic Co., Inc., Holtzer-Cobot Divs.
Peer, Inc.
Philco Corp., Government & Industriol Div.
Rimok, Inc.
Telectro Industries Corp.

CONSOLES, LIGHTING CONTROL

Anchor Specialty Mfg. Co. Inc.
*ELECTROSNAP CORP.
*ETS-HOKIN & GALVAN
Fletcher Mfg. Co., Inc., The
Ludwig Honold Mfg. Co.
Kirk & Blum Mfg. Co., The
*MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS OIV.
Mullenboch Div.-Electric Mochinery Mfg. Co.
Peer, Inc.
Sequoio Wire & Coble Co.-Div.-Mondrel Industries, Inc.
Technicol Apporotus Builders
Telectro Industries Corp.

CONTACT CLEANERS
See CLEANERS, CONTACT

CONTACTORS

Arrow-Hart & Hegemon Electric Co., The
Automotic Switch Co.
Cole Electric Co.
Cutler-Hammer Inc.
Electro-Mechnical Products Co.
Electro-Miniotures Corp.
Erwin-Newmon Co., The
General Electric Co., Apparotus Soles Div.
Hartmon Electricol Mfg. Co., The
E. F. Johnson Co.
J. E. Menough Co.
Vop-Air Aeronoutical Products Div., Vapor Heoting Corp.
Zenith Electric Co.

CONTAINERS

Air Logistics Corp.
Americon Aluminum Co.
Americon Cor & Foundry, Div.-ACF Industries, Inc.
Americon Mochine & Foundry Co., Government Products Group
Anchor Metol Spinning Co., The
Applied Design Co.
Brooks & Perkins, Inc.
Buffolo Metol Contoiner Corp.
Butler Mfg. Co.
Champion Co., The
Chemold Co.
Chicogo Molded Products Corp.
Chrysler Corp., Defense Operotions Div.
Coloniol Aircroft Corp.
Conco Engrg. Works
Curtiss-Wright Corp., Reseorch Div.
Cutler Metol Products Co.
Dresser Mfg. Div., Dresser Industries, Inc.
FWD Corp.
Forwell Metol Fobricoting
Ferris-Mfg. Co., The
Fletcher Mfg. Co., Inc., The
Fruehouf Troiler Co., Military Equipment Div.
General Box Co.
*HARCO CONTAINERS DIV.-HABOR BOAT BUILDING CO.
Hordmon Tool & Engrg. Co.
Hicks Corp., The
Ludwig Honold Mfg. Co.
Horkey-Moore Associotes
Jeto, Inc.
M. W. Kellogg Co., The
Wolter Kidde & Co., Inc., Aviotion Div.
Kirk & Blum Mfg. Co., The
H. Koch & Sons
Lyon Von & Storage Co., Aircroft Div.
Mercury Tool & Mfg. Corp.
*MIRAX CHEMICAL PROOUCTS CORP., METAL CONTAINER DIV.
Notional Tube Div.,-United Stotes Steel Corp.
Oliver Corp., The
Opeliko Welding, Mochine & Supply Inc.
Ordnonce Div.-Food Mochinery & Chemicol Corp.
Penn-Michigon Mfg. Corp.
Piosecki Aircroft Corp.
Pressed Steel Tonk Co.
Pry Welding & Mfg., Inc.
*RHEEM MFG. CO., OEFENSE & TECHNICAL PROOUCTS OIV.
Smith-Morris Corp.
Superior Air Products Co.
Trailmobile Inc.
United Stotes Rubber Co.
Vendorlotor Mfg. Co.
Woyne Pump Co., The, Div.-Symington Woyne Corp.

CONTAINERS, SHIPPING
See SHIPPING CONTAINERS

CONTAINERS, STORAGE
See STORAGE CONTAINERS

CONTROL OAMPERS
See DAMPERS, CONTROL

CONTROL, PULSATION
See PULSATION CONTROL

CONTROL SYSTEMS DISCONNECTS
See OISCONNECTS, CONTROL SYSTEMS

CONTROL SYSTEMS, HEAT TRANSFER
See HEAT TRANSFER CONTROL SYSTEMS

CONTROL SYSTEMS, HUMIOITY
See HUMIOITY CONTROL SYSTEMS

CONTROL SYSTEMS, SERVO MECHANISM
See SERVO MECHANISM CONTROL SYSTEMS

CONTROL SYSTEMS, TEMPERATURE
See TEMPERATURE CONTROL SYSTEMS

CONTROL UNITS, BRAKE
See BRAKE CONTROL UNITS

CONTROLLERS, REMOTE SOUND
Motorolo Inc., Military Electronics Div.

CONTROLS
a. Audio Recording
b. Automatic Approach
c. Broadcast Input
d. Camera
e. Camera, Remote
f. Capacitance Operated
g. Chemical
h. Combustion
i. Computer
j. Conductivity
k. Counting & Sorting
l. Oensity
m. Oimension
n. Dynamometer
o. Electronic AC Motor Speed
p. Engine
q. Film Thickness
r. Fire
s. Flame Failure
t. Fluid Conductivity
u. Fluid Flow
v. Fuel
w. Gas
x. Heat Treating
y. Humidity
z. Inspection
a1. Liquid Level
b1. Loop Regulation
c1. Machine Safety
d1. Master
e1. Materials Thickness
f1. Motors & Generators
g1. PH
h1. Photographic Exposure
i1. Photoelectric
j1. Positioning
k1. Power Level
l1. Pressure
m1. Push-Pull
n1. Radio Remote
o1. Reactor, Nuclear
p1. Register
q1. Register Cutter
r1. Remote, Antenna
s1. Servo
t1. Signal
u1. Smoke Density
v1. Sound System
w1. Specific Gravity
x1. Speed
y1. Strain
z1. Tension
a2. Timing
b2. Torque, Electronic

c2. Turbidity
d2. Vacuum
e2. Ventilating Control System
f2. Voltage Regulator
g2. Volume
h2. Volume & Tone
i2. Weight
j2. Welding

*AC ELECTRONICS DIV., GENERAL MOTORS CORP., v, x-1.
ACF Industries Inc., w, l-1, s-1, d-2
A-G-A Div., Elastic Stop Nut Corp. of America, o-2
Abrams Instrument Corp., d, o, a-2
Acro Div., Robertshaw-Fulton Controls, i-1.
Acromag Inc., z, a-1, s-1.
Actuation Research Corp., t, u.
Adel Precision Products of California, Div.-General Metals Corp., p, u.
Adept Industries Inc., t-1.
Advanced Products Co., The, a-2
Aero Gasket Corp., u, v.
Aero Supply Mfg. Inc., p, u, v, w, a-1, l-1, s-1, e-2
Aerojet-General Corp., p, u, v, j-1, a-1.
Aerolab Development Co., b-1, k-1, s-1, a-2, f-2.
Aeronca Mfg. Corp., h, v, m-1.
Aeronutronic Systems, Inc., Sub.-Ford Motor Co., i, u.
Aerotec Corp., The, u, a-1, l-1.
Air Logistics Corp., n, s.
Aircraft Controls Co., Div., Gorn Electric Co., Inc., a-1, l-1.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., i, o, p, u, v, w, f-1, j-1, l-1, s-1, e-2
Airpax Electronics Inc. Seminole Div., o, s-1, x-1, a-2
Allied Research Products, Inc., t, a-1.
Allis-Chalmers, a-1, f-1, j-1.
Alloy Bellows Inc., l-1.
Alto Scientific Co., Inc., a-2
Amelco, Inc., s-1.
American Agile Corp., e-2
American Bosch Arma Corp., o, p, u, v, f-1, s-1, x-1.
American Electronics, Inc., f-1, j-1, k-1, s-1, b-2
American Electronics, Inc., Taller & Cooper Div., d, n, e-2
American Machine & Foundry Co., Government Products Group, g-2, i-2, k, m, p, b-1 thru e-1, j-1, k-1, m-1, a-1, r-1, s-1, t-1, x-1.
American Machine & Foundry Co., Greenwich, a-1, r-1, s-1, b-2
American Measurement & Control, Inc., u, j-1, l-1, s-1, x-1.
American Research & Mfg. Corp., z, s-1, f-2
Amglo Corp., t-1, a-2.
Analogue Controls, Inc., i, j-1, s-1.
Anderson Machine & Tool Co., r.
*ANNIN CO., THE, u.
Antlab Inc., j-1.
Applied Dynamics Corp., l-1.
Arens Controls, Inc., p, m-1.
*ARNOUX CORP.
Aro Equipment Corp., w, a-1, l-1, d-2.
Arrow-Hart & Hegeman Electric Co., The, o, a-1, f-1, m-1, e-2.
Assembly Products, Inc., i, f-1, a-2
Associated Engineers, Inc., u-1.
Astronautics Engrg. Co., n, u, l-1, i-2
Atlantic Instrument Corp., Sub.-American Electronics, Inc., u, a-1.
Atlas Precision Products, Co., d, e, j-1, r-1, s-1, x-1, a-2.
Automation Dynamics Corp., n-1.
Automation Products, Inc., l, a-1, w-1.
Autotron, Inc., i-1.
Autotronics Inc., x-1.
*AVCO MFG. CORP., CROSLEY DIV., b, r, n-1.
Avien, Inc., p, u, a-1.
Axler Associates Inc., g.
B & F. Instruments, Inc., y-1, b-2
B & H Instrument Co., Inc., s-1.
Babcock Radio Engrg., Inc., n-1.
Barber-Colman Co., j-1, s-1, e-2
Beaver Precision Products Inc., v, j-1, m-1, a-1.
Beckman Instruments, Inc., Berkeley Div., o, x-1, a-2
Bell Aircraft Corp., Niagara Frontier Div., s-1.
Bell & Howell Co., d, e, q, b-1, h-1, i-1.
Belock Instrument Corp., d, e, r-1, s-1, x-1.
Bendix Aviation Corp., Eclipse-Pioneer Div., b.
Bendix Aviation Corp., Friez Instrument Div., y, l-1, a-2
*BENDIX AVIATION CORP., HAMILTON DIV., p, u, v, s-1.
Bendix Aviation Corp., Pioneer-Central Div., u, a-1.
Bendix Aviation Corp., York Div., a-1, j-1.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., h, p, v, k-1, l-1, s-1, x-1, b-2
Bendix-Pacific Div., Bendix Aviation Corp., u, s-1, a-2
Bendix Utica Div., Bendix Aviation Corp., p, u, l-1, s-1, a-2
Bernco Eng. Corp., p, x, a-1, a-2.
Blackhawk Mfg. Co., u, j-1, m-1.
Blonder-Tongue Labs., Inc., d, e.
Bogue Electric Mfg., Co., b, i, o, a-1, f-1, j-1, s-1, x-1, f-2
Bowmor Instrument Corp., h, j, k, r, u, v, a-1, l-1, s-1.
Bowser, Inc., Defense Dept., g, u, v, w.
Broch Mfg. Corp., Div.-General Bronze, o, b-1, a-1, r-1, s-1, x-1, f-2
Branson Corp., a-2
Branson Instruments, Inc., m, q, e-1.
Briggs Associates, Inc., j-2
Bristol Co., The, f thru l, s thru y, a-1, g-1, j-1, k-1, l-1, n-1, s-1, u-1, w-1, x-1, y-1, a-2, c-2, d-2, e-2.
Bristol Motors Div.-Vocaline Co., of America, Inc., a-2
Brooks Rotameter Co., u, a-1, w-1.
Brown Engrg. Co., Inc., s-1.
Bulow Electric Co., e, a-1, r-1, s-1, a-2
Burroughs Corp., i, r.
Burton-Rodgers, Inc., i, s-1, t-1, v-1.
CDC Control Services, Inc., g, u, y, j-1, l-1, r-1, s-1, i-2
CGS Labs., Inc., f-1.
Cameraflex Corp., d, e, h-1.
J. C. Carter Co., The, u, v, a-1, l-1.
Centrolab, Div.-Globe-Union, g-1, h-2
Centronix Inc., o, i, k, i-1.
Chalco Engrg. Corp., u, A-1.
Chandler Evans Corp., h, l, p, u, v, w, j-1, k-1, l-1, r-1, s-1, x-1, a-2
John Chatillon & Sons, m-1, b-2
Chicago Aerial Industries, Inc., d, e, i, o, h-1, i-1, r-1, s-1, x-1, a-2
Cinemo Engrg., o, c.
Clarostat Mfg. Co., Inc., g-2, h-2
Clory Dynamics, g, h, i, l-1, s-1, g-2
Cleveland Instrument Co., m, z, e-1.
Cleveland Pneumatic Industries, Inc., s-1.
Clifton Precision Products Co., Inc., s-1.
Coils-Electronics, a-1, s-1.
Collins Radio Co., b, c.
Colorado Research Corp., i, j-1.
Columbia Products Co., r-1.
Communications Research Co., n-1.
Components Corp., u, v, w, a-1, s-1, d-2
Conoflow Corp., g, u, v, w, a-1, l-1, s-1, d-2
Consolidated Avionics Corp., j, k, u, z-1, a-2
Consolidated Controls Corp., p, v, w, j-1, l-1, m-1, a-1, s-1, x-1, d-2
Consolidated Diesel Electric Corp., h, v, w, l-1, a-1, d-2, f-2
Consolidated Diesel Electric Corp., Western Div., f-1.
Consolidated Electrodynamics Corp., l-1.
Continental Corbon, Div.-Wirt Co., g-2, h-2
Control Circuits Inc., i, j, k, s-1, w-1.
Control Engrg. Co., Div. Jervis B. Webb Co., n, o, p, d-1, a-2
Controls Co. of America, s, u, v, w, z, z-1.
Cornelius Co., The, Aero Div., l-1, d-2
Cornell Deep Drawing Co., Div.-Lones Industries Corp., z, k-1, c-2
Cosa Corp., n.
Cramer Controls Corp., a-2
Curtiss-Wright Corp., Electronics Div., l, a-1, f-2
Curtiss-Wright Corp., Propeller Div., j-1, s-1.
Curtiss-Wright Corp., Research Div., a-1.
Curtiss-Wright Corp., Wright Aeronautical Div., h, p, k-1.
Curtiss-Wright Electronics Div., IMI Branch, l-1.
Cutler-Hammer Inc., o, a-1, f-1, j-1, l-1, d-2, e-2, f-2
DBM Research Corp., d, e, k, i-1.
Dale Products, Inc., a.
Dalmotor Div., Yuba Consolidated Industries, Inc., i, o, b-1, j-1, s-1, x-1.
Data Instruments Div.-Telecomputing Corp., i-1.
Datex Corp., j-1.
Datran Electronics, Div.-Mid-Continent Mfg., Inc., y-1.
Daven Co., The, o, c, k-1, v-1, h-2
Davenport Mfg. Co., i-1, f-2
Daystrom Pacific Div.-Daystrom, Inc., i, j-1, l-1, s-1.
Dayton Aviation Radio & Equipment Corp., b, b-1, j-1, m-1, r-1, s-1.
Daytronic Corp., m, e-1, j-1, y-1, z-1.
Delsen Corp., f, e-1.
Denison Engrg. Div., American Broke Shoe Co., l-1, g-2
Deringer Metallurgical Corp., j-2
Destron Co., a-2
Detronic Industries, i-1, s-1, j-2
Dial Products Co., z-1.
Di-An Controls, Inc., i, k, a-2
J. W. Dice Co., m, q, z, e-1.
Henry G. Dietz Co., Inc., u, a-1, l-1, a-2, d-2, e-2
W. C. Dillon & Co., Inc., i-2
Donner Scientific Co., i, j-1, a-1.
Dresser Industries, Inc., i, s-1, f-2
M. Ducommun Co., a-2
Dynamic Controls Corp., u, a-1, l-1, a-2
Eastern Industries Inc., u, y, k-1, s-1.
Eastern Jewel Corp., g-2, h-2
Edgerton, Germeshausen & Grier, Inc., d, e, h-1, n-1, a-1, a-2
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., r, s, s-1, a-2
Electric Machinery Mfg. Co., o, e-1.
Electric Regulator Corp., o, p, f-1, k-1, s-1, x-1, f-2
Electro Precision Corp., s-1, f-2
Electro Products Laboratories, Inc., k, c-1, j-1, x-1, b-2
*ELECTROSNAP CORP., r, c-1, j-1, m-1.
Electro-Mechanical Products Co., r, d-1, f-1, r-1, s-1, f-2
Electronic Applications, Inc., w.
Electronic Communications, Inc., n-1, r-1, s-1.
Electronic Control Corp., h, j, k, q, t, x, a-1, c-1, i-1, j-1, k-1, u-1, a-2, b-2
Electronic Engrg. Co. of California, d, e, i, k, a-2
Electronic Specialty Co., a-2
Electron-Radar Products, s, y, i-1.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., d.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., s-1.
Epic, Inc., y.
Erie Resistor Corp., k, a-2
*ETS-HOKIN & GALVAN, a, b, c, o, p, r thru u, y, a-1, b-1, d-1, f-1, j-1, k-1, m-1, r-1, s-1, u-1, v-1, c-2, e-2, thru h-2.
Exact Engrg. & Mfg., Inc., i, a.
Fae Instrument Corp., s-1.
Fairchild Astronics Div., Fairchild Engine & Airplane Corp., p, j-1, s-1, x-1.
Fairfield Engrg. Corp., o, f-1, h-1 thru k-1, s-1, b-2, f-2, j-2
Farmer Electric Products Co., Inc., h-1, z-1.
J. W. Fecker, Inc., d, e, s-1.
Federal Mfg. & Engrg. Corp., h.
Federal Products Corp., m, z, j-1.
Federol Tool Engrg. Co., j-2
Feedback Controls, Inc., i, r, a-1, r-1, s-1.
Fidelity Amplifier Co., h, s.
Fidelity Instrument Corp., o, f-1, f-2
Fischer & Porter Co., u, v, l-1, w-1.
Fisher Governor Co., w, a-1, l-1.
Flight Refueling, Inc., u, a-1, l-1, n-1, g-2
Ford Instrument Co., Div.-Sperry Rand Corp., b, i, u, a-1, r-1, s-1.
Furnas Electric Co., g-1, d-1, f-1, l-1.
Galland-Henning Nopok Div., x-1.
Gardner Laboratory, Inc., q, y, e-1, g-1.
General Communication Co., l, w-1.
General Devices, Inc., a-2
General Electric Co., Apparatus Sales Div., n thru u, w, a-1, d-1, e-1, f-1, i-1 thru l-1, o-1, p-1, s-1, u-1, x-1, y-1, z-1, a-2, c-2, d-2, f-2, j-2
General Electric Co., Computer Dept., i.
General Electric Co., Missile & Space Vehicle Dept., e-1.
General Electric Co., X-Ray Dept., d.
General Electro-Mechanical Corp., s-1, z-1.
General Magnetics, Inc., f-2
General Precision Lab. Inc., d, e.
G. M. Giannini & Co., Inc., i, j-1, l-1, s-1, f-2, g-2
Giannini Plasmadyne Corp., d-2
Gilmore Industries, Inc., i-2
Good Electronic Corp., z, y-1.
Goodyear Aircraft Corp., r-1.
Claud S. Gordon Co., w.
Gordon Enterprises, d, e, h-1, a-2
Graflex Inc., d, e.
Green Rectifier Co., x-1, d-2, f-2
Grimes Mfg., Co., d-1.
Guided Missile Div.-De Havilland Aircraft of Canada Ltd., f-1, s-1, f-2
Gulton Industries, Inc., g, u, z.
Hagan Chemicols & Controls, Inc., g, h, j, l, u, v, y, a-1, g-1, l-1, w-1, x-1, g-2
Haledy Electronics Co., u, a-1, i-1, d-2
Hamilton Standard, Div.-United Aircraft Corp., i, m, p, v, y, b-1, d-1, i-1, j-1, k-1, m-1, a-1, s-1, x-1, b-2
Hamilton Watch Co.-Industrial Div., t-1, a-2
Hammarlund Mfg. Co., Inc., a, e, i, k, r, s, t, u, a-1, n-1, l-1, t-1.
Hammel-Dahl Div.-General Controls Co., u, a-1.
Hannifin Co., Div.-Parker-Hannifin Corp., u, c-1, l, m-1, x-1.
Hanson-Gorrill-Brian, Inc., o, i-1, s-1, x-1.
Paul Hardeman, Inc., t, u, l-1, a-1.
*A. W. HAYDON CO., THE, d, i, k, p, f-1, a-2
Helipot Div.-Beckman Instruments Inc., s-1.
Herlo Engrg. Corp., j-2
High Vacuum Equipment Corp., x, c-2
E. Vernon Hill & Co., f-2
Hobbs Mfg. Co., z-1.
Haffman Electronics Corp., Semiconductor Div., r, i-1, u-1, f-2
Holley Carburetor Co., v.
Hoover Electric Co., e, f, o, f-1, j-1, k-1, a-1, r-1, x-1, a-2, b-2, e-2, f-2
Hufford Corp., The, c-1, j-1.
Hughes Tool Co., Aircraft Div., v.
Hughey & Phillips, Inc., i-1.
Hull Corp., d-2
Walter J. Hyatt Co., The, u, v, r-1.
Hycon Mfg. Co., d, e, h-1, j-1.
Hydro-Power Corp., t thru w, l-1, s-1.
*HYDRO-AIRE CO., DIV.-CRANE CO., v, w.
Hydromatics, Inc., u, j-1, l-1.
Imperial Brass Mfg. Co., The, u, m-1.
Industrial Control Co., k, o, f-1, j-1, s-1.
Industrial Engrg. Corp., k-1.
Industrial Instruments Inc., j, t.
Industrial Timer Corp., a-2
Ingraham Co., The, a-2
Instrument Development Labs., Inc., i-1, u-1.
Instrumentation Div.-Ampex Corp., a, i.
Instruments Corp., The, y.
Instruments Div.-Philips Electronics, Inc., n-1.
International Register Co., a-2
Interstate Engrg. Corp., t.
ITT-Kellogg, d, e, t-1, v-1, a-2
JEM Electronics Corp., i-1.
Jack & Heintz, Inc., f-1, f-2
Jansky & Bailey, Inc., r-1.
Javex Electronics, g-2
Jeto, Inc., f-1.
Jones & Lomson Machine Co., j-1.
Jordan Co., Inc., The, j-1, a-1, s-1, x-1, z-1.
Kahn & Co., Inc., x-1.

anarr Corp., j-2
KEARFOTT CO., INC., i, o, f-1, j-1, r-1, s-1.
eithley Instruments, Inc., o-1.
elsey-Hayes Co., s-1.
etay Dept., Norden Div., United Aircraft Corp., s-1.
alter Kidde & Co., Inc., Aviation Div., s-1.
ilgen Aircraft Div., i, d-1, v-1.
ingston Electronics-Div.-Kingston Industries Inc., f-1.
inney Mfg. Div., The New York Air Brake Co., d-2
oehler Aircraft Products Co., u, v, w, o-1.
ordo Industries, h, p, u, v, x-1.
arold Kruger Instruments, g, g-1, c-2
and-Air Inc., d, e, i, n, u, v, z, o-1, j-1, n-1, s-1, o-2.
ane Electronics Mfg. Corp., n-1.
each Corp., o, f-1, o-2, f-2
ear, Inc., b, p, j-1, n-1, o-1, s-1, z-1, b-2.
ear, Inc., Grand Rapids Div., b, o, f-1, j-1, r-1, s-1.
eor Inc., Lear-Romec Div., s-1.
eeds & Northrup Co., g, h, j, o, t, x, y, o-1, g-1, o-1, w-1, x-1, i-2
eland Airborne Products, Div.-American Machine & Foundry Co., f-1, f-2
WALLACE O. LEONARD, INC., i, o-1, l-1, s-1.
eslie Co., u, v, l-1, d-2
ibrascope Inc., i.
iquidometer Corp., The, o-1.
undy Mfg. Corp., c, o, f-1, b-2, e-2
agnaflux Corp., q, z, e-1.
agnetic Instrument Co. Inc., f, l, v, o-1, o-1, s-1, y-1.
agnetico, Inc., s-1.
agnetrol, Inc., u, o-1.
agtrol, Inc., n, j-1, s-1, b-2.
aico Electronics, Inc., j-1.
. R. Mallory & Co. Inc., o-2, g-2, h-2
arquardt Aircraft Co., h, p, v, j-1, k-1, o-1, x-1.
ason-Neilan, u, o-1, l-1, w-1, d-2
atheson Co., Inc., The, w, l-1.
. L. Maxson Corp., The, u, o-1, t-1.
eriam Instrument Co., u.
erix Chemical Co., g.
etals & Controls Corp., Spencer Div., m-1.
icro Gee Products, Inc., s-1.
idwestern Instruments, Inc., o.
ilgo Electronic Corp., i, s-1.
initran Corp., f-2
inneapolis-Honeywell Regulator Co., Aeronautical Div., b, f, i, p, s, o-1, j-1, s-1.
inneapolis-Honeywell Regulator Co., Boston Div., s-1.
inneapolis-Honeywell Regulator Co., Industrial Div., j, l, s thru v, x, y, o-1, g-1, j-1, l-1, o-1, s-1, w thru z-1, o-2, d-2
inneapolis-Honeywell Regulator Co., Industrial Product Group, i, l, u thru y, o-1, b-1, g-1, j-1, k-1, l-1, o-1, s-1, u-1, w-1 thru z-1, d-2
inneapolis-Honeywell Regulator Co., Ordnance Div., y, u-1, b-2, f-2
iratel, Inc., o.
issouri Research Labs., Inc., s-1.
. J. Monaghan Co., Inc., l-1.
onogram Precision Industries, r-1.
oore Associates, Inc., m-1.
oran Instrument Corp., s-1.
orse Instrument Co., The, p, h-1, i-1, m-1, r-1, s-1.
otorola Inc., Military Electronics Div., b, i, j-1, n-1, r-1, s-1, v-1.
einz Mueller Eng. Co. Inc., o, f-1.
ullenbach Div. Electric Machinery Mfg. Co., c-1, j-2
RC Equipment Corp., d-2
eorge L. Nankervis Co., m, n, o, t, u, s-1, w-1.
ational Instrument Laboratories, Inc., u.
ational Pneumatic Co., Inc., Holtzer-Cabot Divs., s-1, g-2, h-2
atl. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc., p, u, s-1.
avigation Computer Corp., i.
elson Labs., Inc., k.
etworks Electronic Corp., o, b-1, f-1, m-1, s-1, f-2.
ew England Scientific Instruments Co., y, o-1, j-1, k-1, l-1, s-1, x-1.
ewark Controls Co., l, w, o-1, l-1, d-2
ewton Co., The, i, s-1.
orth Atlantic Industries, Inc., s-1.
orth Electric Co., e, i, k, k-1, v-1.
ortheastern Engrg. Inc., f-1.
orthrop Corp., s-1.
orwood Controls Unit Detroit Controls Div., g, u, o-1, j-1, l-1, o-1.
uclear Products-Erco Div.-ACF Industries, Inc., i, o-1.
aul Nurches Co., o-2
PW-Jordan, o-1, l-1.
hio Semiconductors, Inc., i, k-1, s-1, f-2
mart Corp., The, l, o-1, w-1.
il-Dyne, Inc., t.
tis Elevator Co., Electronic Div., s-1.
xygen Equipment & Service Co.
zone Metal Products Corp., r-1, u-1.
acific Scientific Co., x, z-1.
PACKARD-BELL ELECTRONICS CORP., i.
apesch & Kolstad, Inc., x.
aragon Electric Co., o-2
arts Engrg. Co., Inc., u, v, w.
eer, Inc., j-2
eschel Electronics, Inc., z.
hilco Corp., Government & Industrial Div., b thru e, i, r, n-1, s-1, t-1, v-1, f-2, g-2, h-2.
Photobell Co., Inc., b, f, k, l, m, y, z, o-1, b-1, c-1, i-1, j-1, p-1, q-1, u-1, z-1, b-2, c-2
Photo-Crystals, Inc., h, s, y, i-1.
Photomation, Inc., h, s, u, o-1, b-1, c-1, i-1, j-1, c-2
Photovolt Corp., l, g-1, h-1.
Pioneer Industries Div., Almor-York Co. Inc., z, j-2
Pneu-Hydro Volve Corp., u, v, w, o-1, l-1.
Potter Aeronautical Corp., u, v, w.
Power Designs Inc., f-2
Power Supplies Inc., b-1, f-1, f-2
Power-Tronic Systems Inc., b, i, k, o, u, x, o-1, b-1, s-1, b-2, f-2, g-2, h-2
Precision Thermometer & Instrument Co., l, w-1.
Process & Instruments, g-1, d-2
Radiation, Inc.
Radiation Instrument Development Lab., Inc., o-1.
Romo-Wooldridge Div., Thompson Romo Wooldridge of Calif.
Raymond Engrg. Lab., Inc., r-1, o-2
Raytheon Mfg. Co., o-2, j-2
Reoction Motors Div., Thiokol Chem. Corp., p, u, v, j-1.
Redmond Co., Inc., f-1.
Reeves Instrument Corp., s-1.
Reinhold Engrg. & Plastics Co., v, w, j-1, r-1.
Republic Aviation Corp., s-1.
Research Appliance Co., d-2
Research Controls, g, h, u, v, j-1, l-1.
Revere Corp. of Americo, u, o-1.
M. H. Rhodes, Inc., o-2
Rinco, Inc., i.
Robot Industries Inc., b, p, i-1, m-1, r-1.
Ronan & Kunzl, Inc., m-1.
Ronson Hydraulic Units Corp., u, l-1, s-1.
Milton Roy Co., g, o-1, g-1.
Royal Industries, Inc., d, j-1, m-1, r-1, s-1.
Ryan Aeronautical Co., p, s-1.
Rytron Co., Inc., o, f-1, f-2
Safety Electrical Equipment Corp., f-1.
Sangomo Electric Co., o-2
Sargent Engrg. Corp., p, u, l-1, o-1, s-1, g-2
Scaico Controls, Inc., r, s, o-1, l-1, d-2
Scioky Brothers, Inc., z-1, i-2
Scientific Instrument Co., g, y, l-1.
Scientific-Atlanta, Inc., j-1.
H. H. Scott, Inc., v-1.
Seiscor Mfg. Co., n-1.
Sequoia Wire & Cable Co., Div.-Mandrel Industries, Inc., o-2, f-2
Servomechonisms, Inc., h, i, l, p, r, u, v, o-1, l-1, s-1, w-1, x-1.
Servomechonisms, Inc., Mechatrol Div., e-1, r-1, w-1.
Servwell Products Co., m-1.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., m, q, z, e-1.
Simmonds Aerocessories, Inc., u, v, w, o-1, m-1.
Singer Mfg. Co., The, Military Products Div., s-1, o-2
Sioux Oil Co., v.
Skiatron Electronics & Television Corp., i.
A. O. Smith Corp., t, u.
Soroban Engrg., Inc., i.
Southwest Products Co., n, p, v, j-1, m-1, z-1.
Southwestern Industrial Electronics Co., g, h, i, k, p, s thru x, o-1 thru d-1, g-1, l-1, m-1, s-1, t-1, w-1 thru z-1, o-2, b-2
Space Corp., o-1.
Specialties, Inc., d, e, h-1, l-1, s-1.
Specialty Engrg. & Electronics Co., w.
Spectrol Electronics Corp., j-1, s-1.
Sperry Piedmont Co. – Div.-Sperry Rand Corp., p, j-1.
Standord Controls, Inc., u, l-1.
Standord-Thomson Corp., Clifford Mfg. Co. Div., e-2
Stanley Aviation Corp., o-1.
Sterling Precision Corp., Instrument Div., i, i-1.
F. W. Stewort Corp., m-1, n-1.
A. U. Stone & Co., Inc., u, v, w.
Strand Engrg. Co., j, k.
Stratos, Di v.-Fairchild Engine & Airplone Corp., v, w.
Summers Gyroscope Co., s-1.
Sun Electric Corp., Aeronautical Div., j-1, s-1.
Superior Electric Co., The, j-1, f-2
Swartwout Co., The, g, u, o-1, l-1, s-1.
Systron Corp., k, u, x-1, o-2
Tactair Valve Div.-Aircraft Products Co., u.
Taft-Peirce Mfg. Co., The, m, z.
Talley Corp., The, o, f-1, j-1, f-2
Tapco Group, Thompson-Ramo-Wooldridge Inc., e, o, p, v, w, o-1, f-1, j-1, l-1, o-1, r-1, s-1, x-1.
Taylor Winfield Corp., o-2, j-2
Technical Apporatus Builders, o, f-2
Telechrome Mfg. Corp., d, e, k, m, q, y, z, o-1, i-1, n-1, y-1 thru b-2, i-2
Telectro Industries Corp., o, b, f, i, d-1, j-1, n-1, r-1, v-1, f-2, g-2
Teleflex Inc., p, v, m-1, z-1.
Tel-Instrument Electronics Corp., f-2
Temperature Engrg. Corp., x, y, d-2
Tempo Instrument Inc., o-2
Thiokol Chemicol Corp., b.
Thomas Electronics, Inc., q.
Thompson-Ramo-Wooldridge Products Co., The, i.
Transco Products, Inc., r-1.
George Ulanet Co., o-2
United Aircraft Products, Inc., p, t, u, v, y, l-1, e-2
United Control Corp., e, o-1, j-1, l-1, s-1, e-2
United Electric Controls Co., p, r, v thru y, o-1, c-1, f-1, j-1, k-1, l-1, d-2, e-2
United Electrodynamics, Inc., f-2
U. S. Science Corp., Div.-Topp Industries, Inc., d, e, k-1, j-1, s-1, o-2, e-2
United Transformer Co., f-2
Universal Dynamics Corp., y.
University Loudspeakers, Inc., h-2
Vacuum Tube Products, Div.-Hughes Aircraft Co. o-2, d-2, j-2.
Variety Aircraft Corp., m-1.
Varo Mfg. Co., Inc., o, b-1, f-1, j-1, m-1, s-1, x-1, f-2
Veeco Vacuum Corp., d-2
Vemaline Products Co., o-2
Vickers Inc., Div.-Sperry Rand, s-1.
Victory Engrg. Corp., f, t, o-1.
Wacline, Inc., o, x-1.
Waldorf Electronics. Div.-F.C. Huyck & Sons, i, j-1, s-1.
Walkirt Co., k.
Waltham Engrg. Corp., o-2, d-2
Waltham Precision Instrument Co., o-2
Watertown Div., The New York Air Brake Co., u, l-1, s-1.
Waugh Engrg. Co., u, s-1, o-2
Webcor, Inc., Government Div., o, i, k, n-1, r-1, o-2, b-2
Weighing & Control Components, Inc., y, z-1, i-2
West Instrument Corp., x.
Western Arc Welding, Inc., p, m-1, b-2
Western Design Div.-U.S. Industries, Inc.; Santa Barbara Div., o, o-2, f-2
Westinghouse Air Brake Co., Industrial Products Div., k-1.
Westinghouse Electric Corp., o, f-1, o-1, s-1, z-1, e-2, f-2, i-2
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp., l-1, s-1.
Weston Instruments, Div.-Daystrom, Inc., q, y, h-1, i-1, l-1.
Westronics Inc., o-1, s-1, y-1.
Wilcolator Co., The, y.
G. C. Wilson & Co., i-1, o-2
Winder Aircraft Corp., of Florida, f-2
Winzen Research Inc., n-1.
Worner Electronic Devices, g, j, k, r, y, z, o-1, b-1, h-1, r-1, u-1, w-1, o-2, c-2
Zenith Rodio Corp., n-1.
Zoomar Inc., d, e, h-1.

CONTROLS, ALARM SYSTEM

American Electronics, Inc., Taller & Cooper Div.
American Machine & Foundry Co., Government Products Group
American Research & Mfg. Corp.
Assembly Products, Inc.
Barker Sales Co.
Bristol Co., The
Centronix Inc.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Curtiss-Wright Corp., Electronics Div.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Electronic Control Corp.
*ETS-HOKIN & GALVAN
Federal Mfg. & Engrg. Corp.
Fenwal Inc.
Fischer & Porter Co.
Globe Automotic Sprinkler Div., The Fyr-Fyter Co.
Hamilton Standard, Div.-United Aircraft Corp.
Hammarlund Mfg., Co., Inc.
Paul Hardemon, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
*MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.
Missouri Research Labs., Inc.
Motorola Inc., Military Electronics Div.
North Electric Co.
Philco Corp., Government & Industrial Div.
Photobell Co., Inc.
Scaico Controls, Inc.
Scam Instrument Corp., The
Scientific Instrument Co.
Simmonds Aerocessories, Inc.
Southwestern Industrial Electronics Co.
Specialty Engrg. & Electronics Co.
Sun Electric Corp., Aeronautical Div.
Technical Apporatus Builders
Thermo Electric Co., Inc.
Thompson-Ramo-Wooldridge Products Co., The
United Control Corp.
United Electric Controls Co.

CONTROLS, GENERATOR

a. Illumination
b. Mechanical Overload
c. Mechanical Switch
d. Motor & Generator Communications
e. Motor & Generator, Industriol
f. Oxygen
g. X-roy

Air Products, Inc., f.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., f.
Allis-Chalmers, e.
Americon Aeroparts, b.
American Bosch Arma Corp.

American Electronics, Inc., e.
Aro Equipment Corp., f.
Atlas Precision Products, Co., b, c.
Borker Sales Co., d.
Bendix Aviotion Corp., Red Bank Div.
Bogue Electric Mfg., Co.
Bracke-Seib X-ray Co., Inc., g.
Bristol Co., The, f.
Cole-Hersee Co., c.
Consolidated Diesel Electric Corp., a, d, e.
Consolidated Diesel Electric Corp., Western Div., e.
Cornell Deep Drowing Co., Div.-Lanes Industries Corp., c.
Cutler-Hammer Inc., e.
Electric Machinery Mfg., Co., e.
Electric Regulator Corp.
Electro-Mechonicol Products Co., b, c.
Electronic Control Corp., g.
*ETS-HOKIN & GALVAN, a thru e.
FXR, Inc., g.
General Electric Co., Apporotus Sales Div., a, d, e, g.
General Electric Co., X-roy Dept., g.
Guided Missile Div.-De Havillond Aircroft of Canodo, Ltd.
Hoover Electric Co., b, c, d, e.
Instruments Div.-Philips Electronics, Inc., g.
Jock & Heintz, Inc.
Jeto, Inc., e.
Kilgen Aircroft Div., a, c.
Leach Corp., e.
Leland Airborne Products, Div.-American Mochine & Foundry Co.
Motoresearch Co.
Heinz Mueller Eng. Co. Inc., d, e.
Mullenbach Div.-Electric Machinery Mfg. Co., e.
National Pneumotic Co., Inc., Holtzer-Cobot Divs., d, e.
Overload Control Co., b.
Oxygen Equipment & Service Co., f.
PIC Design Corp., Sub.-Benrus Watch Co., Inc., b.
Ports Engrg. Co., Inc., f.
Picker X-roy Corp., g.
Power Supplies Inc., d, e.
Robot Industries Inc., c.
Sofety Electricol Equipment Corp., e.
Smith-Morris Corp., g.
Tolley Corp., The, b thru e.
Topco Group, Thompson Romo Wooldridge Inc.
Technical Apporatus Builders, a.
Telectro Industries Corp., b.
United Electric Controls Co., b, e.
Voro Mfg. Co., Inc., d, e.
Wocline, Inc., d, e.
Westinghouse Electric Corp., e, g.
Winder Aircraft Corp. of Florida, b, c.
Winzen Research Inc., f.

CONTROLS, OXYGEN SYSTEMS &
See OXYGEN SYSTEMS & CONTROLS

CONTROLS & STARTING SYSTEMS
See STARTING SYSTEMS & CONTROLS

CONTROLS, SURFACE FINISH

American Research & Mfg. Corp.
Brush Instruments, Div.-Clevite Corp.
Clevelond Instrument Co.
*ENGIS EQUIPMENT CO.
General Electric Co., Apporatus Soles Div.
Micrometrical Fg. Co.
Sel-Rex Corp.

CONTROLS & SYSTEMS, PNEUMATIC
See PNEUMATIC CONTROLS & SYSTEMS

CONTROLS, VIBRATION
See VIBRATION CONTROLS

CONVERTERS

a. AC-DC
b. Analog Digital
c. DC-AC
d. Electric
e. Field Sequential
f. FM Communicatians
g. Frequency, Measurement & Test
h. Frequency, Pawer Supplies
i. Liquid Oxygen
j. Micrawave
k. RF
l. Rotary
m. Valtage
n. Waveform

ACF Industries Inc., b.
Accurate Instrument Co., c, h.
Adler Electronics, Inc., g.
Aerolab Development Co., a, c, d, f, g, h, m.
Aeronca Mfg. Corp., Baltimore Facility, b.
Airborne Accessories Corp., a, c.
Aircom Inc., j.
Aircom Inc. of New Jersey, j.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, i.
Airflyte Electronics Co., b.
Airpax Electronics Inc. Seminole Div., c, g, h.
Allis-Chalmers, a, c.
Alto Scientific Co., Inc., a, c.
Amelco, Inc., a, c, d, f, h, k.
Amerac Inc., j.
American Electronics, Inc., a, c, h, l.
American Electronics, Inc., Electric Machinery & Equipment Div., a, c, h, m.
American Electronics, Inc., Toller & Cooper Div., b.
Americon Missile Products Co., Inc., a, b, c.
American Research & Mfg. Corp., a, c, d, h.
Anologue Controls, Inc., b.
Andromeda, Inc., b.
Applied Science Corp. of Princeton, b.
*ARNOUX CORP., a, c, d, h, m.
Aro Equipment Corp., i.
Atlas Precision Products, Co., b.
Austin Co., The, Speciol Devices Div., b.
B & H Instrument Co., Inc., b.
Baldwin Piono Co., The, Industrial Products Div., b.
Ballontine Lobs., Inc., c.
Beckmon Instruments, Inc., Berkeley Div., b, g, j.
Beckmon-Systems Div., a, b, c.
Bendix Aviation Corp., Eclipse-Pioneer Div., b.
Bendix Aviotion Corp., Pioneer-Central Div., i.
Bendix Aviation Corp., Red Bank Div., a, c, h, l, m.
Bendix Aviotion Corp., York Div., j.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., g.
Bogue Electric Mfg., Co., a, c, d, h, l.
Briggs Associates, Inc., b.
Bristol Co., The, a, b, c,.
Brown Engrg, Co., Inc., c.
Burroughs Corp., a.
Corruthers & Fernondez, Inc., a, c, h.
Centronix Inc., a, b.
Chalco Engrg. Corp., a, c.
Christie Electric Corp., a.
Clifton Precision Products Co., Inc., b.
Coils-Electronics, a.
Coleman Engrg. Co., Inc., b.
G. L. Collins Corp., c.
Colorodo Research Corp., b.
Computer Engrg. Associotes, Inc., a, c.
Consolidated Avionics Corp., a, b, c, m.
Consolidated Controls Corp., b.
Consolidated Diesel Electric Corp., a thru d, l, m.
Consolidated Diesel Electric Corp., Western Div., a, c, h.
Consolidated Electrodynamics Corp., b.
Cornell-Dubilier Electric Corp., a, c.
Crescent Engrg. & Reseorch Co., a.
Crosby Laboratories, Inc., f.
Cubic Corp., a, b, c.
Curtiss-Wright Electronics Div., IMI Branch, b.
D. & R. Ltd., l.
Dalmotor Div., Yubo Consolidated Industries, Inc., a, c, d, l, m.
Dota Instruments Div.-Telecomputing Corp., b.
Datex Corp., b.
Daven Co., The, a, c, h, k.
Davenport Mfg. Co., a, b, c, m.
Demornay-Bonardi, j.
Di-An Controls, Inc., b.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp., b.
Dorsett Labs., Inc., c.
Dresser Electric Co., a.
Dresser Industries, Inc., a thru d, h, m.
Dychro Corp., b.
Dymec Inc., b.
Dynomic Devices, Inc., i.
Eicor Div.-Scranton, c, l.
Electro Development Corp.
Electro Instruments, Inc., a, b, g.
Electro Products Laborotories, Inc., a, c.
Electro-Mec Lab. Inc., b
Electro-Mechanicol Reseorch, Inc., a, f.
Electronic Assembly Co., Inc., a, c, m.
Electronic Communicotions, Inc., b, f, j, k.
Electronic Research Associates, Inc., a, c, h.
Electronic Specialty Co., a, c.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., b.
Engineered Magnetics, Div.-Gulton Industries, Inc., a.
Entron, Inc., g, k.
Ero Electric Corp., c.
FXR, Inc., j, k, n.
Ferrotron Electronics Co., Inc., a, c, k, m.
Fischer & Porter Co., b.
Ford Instrument Co., Div.-Sperry Rond Corps., b.
Freed Transformer Co. Inc., a, c.
Generol Devices, Inc., l.
Generol Electric Co., Apporotus Soles Div., a, c, d, h, k, l, m.
General Magnetics, Inc., c.
General Photo Products Co., Inc., a.
Generol Precision Lab. Inc., b.
Georator Corp., a, d, g, h, l.
Geotronic Labs. Inc., c, f.
Gionnini Plasmodyne Corp., a.
Gordon Enterprises, a, c, d.
Green Rectifier Co., a, d, m.
Guided Missile Div.-De Havilond Aircraft of Canada, Ltd., a, c, h.
Gulton Industries, Inc., a, b.
Hollomore Electronics Co., c.
Hamilton Standard, Div.-United Aircraft Corp., a, c, d, h, m.
Hertner Electric Co., The, a, c, d, h, l.
Hofmon Labs., Inc., i.
Hoover Electric Co., a thru e, g, h, l, m.
Walter J. Hyott Co., The, j.
ITT Labs., b, j.
Industrial Test Equipment Co., h.
Instrument Development Labs., Inc., b, e.
International Research Associates, b.
Jock & Heintz, Inc., a, c, d, m.
Jordan Electronics, Div.-Victoreen Instrument Co.
Julie Research Labs., Inc., b.
Kaiser Aircroft & Electronics, Div.-Kaiser Industr c.
*KEARFOTT CO., INC., b, j, l.
Kin Tel Div.-Cohu Electronics, Inc., b.
Land-Air Inc., a thru g.
La Pointe Industries Inc., j, k.
La Roe Instruments, Inc., a, c, d, h, m.
Leach Corp., a, c, d, l, m.
Lear, Inc., a, c, k.
Leland Airborne Products, Div.-American Mochine Foundry Co., a, c, d, h, l, m.
Libroscope Inc., b.
Lieco, Inc., i, j.
Litton Industries, Inc., b.
Lundy Mfg. Corp., a, c.
Moc Leod & Honopol, Inc., b.
Mognovox Co., The, c.
Mognetic Controls Co., a, c, h, m.
Magnetic Instrument Co. Inc., c.
Magnetic Research Corp.
Magnetico, Inc., c.
Moico Electronics, Inc., b, c.
Monson Lobs., Inc., k.
Meridion Metalcroft, Inc., j, k.
Micrometrical Mfg. Co., g.
Milgo Electronic Corp., b.
Minneapolis-Honeywell Regulator Co., Aeronautic b.
Minneapolis-Honeywell Regulotor Co., Boxton Div
Minneapolis-Honeywell Regulator Co., Industriol c.
Minneapolis-Honeywell Regulotor Co., Industriol Product Group, b, c.
Minneapolis-Honeywell Regulotor Co., Ordnance a, b, c.
Model Rectifier Corp., a, m.
*MOTOR GENERATOR CORP., a, c.
Motorolo Inc., Military Electronics Div., b, f, j, k
Heinz Mueller Eng. Co. Inc., a, c, l.
Multi-Amp Corp., a.
NYT Electronics, Inc., a, c, m.
George L. Nankervis Co., b.
National Pneumatic Co., Inc., Holtzer-Cobot Divs a, b, d thru h, l.
Networks Electronic Corp., a, c, d.
Newton Co., The, b.
Non-Linear Systems, Inc., a, b.
Ernest Norrmon Loboratories, g, h.
North Atlantic Industries, Inc., a.
Northeost Electronics Corp., c.
Northrop Corp., a.
Northrop Corp., The, Nortronics Div., b.
Norwood Controls Unit Detroit Controls Div., b.
Ohio Semiconductors, Inc., a, c.
Pacific Magnetic Corp.
*PACKARD-BELL ELECTRONICS CORP., b, m.
Palo Alto Engrg. Co., a, c.
Ralph M. Parsons Co., The, Electronics Div., c.
Patterson, Moos Div. - Universol Winding Co., In a.
Perkin Engrg. Corp., a, c, d, m, n.
Perry Plostics, Inc., h.
Pesco Products Div.-Borg-Worner Corp., a, c,
Philco Corp., Government & Industrial Div., a, b, f, g, h, j, k.
Potter Aeronoutical Corp., a, b, g.
Power Designs Inc., a, c.
Power Supplies Inc., c, h.
Power Sources, Inc., a, c, d, h, m, n.
Power-Tronic Systems Inc., a thru d, m.
Precise Development Corp., g, h.
Project Fobrication Corp., i.
RS Electronics Corp., a, k.
Rodar Design Corp., j, k.
Radiation, Inc.
Radiation Instrument Development Lab., Inc., b.
Radiatronics, Inc., j.
Ramo-Wooldridge Div., Thompson Ramo Wooldrid Colif., a, b.
Reseorch Appliance Co., b.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV., c, f, k.
Rixon Electronics Inc., a, c.
Ronon & Kunzl, Inc., i.
Royol Industries, Inc., a thru d, g, h, l.
Safety Electricol Equipment Corp., a, c, d, l, m.
Sangamo Electric Co., a, c, h, l.
Sel-Rex Corp., a, d, m.
Sequoia Wire & Coble Co.-Div.-Mandrel Industrie a, c, d, h, m.
Servomechonisms, Inc., a, b, c, m.
Singer Mfg. Co., The, Military Products Div., a.
Small Motors Inc., d.
Sorensen & Co., Inc., a, h.
Southwestern Industrial Electronics Co., a thru l
Specialty Engrg. & Electronics Co., a.
Spectrol Electronics Corp., a, c, h, m.
Standard Electric Time Co., The, c.
Strong Scott Mfg. Co., The, n.
Sun Electric Corp., Aeronautical Div., g.
Syntron Co., a.
Systron Corp., a, b, g.
TKM Electric Corp., a.
Tolley Corp., The, a, c, d, l.
Tapco Group, Thompson-Romo-Wooldridge Inc.,
Technical Apparatus Builders, a, c, d, h, l, m,
Telechrome Mfg. Corp., b, e, n.
Telectro Industries Corp., a, b, c, f, h, n.

Telerad Mfg. Corp., j.
Tel-Instrument Electronics Corp., g, h.
Terada Co., c, m.
Thompson-Ramo-Wooldridge Products Co., The, b.
Torwico Electronics, Inc., a, c.
Trons Electronics, Inc., a, c.
Transonic, Inc., a, c, d, h, m.
Turbo Machine Co., h, j, k.
United Control Corp., a, c.
United Electrodynamics, Inc., a, b, c, g, h, m.
U. S. Science Corp., Div.-Tapp Industries, Inc., c, e, m.
Varo Mfg. Co., Inc., a, c, g, h, l, m.
Vitro Labs., b.
Waldorf Electronics. Div.-F.C. Huyck & Sons, b.
Waste King Corp., Technical Products Div., i.
Waugh Engrg. Co., a, g.
Wayne-George Corp., b.
Western Gear Corp., a, c, d, l, m.
Westinghouse Electric Corp., a, d, j.
Weston Instruments, Div.-Daystrom, Inc., a, b.
Wincharger Corp., Sub.-Zenith Radio Corp., a, c, m.
Winzen Research Inc., i.

NVEYORS

American Conveyor Co.
American Machine & Foundry Co., Government Products Group
American Monorail Co., The
Albert H. Cayne Equipment Corp.
Chain Belt Co.
Calson Corp., The
Control Engrg. Co., Div. Jervis B. Webb Co.
Electronic Control Corp.
Goodyear Tire & Rubber Co., The, Aviation Products Div
Hapman Conveyors, Inc.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co., The
Link-Belt Co.
Mc-Dowell-Wellman Companies, The
Mercury Tool & Mfg. Corp.
Mid-West Metal Products, Inc.
Nelson Labs., Inc.
Oliver Corp., The - A. B. Forquhar Div.
Pyles Industries, Inc.
Rapids-Standard Co., Inc., The
Ravenna Metal Products, Div.-Standard Screw Co.
Edw. Renneburg & Sons Co.
Richardson Scale Co.
Richords-Wilcox Mfg. Co.
Sealmaster Bearing Div., Stephens-Adamson Mfg. Co.
Smith-Morris Corp.
Stephens Adamson Mfg. Co., Seal Master Bearing Div.
A. T. Stevens Co.
Sturtevont Mill Co.
Syntron Co.
Texas Metol & Mfg. Co., Inc.
United States Rubber Co.
Western Gear Corp.

OKERS, ELECTRONIC

Monogram Precision Industries
Raytheon Mfg. Co.

OLANT RADIATORS
ee RADIATORS, COOLANT

OLANTS

nderson Oil & Chemical Co., Inc.
ro Equipment Corp.
eorge Basch Co., The
DOW CORNING CORP.
. F. Houghton & Co.
SA Research Corp.
innesota Mining & Mfg. Co.
onsanto Chemical Co. – Organic Chemicals Div.
YE Industries

OLERS, OIL

AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
merican Aeroparts
BENDIX AVIATION CORP.-HAMILTON DIV.
ean Products, Inc.
enison Engrg. Div., American Brake Shoe Co.
oyle & Roth Mfg. Co., Inc.
unham-Bush Inc.
astern Industries Inc.
llis & Watts Products, Inc.
riscom-Russell Co., The
ercury Tool & Mfg. Corp.
anogram Precision Industries
ortland Copper & Tank Works Inc.
outh Wind Div., Stewart Warner Corp.
andard-Thomson Corp., Clifford Mfg. Co. Div.
hampson Engrg. Co., The, Missile Products Div.
rane Co., The
ranter Mfg., Inc.
nited Aircraft Products, Inc.
ilter Mfg. Co., The
aste King Corp., Technical Products Div.

OLING SYSTEMS, ELECTRONIC

AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
ro Equipment Corp.
BENDIX AVIATION CORP.-HAMILTON DIV.
endix Utica Div., Bendix Aviation Corp.
unham-Bush Inc.
astern Industries Inc.
llis & Watts Products, Inc.
amilton Standard, Div.-United Aircraft Corp.
G. Hokanson Co., Inc.
Hoover Electric Co.
Hussmann Aircraft Div.
Lear Inc., Lear-Romec Div.
Northrop Corp., The, Nortronics Div.
Ohio Semiconductors, Inc.
Pesco Products Div.-Borg-Warner Corp.
Pneumafil Corp.
South Wind Div., Stewart Warner Corp.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Task Corp.
Trone Co., The
United Aircraft Products, Inc.
Waste King Corp., Technical Products Div.

COPPER LAMINATES, PRINTED CIRCUIT

Adept Industries Inc.
Carnish Wire Co. Inc.
General Plastics Corp. of New Jersey
Minnesota Mining & Mfg. Co.
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
Rogers Corp.
St. Regis Paper Co., Panelyte Div.
Spaulding Fibre Co., Inc.
Taylor Fibre Co.
United States Chemical Milling Corp.

CORD SETS

Aerolite Electronics Corp.
Alden Products Co.
American Insulated Wire Corp.
W. A. Beauchaine & Sons Inc.
Birnbach Radio Co., Inc.
Cable Electric Products Inc.
Carmody Corp.
Consolidated Wire & Associated Companies
Cooper Industries, Inc.
Eagle Electric Mfg. Co. Inc.
Electrocraft, Inc.
Empire Electronics Co., Inc.
Essex Wire Corp.
First Electronics Corp., The
General Cable Corp.
Gordon Enterprises
Holyoke Wire & Cable Corp.
Koiled Kords Inc.
Modelectric Products Corp.
Mutron Corp.
National Pneumotic Co., Inc., Holtzer-Cabot Divs.
North Electric Co.
Paraplegics Mfg. Co., Inc.
Projects Unlimited inc.
Milton Ross Metals Co., The
Royal Electric Corp.
Sequoia Wire & Cable Co.-Div.-Mandrel Industries, Inc.
Spectra-Strip Wire & Cable Corp.
Waldom Electronics Inc.
Whitaker Cable Corp.

CORDS

a. Attachment
b. Dial
c. Dial Cords & Cables
d. Lacing
e. Line
f. Line Resistance
g. Patch
h. Retractile
i. Shock

Aero Leather Products Co., d.
American Insulated Wire Corp., a, e.
American Super-Temperature Wires, Inc., d.
Associated Engrg. Corp., a, e, g.
Audio Development Co., g.
Aviation Textile Associates, d, e, i.
Belden Mfg. Co., a, e, g.
Birnbach Radio Co., Inc., a, c thru h.
Whitney Blake Co., e, h.
Borden Chemical Co., The, Div.-The Borden Co., Resinite Dept., d.
Coaxial Connector Co. Inc., e, g.
Columbian Rope Co., d.
Consolidated Wire & Associated Companies, a, e, f.
Cornish Wire Co. Inc., a.
C. R. Daniels, Inc., i.
Detronic Industries, g.
Eagle Electric Mfg. Co. Inc., a, e.
Empire Electronics Co., Inc., g.
Ericson Mfg. Co., The, a.
Essex Wire Corp., a, h.
First Electronics Corp., The, g.
General Coble Corp., b, c, g, h.
General Cement Mfg. Co., Div.-Textron, Inc., b, c.
General Electric Co., Wire & Cable Dept., a.
General Insulated Wire Works, a, h.
Gudebrod Bros. Silk Co., Inc., b, c, d.
Heminway & Bartlett Mfg., Co., The, d.
Holyoke Wire & Cable Corp., e, f.
ITT-Kellogg, b, c, g, h.
Koiled Kords Inc., h.
Metals & Controls Corp., General Plate Div.
Narrow Fabric Co., The, d.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., b thru e, g, h.
New England Electrical Works, Inc., b, c,
M. M. Newman, Corp., d.
North Electric Co., b, c, g.
Paul Nurches Co., g.
Phalo Plastics Corp., a, e, g.
Pomona Electronics Co., Inc., g.
Milton Ross Metals Co., The, b, c.
Royal Electric Corp., a, e.
Schlegel Mfg. Co., d.
Sequoia Wire & Cable Co.-Div.-Mandrel Industries, Inc., g.
Spectra-Strip Wire & Cable Corp., d, g, h.
Standard Electric Time Co., The, g.
Stramberg-Carlson Div.-General Dynamics Corp., c, g.
Tap-A-Line Mfg. Co., a.
Vector Electronic Co., g.
Virginia Electronics Co., Inc., g.
Waldom Electronics Inc., e.
Walthom Horologicol Corp., f.
Westwood Cable Corp., g.

CORES

a. C Type
b. Ceramic
c. Cut
d. E Type
e. Ferrite
f. High Permeability Magnetic
g. Iron
h. Laminated
i. Powdered
j. Slug Tuning Units
k. Tape Wound
l. Toraidal

Aeronutronic Systems, Inc., Sub.-Ford Motor Co., e.
Aerovox Corp., a, e, f, i, l.
Airpax Electronics Inc. Seminole Div., l.
Airtron Inc., Div.-Litton Industries, e.
Alden Products Co., k.
Americon Lava Corp., b.
Arnold Engrg. Co., The, a, c, d, f thru l.
Borker Sales Co., a, k, l.
Cable Electric Products Inc., d, k.
Carborundum Co., Refractories Div., b.
Centralab, Div.-Globe-Union, b.
Chemold Co., h.
Collins Radio Co., l.
Continental Con Co., Inc., a, h.
Double E Products Co., g, l.
Dynacor, Inc., f, k, l.
Electro-Mechanical Products Co., g.
G-L Electronics Co., Inc., f, h, k, l.
Glodding, McBean & Co., b.
Hamilton Watch Co., a.
Isolontite Mfg. Corp., b.
Kip Electronics Corp., b.
Land-Air Inc., g, h.
Liss Products, Inc., h.
Louthon Mfg. Co., The, Div.-Ferro Corp., a.
Magnetic Core Corp., b, f thru i, l.
Magnetics Inc., f, i, k, l.
Maryland Lova Co., b.
Metals & Controls Corp., General Plate Div., h.
Minnesota Mining & Mfg. Co., b, e.
Mitronics Inc., b.
J. J. Monaghan Co., Inc., c.
Monogram Precision Industries, e, f, h, i.
Motorola Inc., Military Electronics Div., b, e, i, j, l.
National Beryllia Corp., b.
National Moldite Co., a, b, d thru g, i, j, l.
Newton Co., The, k.
North Electric Co., f, g, l.
Norton Co., b.
Norton Co., New Products Dept., b.
Polymer Corp., The, f, i, l.
Q. O. S. Corp., f, g, i, l.
Radio Cores, Inc., f, g, i, j, l.
Ravenna Metal Products, Div.-Standard Screw Co., h.
Raybestos-Monhattan, Inc., Pa., h.
Research Development Mfg. Inc., g.
Milton Ross Metals Co., The, k, l.
Sangamo Electric Co., l.
Skinner Precision Products, b, e, f.
Smith-Morris Corp., g.
Stackpole Carbon Co., d, f.
Superex Electronics Corp., e.
Superior Steatite & Ceramic Corp., b.
Telemeter Magnetics, Inc., b.
Thermal Refractories Corp., b.
Vitro Labs., e.
Wesrep Corp., e, f, g, i, l.
Westinghouse Electric Corp., a, k, l.

COUNTERS

a. Computer
b. Electro-Magnetic
c. Electronic
d. Footage
e. Frequency
f. Geiger
g. Impulse
h. Mechanical
i. Preset
j. Proportional
k. Radiation
l. Revalutian
m. Scintillatian

Abroms Instrument Corp., b, g, i.
Ad-Yu Electronics Lab., Inc., c, d.
Aeronutronic Systems, Inc., Sub.-Ford Motor Co., a.
Airpax Electronics Inc., Seminole Div., b, c, e, g.
Alwac Corp., a.
Amerac Inc., l.
American Electronics, Inc., k, m.
American Electronics, Inc., American Nuclear Div., f, k.

American Electronics, Inc., Taller & Cooper Div., g, h.
American Machine & Foundry Co., Government Products Group, b thru e, g thru j, l.
Analogue Controls, Inc., a, c.
Anton Electronic Labs., Inc., f, j, k.
Atlas Precision Products, Co., a, h.
Automation Dynamics Corp., b, c, i.
Avien, Inc., g, l.
Baird-Atomic, Inc., c, i, j, k, m.
Baldwin Piano Co., The, Industrial Products Div., c.
Barker & Williamson Inc., l.
Beckman Instruments, Inc., Berkeley Div., c, e, l.
Beckman-Systems Div., a.
Bell & Gossett Co., c.
Bendix Aviation Corp., York Div., a.
Benson-Lehner Corp., g, l.
Beva Lab., Inc., c, g, m.
Ernest E. Blanche & Associates, Inc., a.
Bowmor Instrument Corp., b, h, j, l.
Brown Engrg. Co., Inc., i.
Burroughs Corp., a, b, c.
Burroughs Corp., Electronic Tube Div., c, i.
Burton-Rodgers, Inc., a.
Cameraflex Corp., d.
Centronix Inc., a, c, e, j.
Chicago Aerial Industries, Inc., d.
Clary Dynamics, a, b, c, g, h.
Cleveland Metal Specialties Co., Electronics Div., a.
DBM Research Corp., a, c.
Data Instruments Div.-Telecomputing Corp., i, l.
Davenport Mfg. Co., c.
Di-An Controls, Inc., a, c, e, g, i.
Dresser Industries, Inc., c, l.
Durant Mfg. Co., b, d, e, g, h, i, l.
Dymec Inc., c, e, i.
Elcor, Inc., b.
Eldorado Electronics, c, k.
Electro Precision Corp., c, e, i.
Electronic Control Corp., c.
Electronic Engrg. Co. of California, a, c, e, g, i.
Electro-Tech Equipment Co., b, d, h, l.
Elgin Micronics Div.-Elgin National Watch Co., b, g, m.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., c.
Epic, Inc., b.
Era Engrg. Inc., k.
Erie Instrumation, Div. Erie Resistor Corp., c, e, i, l.
Erie Resistor Corp., c, e, g, h, i, l.
Exact Engrg. & Mfg. Inc., a, b, h.
First Electronics Corp., The, b, g, h.
Fischer & Porter Co., c, g.
Fisher Research Lab., Inc., f, k, m.
Fisher Scientific Co., h.
Ford Instrument Co., Div.-Sperry Rand Corp., a, c, h.
Freed Transformer Co. Inc., c, i.
General Devices, Inc., c, g, h.
General Electric Co., X-Ray Dept., k, m.
General Electro-Mechanical Corp., b, g.
Gordon Enterprises, b, d, e, g, h, i, l.
Hamilton Standard, Div.-United Aircraft Corp., b, c.
Hamilton Watch Co.-Industrial Div., b, g.
Harvey-Wells Electronics Inc., a.
***A. W. HAYDON CO., THE**, b, g, j.
Hayward Scientific Glass Corp., m.
Hewlett-Packard Co., c, e, i, l, m.
Hillburn Electronic Products Co., b, g.
Hoffman Electronics Corp., Semiconductor Div., g.
I-L-S Instrument Div., The Meriam Instrument Co., a, c, d, e, g, i, l.
ITT-Kellogg, g.
Industrial Winding Machinery Corp., h, i.
Instruments Div.-Philips Electronics, Inc., f, j, k, m.
Interstate Electronics Corp., c, f, g, j, k, m.
***KEARFOTT CO., INC.**, a, c, h.
Land-Air Inc., b, g, h, m.
Landis & Gyr Inc., b, g, i, l.
La Roe Instruments, Inc., c, e, f, k.
Lavoie Laboratories Inc., c.
Levinthal Electronic Products, Inc., m.
Librascope Inc., a.
Magnetic Instrument Co. Inc., m.
Mast Development Co., Inc., b, d, g, h, l.
Menlo Research Lab., f, k, l.
Minneapolis-Honeywell Regulator Co.-Davies Labs. Div., d.
Moran Instrument Corp., f, k, m.
Motorola Inc., Military Electronics Div., a, b, c.
Novigation Computer Corp., a, e, i.
Neumade Products Corp., d.
North Electric Co., b, l.
Northeastern Engrg. Inc., e, i.
Nuclear-Chicago Corp., f, g, i, j, k, m.
Orbitron Co., Inc., c.
***PACKARD-BELL ELECTRONICS CORP.**, a, b, c.
Potterson, Moos Div. - Universal Winding Co., Inc., a, b.
Photocon Research Products, b, h, i.
Pilot Chemicals, Inc., m.
Potter Aeronautical Corp., c, e, g, i, j, l.
Radiation, Inc.
Radiation Instrument Development Lab., Inc., f, j, k, m.
Resdel Engrg. Corp., c.
Richardson Scale Co., c, h.
Royal Industries, Inc., c, g.
Singer Mfg. Co., The, Military Products Div., a, b, h, i, j.
Specialty Engrg. & Electronics Co., a, c, e, f, k.
Spectrol Electronics Corp., h.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp., a.
Standard Electric Time Co., The, c, l.
Stanley Aviation Corp., k, m.
Systron Corp., d, e, g, i thru l.
Talley Corp., The, b, h.
Telechrome Mfg. Corp., c, g, h.
Telectro Industries Corp., a, b.
Transistor Electronics Corp., a.
U. S. Industries, Inc.
Veeder-Root Inc., b, c, d, g thru j, l.
Victor Adding Machine Co., c, g.
Vitro Labs., a.
Wakmann Watch Co. Inc.
Walkirt Co., a, c, e, g, i, l.
Waltham Precision Instrument Co., b.
Webcor, Inc., Government Div., a, b, c, e, h.
Wilks Precision Instrument Co., Inc., h.
N. Wood Counter Lab., f, j, k, m.
Wright Engrg. Co., h, l.

COUNTING DEVICES

Abrams Instrument Corp.
Allegany Instrument Co., Inc.
American Electronics, Inc., Toller & Cooper Div.
American Machine & Foundry Co., Government Products Group
Atlas Precision Products, Co.
Automation Dynamics Corp.
Baird-Atomic, Inc.
Beckman Instruments, Inc., Berkeley Div.
Benson-Lehner Corp.
Beva Lab., Inc.
Ernest E. Blanche & Associates, Inc.
Bowmar Instrument Corp.
Bristol Co., The
Brown Engrg. Co., Inc.
Brush Instruments, Div.-Clevite Corp.
Centronix Inc.
Data Instruments Div.-Telecomputing Corp.
Di-An Controls, Inc.
Dresser Industries, Inc.
Durant Mfg. Co.
Electro Precision Corp.
Electro Products Laboratories, Inc.
Electro-Tech Equipment Co.
Exact Engrg. & Mfg. Inc.
Fischer & Porter Co.
General Devices, Inc.
Gordon Enterprises
Harvey-Wells Electronics Inc.
***A. W. HAYDON CO., THE**
Hewlett-Packard Co.
Hoffman Electronics Corp., Semiconductor Div.
I-L-S Instrument Div., The Meriam Instrument Co.
I-T-E Circuit Breaker Co.
Instruments Div.-Philips Electronics, Inc.
***KEARFOTT CO., INC.**
Landis & Gyr Inc.
Motorola Inc., Military Electronics Div.
Northeastern Engrg. Inc.
Northrop Corp., The, Nortronics Div.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Photobell Co., Inc.
Potter Aeronautical Corp.
Royal Industries, Inc.
Servomechanisms, Inc.
Specialty Engrg. & Electronics Co.
Systron Corp.
Telectro Industries Corp.
Vitro Labs.
Walkirt Co.
Webcor, Inc., Government Div.
Worner Electronic Devices

COUPLERS, DIRECTIONAL, MICROWAVE

Aircom Inc.
Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
American Electronics, Inc.
American Machine & Foundry Co., Government Products Group
Antenna & Radome Research Associates
Bogart Mfg. Corp.
Budd Stanley Co. Inc.
Bulow Electric Co.
California Technical Industries, Div.-Textron Inc.
Cooper Development Corp., Sub.-Marquardt Aircroft Co.
Deniornay-Bonardi
Diamond Antenna & Microwove Corp.
Douglas Microwave Co., Inc.
Electronic Communications, Inc.
Walter J. Hyatt Co., The
ITT Federal Div., International Telephone & Telegraph Corp.
Indusl Prod.-Danbury Knudsen Div. Amphenol-Borg Electronics Corp.
J-V-M Microwave Co.
***KEARFOTT CO., INC.**
Lieco, Inc.
Litton Industries, Inc.
Litton Industries, Maryland Div.
W. L. Maxson Corp., The
Meridian Metalcraft, Inc.
Microlab
Microwave Associates, Inc.
Monogrom Precision Industries
Motorola Inc., Military Electronics Div.
N. R. K. Mfg. & Engrg. Co.
Narda Microwave Corp., The
Dmega Labs., Inc.
Philco Corp., Government & Industrial Div.
Polytechnic Research & Development Co., Inc.
Portchester Instrument Corp.
Prodelin Inc.
Radar Design Corp.
Radiation, Inc.
Sage Labs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Technical Appliance Corp.
Telectro Industries Corp.
Telerad Mfg. Corp.
Turbo Machine Co.
Varian Associates
Victor R. F. & Microwave Co.
Weinschel Engrg.
Wheeler Laboratories, Inc.

COUPLERS & KEYERS

See KEYERS & COUPLERS

COUPLERS, TRANSMITTER

Amatom Electronic Hardware Co. Inc.
Amelco, Inc.
Collins Radio Co.
Electronic Communications, Inc.
E. F. Johnson Co.
***KEARFOTT CO., INC.**
Lear, Inc.
Radiation, Inc.
Telerad Mfg. Corp.

COUPLING & PHASING UNITS

Aircom Inc.
Amatom Electronic Hardwore Co. Inc.
***KEARFOTT CO., INC.**
Motorola Inc., Military Electronics Div.
Piasecki Aircraft Corp.
Radiation, Inc.
Telerad Mfg. Corp.

COUPLINGS

a. Flexible
b. Hydraulic
c. Microwave
d. Quick Disconnect
e. Rigid
f. Shaft
g. Shaft, Reducers & Extensions
h. Shaft, Rigid & Flexible
i. Tube

Accurate Electronics Corp., Dept. D, a.
Aeroquip Corp., Jackson Div., a, b, d, i.
Aerotec Corp., The, d.
Airaterra, b, d.
Aircom Inc., c.
Aircom Inc. of New Jersey, c.
Airdome Parts Co., b, i.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**, d.
Airtron Inc., Div.-Litton Industries, a, c, d, e.
Allen Aircraft Products, Inc., d.
Alloy Bellows Inc., a.
Amatom Electronic Hardware Co. Inc., a, e, thru h.
American Machine & Foundry Co., Government Products Group, c, d.
AnchorCoupling Co., Inc., b, i.
Arnav Aircraft Associates, Inc., i.
Atlas Precision Products, Co., f.
Avico Corp., i.
***BALCRANK INC., MACHINE TOOL DIV.**, b.
Baldwin Mfg. Co. Inc., The, f, g.
Barker & Williamson Inc., a.
Benbow Mfg. Corp., b, d.
Bendix Utica Div., Bendix Aviation Corp., a, d.
Best Aircraft Corp., a, b, d, e, i.
Birnbach Radio Co., Inc., f, g, h.
Bobrick Mfg. Corp., d.
Bogart Mfg. Corp., c.
Boston Gear Works, a.
Breeze Corporations, Inc., a.
Bruning Co., The, b, d, h.
Buckeye Iron & Brass Works, d.
Bud Radio Inc., a, f.
Budd Stanley Co. Inc., c.
Bulow Electric Co., c.
Bushings, Inc., a, f.
Carmac Aviation, a thru i.
Century Fasteners Corp., b, d.
Chain Belt Co., h.
Chase Brass & Copper Co., Inc., i.
Chicago Gasket Co., a.
Coaxiol Connector Co. Inc., c, e.
Collins Engrg. Corp., a.
Continentol Rubber Works, a.
Control Engrg. Co., Div. Jervis B. Webb Co., d.
Cooper Development Corp., Sub.-Marquardt Aircraf Co., d.
Curtiss-Wright Corp.-Wright Aeronautical Div., e, f, g, i.
Demornay-Bonardi, c.
Dial Products Co., a, h.
Diamond Antenna & Microwave Corp., c.
Dockendorff & Co. Inc., a, f.
Dodge Mfg. Corp., a, e, f, h.
Douglas Microwave Co., Inc., c.
Dresser Mfg. Div., Dresser Industries, Inc., a, b, e, f, i.
Elsin Electronics Corp., c.
Essex Mfg., Co., Inc., b, d.
FAE Instrument Carp., a.
Forrel Birmingham Co. Inc., a, b.

Federal Machine Co. Inc.
*FLEXONICS CORP., AERONAUTICAL DIV., a.
Flight Refueling, Inc., a, d, i.
Ford Instrument Co., Div.-Sperry Rand Corp., a.
Goe Engrg. Co., e, h.
Jahn Gombos Co., Inc., c.
Graphite Metallizing Corp., c.
Gray Co., Inc., b, d.
B. H. Hadley, Inc., d.
Hallett Mfg., Co., d.
Hansen Mfg. Co., The, b, d.
Helipot Div.-Beckman Instruments Inc., a, e thru h.
Hewitt-Robins, Inc., a, e.
Highland Rim Machine Works Inc., a, d, e, f.
Hofman Labs., Inc., d.
Holland Hitch Co., d, e.
Hufford Corp., The, b, d.
Hupp Aviation Co., e, f, g.
Walter J. Hyatt Co., The, b, c, d.
Hydra-Power Corp., b.
Imperial Brass Mfg. Co., The, i.
Integral Corp., b, d.
Jan Hordwore Mfg. Co., Inc., e, f, g.
*JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP., a, d, e, i.
E. F. Johnson Co., a, e thru h.
Kahn & Co., Inc., d.
*KEARFOTT CO., INC., c.
Keystone Electronics Corp., f.
H. Koch & Sons, a, d, e.
Koppers Co., Inc., a.
Koppers Co., Inc., Metal Products Div., a.
Ladish Co., b, d, e.
Lear, Inc., h.
Lear, Inc., Grand Rapids Div., a.
Lieco, Inc., c, d.
Link-Belt Co., a, e thru h.
Litton Industries, Inc., a, c, d.
Litton Industries, U. S. Engrg. Co. Div., f.
Lord Mfg. Co., a, h.
Lovejoy Flexible Coupling Co., a, e.
Marman Div., Aeroquip Corp., a, b, d, e.
W. L. Maxson Corp., The, c.
Mercury Tool & Mfg. Corp., b, e, i.
Meridian Metalcraft, Inc., c.
Metron Instrument Co., a.
Microwave Associates, Inc., c.
Monogram Precision Industries, c, d.
Motorola Inc., Military Electronics Div., c.
Mueller Brass Co., i.
N. R. K. Mfg. & Engrg. Co., c, e.
Narda Microwave Corp., The, c.
National Utilities Corp., a, b, d, e, i.
NPW-Jordan, d.
Omega Labs., Inc., c.
On Mark Couplings, Inc., a thru e, i.
Orchard Industries, Inc., Actionflex Div., a, b, i.
Owatonna Tool Co., b.
Ozone Metal Products Corp., b, d.
PIC Design Corp., Sub.-Benrus Watch Co., Inc., a, d thru h.
Parker Fittings & Hose Div., Parker-Hannifin Corp., i.
Parts Engrg. Co., Inc., a, b, d thru i.
Philco Corp., Government & Industrial Div., c.
Piosecki Aircraft Corp., d.
Pyles Industries, Inc., b, d.
Radar Design Corp., c.
Randall Engrg. Corp., b, d.
Reeves Instrument Corp., h.
Reflectone Corp., The, a.
Rembrandt, Inc., a.
Resistoflex Corp., a, b, e.
Ronson Hydraulic Units Corp., b.
Roylyn Inc., b, e.
Rubber Teck Inc., a, b, e, i.
Sargent Engrg. Corp., d, f, g, h.
Servamechanisms, Inc., Mechatrol Div., a, f, g.
Sier-Bath Gear & Pump Co., Inc., a, d thru h.
Smith-Morris Corp., d, e.
Snap-Tite, Inc., b, d.
Southwest Products Co., a, h.
Special Instruments Div., British Industries Corp., c.
Specialty Products Corp., d.
Stainless Steel Products, Inc., a.
Sterling Precision Corp., Instrument Div., a, f, g, h.
E. W. Stewart Corp., h.
Stratoflex, Inc., a, b, d, i.
Strong Scott Mfg. Co., The, f, g.
Superior Pneumatic & Mfg., Inc., d.
Surface Combustion Corp., e.
Tapco Group, Thompson Ramo Wooldridge Inc., b, d.
Teleflex Inc., d, e.
Telerad Mfg. Corp., c.
Thiokol Chemicol Corp., d.
Titeflex, Inc., b, d.
Turbo Machine Co., c.
Turbo Products, Inc., b, d.
U. S. Flexible Metallic Tubing Co., a, d.
United States Rubber Co., a.
Variety Aircraft Corp., a, e thru h.
Vemaline Products Co., a.
Victor R. F. & Microwave Co., c.
W-S Fittings Works, Forge & Fittings Div., H. K. Porter Co., Inc., b.
Waveline, Inc., c.
Wesrep Corp., a.
Western Gear Corp., d, e, f.
Western International Co., a, c, d.
J. B. Wiggins Oil Tool Co. Inc., a thru h.
Wyzenbeek & Staff, Inc., f.
Zalfea Brothers, a.

CRANES

Acco Equipment Div., American Chain & Coble Co., Inc.
American Monorail Co., The
Austin-Western, Constr. Equip. Div., Baldwin-Lima-Hamilton Corp.
Baker Industrial Trucks, Div.-Otis Elevator Co.
Blackhawk Mfg. Co.
Breeze Corporations, Inc.
Albert H. Cayne Equipment Corp.
Chisholm-Moore Hoist Div., Columbus McKinnon Chain Corp.
Cleveland Pneumatic Industries, Inc.
Conco Engrg. Works
Crane Carrier Corp.
Detroit Hoist & Machine Co.
Elwell-Parker Electric Co., The
Link-Belt Co.
McDowell-Wellman Companies, The
Pacific Coast Engrg. Co.
Regent Jack Mfg. Co., Inc.
Richards-Wilcox Mfg. Co.
Robbins & Myers, Inc., Hoist & Crane Div.
Silent Hoist & Crane Co.
Unit Crane & Shovel Corp.
Western Gear Corp.

CRANKS

*BALCRANK INC., MACHINE TOOL DIV.

CRASH LOCATOR, BEACONS

See BEACONS, CRASH LOCATOR

CRYSTAL

a. Crystal Analysis Equipment
b. Cartridges
c. Communicatians
d. Maunts
e. Sockets

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., a.
Aircom Inc., d.
Airtron Inc., Div.-Litton Industries, d.
American Electronic Labs., Inc., d.
Augat Brothers, Inc., d, e.
Baldwin Piano Co., The, Industrial Products Div., a, c, d.
Rex Bassett, Inc., c.
Bulova Watch Co., Electronics Div., c.
Clark Crystal Co., c.
Demornay-Bonardi, d.
Douglas Microwove Co., Inc., d.
General Crystal Co., Inc., c.
Hunt Corp., The, a, c.
Instruments Div.-Philips Electronics, Inc., a.
Javex Electronics, e.
E. F. Johnson Co., e.
Kay Electric Co., a.
E. B. Lewis Co., Inc., c.
Lieco, Inc., d.
Linde Co., Div.-Union Carbide Corp.
Mc Coy Electronics Co., c.
Midland Mfg. Co., Inc., c.
Mosley Electronics, Inc., e.
Motorola Inc., Military Electronics Div., a thru e.
Norda Microwave Corp., The, d.
Northern Engrg. Laboratories, Inc., c.
Norton Co., New Products Dept.
Philco Corp., Government & Industrial Div., c.
Piezo Crystal Co., c.
Polytechnic Research & Development Co., Inc., d.
Premier Research Labs., Inc., c.
Radar Design Corp., d.
Sage Labs., Inc., d.
Scientific-Atlanta, Inc., d.
Special Instruments Div., British Industries Corp., d.
Staver Co., Inc., The, d.
Sylvania Electric Products Inc., Parts Div., e.
Valpey Crystal Corp., c.
Victor R. F. & Microwove Co., d.
Waldom Electranics Inc., e.
Wright Electronics Inc., c.
Wright Engrg. Co., a.

CRYSTAL HOLDERS

See HOLDERS, CRYSTAL

CRYSTAL OVEN, HEATING, ELEMENTS

See ELEMENTS, HEATING, CRYSTAL OVEN

CRYSTAL RECTIFIER CHECKERS

See CHECKERS, CRYSTAL RECTIFIER

CRYSTALS

Baldwin Piano Co., The, Industrial Products Div.
Rex Bassett, Inc.
Bram Metallurgical & Chemical Co.
Bulova Watch Co., Electronics Div.
Cambridge Thermionic Corp.
Diamond Drill Carbon Co., The
Genalex Div.-British Industries Corp.
General Electric Co., X-Ray Dept.
P. R. Hoffman Co.
Hunt Corp., The
E. B. Lewis Co., Inc.
Linde Co., Div.-Union Carbide
Mc Coy Electronics Co.
Midland Mfg. Co., Inc.
Motorola Inc., Military Electronics Div.
Northern Engrg. Laboratories, Inc.
Norton Co.
Philco Corp., Government & Industrial Div.
Piezo Crystal Co.
Premier Research Labs., Inc.
Radiation Instrument Development Lab., Inc.
Scientific Radio Products, Inc.
U. S. Semiconductor Products, Inc.
Valpey Crystal Corp.

CRYSTALS, DIAL

See DIAL CRYSTALS

CRYSTALS, RAW

Baldwin Piano Co., The, Industrial Products Div.
Diamond Drill Carbon Co., The
P. R. Hoffmon Co.
Linde Co., Div.-Union Corbide
Motorola Inc., Military Electronics Div.
U. S. Semiconductor Products, Inc.
Valpey Crystal Corp.

CRYSTALS, SAPPHIRE

Baldwin Piano Co., The, Industrial Products Div.
Bram Metallurgical & Chemical Co.
Linde Co., Div.-Union Carbide
Teiner Engrg. Corp.
Weaver Mfg., Co.

CUTTERS

Aircraft Tools, Inc.
Fulton-Irgon Corp., The
Hobbs Mfg. Co.
Lovejoy Tool Co., Inc.
Norwalk Cutter Sharpening Co.
Dnsrud Cutter Mfg. Co., Inc.
Dnsrud Machine Works, Inc.
Pioneer Industries Div., Almar-York Co., Inc.
H. K. Porter Co., Inc.
H. P. Preis Engraving Machine Co.
Radial Cutter Mfg. Corp.
M. H. Rhodes, Inc.

CYLINDERS

a. Air
b. Compressed Gas
c. Hydraulic
d. Racket Engine

ACF Industries Inc., c, d.
Adel Precision Products of California, Div.-General Metals Corp., c.
Aerojet-General Corp., d.
Alco Products, Inc., d.
Allenair Corp., a, c.
American Aeroparts, c.
American Car & Foundry, Div.-ACF Industries, Inc., d.
American Machine & Foundry Co., Government Products Group, a thru d.
American Measurement & Control, Inc., c.
*ANNIN CO., THE, a, c.
Astronautics Engrg. Co., c.
Baker Industrial Trucks, Div.-Otis Elevator Co., c.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., d.
Benton Harbor Engrg. Works, Inc., c.
Blackhawk Mfg. Co., c.
E. W. Bliss Co., d.
Brooks & Perkins, Inc., d.
Bruning Co., The, c.
Burklyn Co., a.
Cadillac Gage Co., c.
*CAMERON IRON WORKS, INC., d.
Captial City Mfg. Co., c, d.
Carter Controls, Inc., a, c.
Chrysler Corp., Defense Operations Div., d.
Cleveland Pneumatic Industries, Inc., a, b, c.
Clippord Instrument Lab., Inc., a, c.
Commercial Shearing & Stamping Co., c.
Components Corp., a, b.
Conoflow Corp., a.
Cornelius Co., The, Aero Div., a.
Curtiss-Wright Corp.-Wright Aeronautical Div., d.
D K Mfg. Co., a.
Doyle & Roth Mfg. Co., Inc., a thru d.
Dresser Industries, Inc., a thru d.
Dukes Co., Inc., c.
Eastern Industries Inc., c.
Electrol Inc., c.
Electro-Tech Equipment Co., a.
Galland-Henning Nopak Div., a, c.
Globe Hoist Co., a, c.
Hannifin Co., Div.-Parker-Hannifin Corp., a, c.
Haskel Engrg. & Supply Co., a, b, c.
Hoke Inc., a, b.
Walter J. Hyatt Co., The, c.
Hydra-Power Corp., a, c.
Hydraulic Press Mfg. Co., The, Div.-Koehring Co., a, c.
Integral Corp., c.
Intercontinental Mfg. Co., Inc., d.
Interstate Engrg. Corp., c.
Kahn & Co., Inc., a.
Kaiser Metal Products, Inc. - Fleetwings Div., d.
M. W. Kellogg Co., The, d.
Wolter Kidde & Co., Inc., Aviation Div., a, b.
Lamtex Industries, Inc., a thru d.
Lear, Inc., a, c.
Ledeen Inc., a, c.
*LYCOMING DIV., AVCO MFG. CORP., d.
Machine Products Div., New Haven Trap Rock Co., d.
Matheson Co., Inc., The, a, b.

McDowell-Wellman Companies, The, a, c.
Menasco Mfg. Co., a, b, c.
Mercury Tool & Mfg. Corp., c, d.
Minnesota Mining & Mfg. Co., b, d.
Monogram Precision Industries, a thru d.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., a.
National Tube Div.-United States Steel Corp., a, b.
Newbrook Machine Corp., d.
Newton Hydraulic Tooling Co., c.
Norris-Thermador Corp., b, c, d.
Oliver Corp., The, c.
Ortman-Miller Machine Co., Inc., a, c.
Owatonna Tool Co., c.
Dzone Metal Products Corp., a, c.
Pioneer Tool & Engrg. Co., c.
Pressed Steel Tank Co., a thru d.
Reaction Motors Div., Thiokol Chem. Corp., d.
Red Lion Cabinet Co., Redco Tool Div., c, d.
Regent Jack Mfg. Co., Inc., c.
Republic Mfg. Co., c.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV., d.
Rivett Lathe & Grinder Inc., a, c.
Ranson Hydraulic Units Corp., a thru d.
Rotary Lift Co., Div.-Dover Corp., c.
Rotex Punch Co., Inc., a, b, c.
Ryan Aeronautical Co., d.
S-P Mfg. Corp., The, a, c.
Sancor Corp., c.
Sargent Engrg. Corp., a, b, c.
A. O. Smith Corp., b, d.
Smith-Morris Corp., a, c, d.
Strong Scott Mfg. Co., The, d.
Tapco Group, Thompson Ramo Wooldridge Inc., c, d.
Taylor Winfield Corp., a.
Twigg Industries, d.
United Aircraft Products, Inc., c.
Vickers Inc., Marine & Ordnance Dept., Machinery Hydraulics Div., c.
Waste King Corp., Technicol Products Div., d.
Weaver Mfg., Co., c.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp., a, b, c.
Wheland Co., The, d.
Wickfield, Inc., c.
Wise Aerodraulics, Inc., c.
Worcester Pressed Steel Co., b.

DAMPERS, CONTROL

Anchor Metal Spinning Co., The
Chandler Evans Corp.
Clemco Aero Products, Inc.
Cleveland Pneumatic Industries, Inc.
Federal Shock Mount Corp.-Div. The Korfund Co., Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
*HOUDAILLE INDUSTRIES, INC., BUFFALO HYDRAULICS DIV.
Korda Industries
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Lundy Mfg. Corp.
Lyndon Aircraft, Inc.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Monogram Precision Industries
Dzone Metal Products Corp.
Edw. Renneburg & Sons Co.
Ryan Aeronautical Co.
Sargent Engrg. Corp.
Sesco Mfg., Inc.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp.

DAMPERS, PULSATION

Anchor Metal Spinning Co., The
Barrett-Christie Co.
Cleveland Pneumatic Industries, Inc.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
*DOW CORNING CORP.
Dunbar-Kapple Inc.-Aircraft Components Div.
Korda Industries
Lyndon Aircraft, Inc.
Monogram Precision Industries
National Engrg. Products, Inc.
Dzone Metal Products Corp.
Parker Fittings & Hose Div., Parker-Hannifin Corp.
Edw. Renneburg & Sons Co.
Sorgent Engrg. Corp.
A. U. Stone & Co., Inc.

DAMPERS, VIBRATION & SHIMMY

Actuation Research Corp.
American Aeroparts
Anaconda Metal Hose Div., The American Brass Co.
Anchor Metal Spinning Co., The
Clemco Aero Products, Inc.
Cleveland Pneumatic Industries, Inc.
*DOW CORNING CORP.
Federal Shock Mount Corp.-Div. The Korfund Co., Inc.
General Electric Co., Metallurgical Products Dept.
B. F. Goodrich Industrial Products Co.
*HOUDAILLE INDUSTRIES, INC., BUFFALO HYDRAULICS DIV.
Huntington Rubber Mills
Hydra-Power Corp.
J. W. Johnson & Co., Inc.
Korda Industries
Lord Mfg. Co.
Lyndon Aircraft, Inc.
MB Mfg. Co.
McDowell-Wellman Companies, The
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
Monogram Precision Industries
George L. Nankervis Co.
Dzone Metal Products Corp.
Raybestos-Manhattan, Inc.
Robinson Technical Products, Inc.
Ranson Hydraulic Units Corp.
Rubbercraft Corp. of California
Sargent Engrg. Corp.
Sesco Mfg., Inc.
A. T. Stevens Co.
Taylor Devices, Inc.
Turbo Products, Inc.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp.

DATA

a. Recorders, Analog
b. Recorders, Digital
c. Recording Equipment

ACF Industries Inc., a, b, c.
Aeronutronic Systems, Inc., Sub.-Ford Motor Co. b, c.
Airpax Electronics Inc. Seminole Div., b.
Allegany Instrument Co., Inc., a, b, c.
Alwac Corp., b.
American Electronics, Inc., a, b, c.
American Electronics, Inc., Taller & Cooper Div., a, b, c.
American Machine & Foundry Co., Government Products Group, c.
Atlas Precision Products, Co., a.
*AVCO MFG. CORP., CROSLEY DIV.
B & F Instruments, Inc., c.
BJ Electronics, Borg-Warner Corp., c.
Barker Sales Co., c.
Beckman Instruments, Inc., Berkeley Div., b.
Bendix Aviation Corp., York Div., a, b.
Benson-Lehner Corp., c.
Ernest E. Blanche & Associates, Inc., b.
Bristol Co., The, a, b, c.
Brush Instruments, Div.-Clevite Corp., a, b, c.
Bulow Electric Co., c.
Centronix Inc., a, b, c.
Century Electronics & Instruments, Inc., a, c.
Clary Dynamics, b.
Consolidated Avionics Corp., c.
Consolidated Electrodynamics Corp., a, b, c.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., c.
Data Instruments Div.-Telecomputing Corp., b.
Data-Control Systems, Inc., a, c.
Datex Corp., b, c.
Datran Electronics, Div.-Mid-Continent Mfg. Co., Inc., b.
Di-An Controls, Inc., b, c.
Dresser Industries, Inc., a, b, c.
Dymec Inc., c.
Edgerton, Germeshausen & Grier, Inc., c.
Eldorado Electronics, b.
Electro Instruments, Inc., a, b, c.
Electronic Engrg. Co. of California, a, b, c.
Electronic Tube Corp., b.
Elgin Micronics Div.-Elgin National Watch Co., a.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., a.
Federal Scientific Corp., c.
Fischer & Porter Co., a, b.
Ford Instrument Co., Div.-Sperry Rand Corp., a, b, c.
General Electric Co., Apparatus Sales Div., a, b, c.
General Electric Co., Computer Dept., a, b, c.
General Precision Lab. Inc., c.
G. M. Giannini & Co., Inc., a, b.
Gilmore Industries, Inc., a, b, c.
Gordon Enterprises, c.
Graflex Inc., c.
Hagan Chemicals & Controls, Inc., c.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co., c.
Hanson-Gorrill-Brian, Inc., b.
Wolter J. Hyatt Co., The, a.
*KEARFOTT CO., INC., a, b, c.
Land-Air Inc., c.
Leach Corp., a, b, c.
Leeds & Northrup Co., a, c.
Librascope Inc., a, b.
Litton Industries, Inc., c.
Magnavox Co., The, b.
Magnetic Instrument Co. Inc., a.
Maico Electronics, Inc., a, b, c.
Massa Div.-Cohu Electronics, Inc., a, c.
Micrometrical Mfg. Co., c.
Midwestern Instruments, Inc., a, b, c.
Milgo Electronic Corp., a, b, c.
Minneapolis-Honeywell Regulator Co., Davies Labs. Div., a, b, c.
Minneapolis-Honeywell Regulator Co., Industrial Div., a, b, c.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, a, b, c.
F. L. Moseley Co., a, b, c.
Motorola Inc., Military Electronics Div., a, b, c.
New England Scientific Instruments Co., c.
Offner Electronics Inc., a, c.
Philco Corp., Government & Industrial Div., b, c.
Radiation, Inc., a, b, c.
Research Appliance Co., b.
Royal Industries, Inc., a, b, c.
Sanborn Co., a, c.
Seiscor Mfg. Co., a, b.
Saroban Engrg., Inc., b, c.
Systran Corp., a, b, c.
Technitrol Engrg. Co., b, c.
Telechrame Mfg. Corp., a, b, c.
Telectro Industries Corp., a, b, c.
Thompson-Ramo-Wooldridge Products Co., The, a, b, c.
Traid Corp., c.
Varian Associates, a.
Victor Adding Machine Co., b, c.
Vitro Labs., b, c.
Vought Co., c.
Wang Labs., Inc., b.
Waste King Corp., Technical Products Div., a, c.
Wayne-George Corp., b.
Webcor, Inc., Government Div., a, b, c.
Westronics Inc., a.

DECADE BOXES

Abalon Precision Mfg. Corp.
Aerovox Corp.
Anchor Metal Spinning Co., The
Cambridge Instrument Co., Inc.
Clarostat Mfg. Co., Inc.
Cornell-Dubilier Electric Corp.
Daven Co., The
Electro-Measurements Inc.
Electro-Tech Equipment Co.
Epic, Inc.
Fletcher Mfg. Co., Inc., The
Freed Transformer Co. Inc.
Industrial Instruments Inc.
Julie Research Labs., Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
New England Scientific Instruments Co.
Precise Development Corp.
Projects Unlimited Inc.
Shallcross Mfg. Co.
H. W. Sullivan Ltd.
Telectro Industries Corp.
Universal Mfg. Co., Inc.

DECADE VOLTAGE SUPPLIES

See VOLTAGE SUPPLIES, DECADE

DECALCOMANIAS

Adept Industries Inc.
W. H. Brody Co.
Duralith Corp.
Landsverk Electrometer Co., The
Meyercord Co.
Minnesota Mining & Mfg. Co.
New England Etching & Plating Co., Inc.
D. A. Schultz Co.
Scioto Sign Co.
Topflight Corp.
E. F. Twomey Co., Inc.

DECODERS

ACF Industries Inc.
Applied Science Corp. of Princeton
Babcock Radio Engrg., Inc.
Bendix Aviation Corp., York Div.
CGS Labs., Inc.
Di-An Controls, Inc.
Electro Instruments, Inc.
Electronic Communications, Inc.
Electronic Engrg. Co. of California
Elgin Micronics Div.-Elgin National Watch Co.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co.
*A. W. HAYDON CO., THE
Litton Industries, Maryland Div.
Minneapolis-Honeywell Regulator Co.-Davies Labs. Div.
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Radiation, Inc.
Telectro Industries Corp.
Tele-Dynamics Inc.
Vitro Labs.
Wang Labs., Inc.
Webcor, Inc., Government Div.
Wright Engrg. Co.

DEFLECTOR, PADS & TUBES, BLAST

See BLAST DEFLECTOR, PADS & TUBES

DEFLECTION YOKES

See YOKES, DEFLECTION

DEHUMIDIFIERS

Accessory Controls & Equipment Corp.
Aluminum Co. of America
American Aeroparts
Associated Engineers, Inc.
Barium & Chemicals, Inc.
Bulow Electric Co.
Dampp-Chaser, Inc.
Desomatic Products, Inc.
Drayer-Hanson Div., National-U. S. Radiator Corp.
Driaire, Inc.
Dryomatic Corp.
Eastern Industries Inc.
Ellis & Watts Products, Inc.

International Radiant Corp.
Kohn & Co., Inc.
Lear, Inc.
Morla Coil Co.
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
Missimers Inc.
Pioneer Industries Div., Almar-York Co., Inc.
Surface Combustion Corp.
United States Dynamics Corp.
Universal Dynamics Corp.
Waldorf Electronics Div.-F. C. Huyck & Sons
Wenzlau Engrg. Co.
Winder Aircraft Corp. of Florida

DEHYDRATING AGENTS

American Aeroparts
Associated Engineers, Inc.
Barium & Chemicals, Inc.
Bowser, Inc., Defense Dept.
Chandler Evans Corp.
Delta Chemical Works, Inc.
Desomatic Products, Inc.
Driaire, Inc.
Fisher Scientific Co.
Lithium Corp. of America, Inc.
Metal Hydrides Inc.
Robbins Aviation, Inc.
Universal Dynamics Corp.

DEHYDRATOR PLUGS

American Aeroparts
Associated Engineers, Inc.
Chandler Evans Corp.
Driaire, Inc.
Lear, Inc., Grand Rapids Div.
Robbins Aviation, Inc.
Universal Dynamics Corp.

DEHYDRATORS, AUTOMATIC

American Aeroparts
Applied Dynamics Corp.
Associated Engineers, Inc.
Bowser, Inc., Defense Dept.
Cincinnati Cleaning & Finishing Machinery
Cornelius Co., The, Aero Div.
Desomatic Products, Inc.
Drioire, Inc.
Dryomatic Corp.
Eastern Industries Inc.
Kahn & Co., Inc.
Walter Kidde & Co., Inc., Aviation Div.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Lear, Inc., Lear-Romec Div.
Robbins Aviation, Inc.
Selas Corp. of America
Universal Dynamics Corp.

DEHYDRATORS, OXYGEN EQUIPMENT

Aro Equipment Corp.
Associated Engineers, Inc.
Bowser, Inc., Defense Dept.
Desomatic Products, Inc.
Lear, Inc.
Mueller Brass Co.
Robbins Aviation, Inc.
Universal Dynamics Corp.

DELAY LINES

a. Computer
b. Digital
c. Distributed-Constant Fixed
d. Distributed-Constant Variable
e. Lumped-Constant Fixed
f. Lumped-Constant Variable
g. Measurement & Test
h. Printed Circuit

AMP Inc., a thru f.
Acton Labs. Inc., g.
Adept Industries Inc., h.
Ad-Yu Electronics Lab., Inc., c thru g.
Aeronca Mfg. Corp., Baltimore Facility, d, f.
Aeronutronic Systems, Inc., Sub.-Ford Motor Co., a, b.
Airtronics International Corp., c, e.
Alden Products Co., a.
Andersen Labs., a, e.
Bel Fuse Inc., a, c, d, h.
Richard D. Brew & Co., Inc., a thru h.
Burnell & Co., Inc., e, h.
Cambridge Thermionic Corp., e, f.
Columbia Technical Corp., a, b, c, e.
Computer Control Co., Inc., b.
Cornell-Dubilier Electric Corp.
Corning Glass Works
Curtiss-Wright Corp., Electronics Div.
Data-Control Systems, Inc.
Doven Co., The, c, e.
Di-An Controls, Inc., b.
Dietz Design & Mfg. Co., a thru h.
Danner Scientific Co., a, d.
Dresser Industries, Inc., a thru f.
ESC Corp., a thru h.
Ferranti Electric Inc., a, b, c.
Filtron Co., Inc., a thru f.
Forbes & Wagner, Inc., a, c, e.
Gato-Video Labs., Inc., e.
Gugle-Miller Labs. Inc., c, e.
Geotronic Labs. Inc., a, e, f, g.
Gudeman Co. of California, Inc., The, Monrovia Div., c, e.
Helipot Div.-Beckman Instruments Inc., d.
Hewlett-Packard Co., b.
Instruments for Industry, Inc., g.
JFD Electronics Corp., a, b, c, e.
Kay Electric Co., g.
La Pointe Industries Inc., h.
Librascope Inc., a.
Litton Industries, U. S. Engrg. Co., Div., e.
Monogram Precision Industries, d, f.
Motorola Inc., Military Electronics Div., a thru f, h.
NYT Electronics, Inc., a, b, c, e, g, h.
Navigation Computer Corp., b.
Orbitron Co., Inc., a, e, g.
PCA Electronics Inc., c thru f.
*PACKARD-BELL ELECTRONICS CORP., a thru f, h.
Ralph M. Parsons Co., The, Electronics Div., a, c thru g.
Penn Keystone Corp., h.
Philco Corp., Government & Industrial Div., a, b, h.
Precision Circuits, Inc., h.
Redman Electronics Corp., a, b, e.
Shallcross Mfg. Co., a thru f.
Southwestern Industrial Electronics Co., a thru h.
Technitrol Engrg. Co., a thru f, g.
Technology Instrument Corp., g.
Telectro Industries Corp., a, b, e thru h.
Tobe Deutschmann Corp., a, e, h.
Transistor Electronics Corp., a.
Transonic, Inc., e.
Tucson Instrument Corp., c, e.
Vanguard Electronics Co., c, e, f.
Vitro Labs., b.
Wong Labs., Inc., b.
Wheeler Electronic Corp., Sub.-Sperry Rond Corp., e.

DELAY NETWORKS

Airtronics International Corp.
American Bosch Arma Corp.
Andersen Labs.
Burnell & Co., Inc.
Daven Co., The
Dietz Design & Mfg. Co.
Double E Products Co.
Dresser Industries, Inc.
ESC Corp.
General Electric Co., Apparatus Sales Div.
Geotronic Labs. Inc.
JFD Electronics Corp.
Miratel, Inc.
Motorola Inc., Military Electronics Div.
NYT Electronics, Inc.
Navigation Computer Corp.
Networks Electronic Corp.
Orbitron Co., Inc.
*PACKARD-BELL ELECTRONICS CORP.
Ralph M. Parsons Co., The, Electronics Div.
Philco Corp., Government & Industrial Div.
Servomechanisms, Inc.
Shallcross Mfg. Co.
Telectro Industries Corp.
Tobe Deutschmonn Corp.
Vanguard Electronics Co.

DEMAGNETIZERS

R. B. Annis Co.
Bearing Inspection, Inc.
Coils-Electronics
General Electric Co., Apparatus Sales Div.
Green Rectifier Co.
Ideal Industries, Inc.
Kohn & Co., Inc.
Kinevox Div.-Electromotion Co.
Magnaflux Corp.
Modelectric Products Corp.
Projects Unlimited Inc.
Robins Industries Corp.
Taft-Peirce Mfg. Co., The
Telectro Industries Corp.

DEMINERALIZERS & STILLS
See STILLS & DEMINERALIZERS

DEMODULATORS, COMPUTER

Airpax Electronics Inc. Seminole Div.
Andersen Labs.
Consolidated Diesel Electric Corp.
Lear, Inc.
Magnetic Research Corp.
Motorola Inc., Military Electronics Div.
Ohio Semiconductors, Inc.
Radiation, Inc.
Servomechanisms, Inc.
Solartron Inc.
Sperry Farragut Co., Div.-Sperry Rand Corp.
Telectro Industries Corp.
Tempo Instrument Inc.

DENSITOMETERS, ELECTRONIC

Applied Research Labs., Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Edgerton, Germeshausen & Grier, Inc.
NRC Equipment Corp.
National Spectrographic Labs., Inc.
Photobell Co., Inc.
Photovolt Corp.
Potter Aeronautical Corp.
Weston Instruments, Div.-Daystrom, Inc.

DESTRUCTORS

Aerojet-General Corp.
Atlantic Research Corp.
Beckman & Whitley, Inc., Missile Products Div.
Edgerton, Germeshausen & Grier, Inc.
Elgin Micranics Div.-Elgin National Watch Co.
Ensign-Bickford Co., The
Fulton-Irgan Corp., The
Gabriel Co., The-Talco Engrg. Co. Div.
*MC CORMICK SELPH ASSOCIATES
Olin Mathieson Chemical Corp., Energy Div.
*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.
Raymond Engrg. Lab., Inc.
Thiokol Chemical Corp., Hunter-Bristol Div.
Waltham Engrg. Corp.
Waste King Corp., Technical Products Div.

DESTRUCTORS & ASSOCIATED MECHANISMS

Aerojet-General Corp.
Aeronca Mfg. Corp.
American Machine & Foundry Co., Government Products Group
Atlantic Research Corp.
Beckman & Whitley, Inc., Missile Products Div.
Belock Instrument Corp.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Edgerton, Germeshausen & Grier, Inc.
Ensign-Bickford Co., The
Horkey-Moore Associates
Land-Air Inc.
Lear, Inc.
*MC CORMICK SELPH ASSOCIATES
Olin Mathieson Chemical Corp., Energy Div.
Potterson, Moos Div.-Universal Winding Co., Inc.
RS Electronics Corp.
Raymond Engrg. Lab., Inc.
Stanley Aviation Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
U. S. Industries, Inc.
Waltham Engrg. Corp.
Waste King Corp., Technical Products Div.
Western Gear Corp.

DETECTION SYSTEMS

American Machine & Foundry Co., Government Products Group
Anton Electronic Labs., Inc.
Bowser, Inc., Defense Dept.
Consolidated Electrodynamics Corp.
Dresser Industries, Inc.
Edgerton, Germeshausen & Grier, Inc.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Fenwal Inc.
Fisher Scientific Co.
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Land-Air Inc.
Litton Industries, Maryland Div.
Mine Safety Appliances Co.
Miratel, Inc.
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Photobell Co., Inc.
Servomechanisms, Inc.
Stanley Aviation Corp.
Telectro Industries Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Veeco Vacuum Corp.
Wintronics

DETECTORS

a. Crack
b. Crystal
c. Detonation
d. Explosive Gas
e. Flaw & Defect, Electronic
f. Impedance
g. Leak
h. Magnetic
i. Metal, Electronic
j. Monoxide
k. Null
l. Null, RF
m. Radiation
n. Radiation, Nuclear
o. Resistance
p. Scintillation
q. Smoke
r. Standing Wave
s. Vibration
t. Voltage
u. Water Leak

Acromag Inc., h.
Advanced Electronics, Inc., s.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., m.
Aircom Inc., r.
Aircom Inc. of New Jersey, r.
*AIRESEARCH MFG. CO. OF ARIZ.
Airpax Electronics Inc. Seminole Div., h.
Allis-Chalmers, i.
American Aeroparts, s.
American Electronics, Inc., g, m, n, p.
American Electronics, Inc., American Nuclear Div., g, n, p.

American Electronics, Inc., Toller & Cooper Div., d, j.
American Research & Mfg. Corp., k, s.
R. B. Annis Co., h.
Antenna & Radome Research Associates, b.
Anton Electronic Labs., Inc., m, n, t.
*ARNOUX CORP., a.
Associated Engineers, Inc., q.
Associated Research, Inc., a, t.
Atlantic Research Corp., c.
Baird-Atomic, Inc., d, m, n, p.
Borber-Colman Co., k.
Bearing Inspection, Inc., e.
Beva Lab., Inc., p.
Branson Instruments, Inc., o, e.
E. W. Brilmoyer Labs., Inc., i.
Budd Stanley Co. Inc., r.
California Technicol Industries, Div.-Textran Inc., r.
Consolidoted Electradynamics Corp., g, s.
Curtiss-Wright Corp., Electronics Div., n.
Curtiss-Wright Corp., Princeton Div., e.
Curtiss-Wright Carp., Research Div., a, g.
Dovenport Mfg. Co., t.
Davis Instruments, d, g.
Delsen Carp., e.
Demornay-Banardi, b, r.
Device Development Corp., h.
J. W. Dice Co., a, e, h, i.
Douglas Microwave Co., Inc., b.
Dresser Industries, Inc., c, h, n, s.
Dytronics Co., u.
Eastman Kodak Co., m, n.
Edgerton, Germeshausen & Grier, Inc., c, n.
Thomas A. Edisan Ind. Instrument Div.-McGraw-Edison Co., k, a.
Electro Products Laboratories, Inc., i, s.
Electra-Measurements Inc., k.
Electranic Control Carp., e, i, q.
Electro-Tech Equipment Co., g.
Elgin Micronics, West Coast Div.-Elgin Notional Watch Co., m, n.
Epic, Inc., s.
Eppley Laboratory, Inc., The, m.
Ero Engrg. Inc., n.
FXR, Inc., f, r.
Fenwal Inc., d.
Ferrotran Electronics Co., Inc., t.
Fisher Research Lab., Inc., i, n, p, u.
Fisher Scientific Co., g.
Freed Transformer Co. Inc., k.
Gas Appliance Stores, Inc., g.
General Electric Co., Apparatus Sales Div., g, n, t.
General Electric Co., X-Ray Dept., m, n, p.
General Electradynamics Carp., m.
General Scientific Equipment Co., d, f, q.
John Gambas Co., Inc., r.
Gulton Industries, Inc., e, s.
Hamilton Standard, Div.-United Aircraft Carp., t.
Hewlett-Packard Co., l, r.
High Voltage Engrg. Carp., a.
E. Vernan Hill & Co., g.
Haffman Electronics Corp., Semicanductar Div., d, i, q.
Hoffman Labs. Div., Haffman Electranics Carp., m.
ITT Labs.-Ft. Wayne, I, m, n.
Industrial Test Equipment Co., k.
Infrared Industries Inc., m.
Instruments Div.-Philips Electranics, Inc., m, p.
International Research & Development Corp., s.
Jansky & Bailey, Inc., e, l, m.
Johnsan-Williams, Inc., d.
Land-Air Inc., m, n, p, s.
Leeds & Narthrup Co., k, a, t.
Levinthal Electranic Products, Inc., p.
Lieco, Inc., b.
Lisle Corp., h.
MB Mfg. Co., s.
Magnaflux Carp., a, e, g, h, i, u.
Magnetic Instrument Co. Inc., m, n, p.
Jas. P. Marsh Carp., g, u.
Menlo Research Lab., a, b, g, m, n, p, u.
Meridian Metalcraft, Inc., b, l, r.
Micrometrical Mfg. Co., s.
Microwave Associates, Inc., b, r.
Millitest Corp., k.
Mine Safety Appliances Co., d, g, j.
Minneapolis-Honeywell Regulatar Co., Aeronautical Div., d, j, q.
Minneapolis-Haneywell Regulatar Co., Bostan Div., k.
Minneapolis-Honeywell Regulator Co., Industrial Div., k, m.
Minneapolis-Honeywell Regulatar Co., Industriol Product Group, k, a, t.
Minneopolis-Honeywell Regulatar Co., Ordnance Div., q.
Motarala Inc., Military Electronics Div., b, i.
NRC Equipment Corp., g.
Narda Microwave Corp., The, b.
National Research Corp., g.
National Ultrasonic Corp., e.
Newbrook Machine Carp., a.
Narth Atlantic Industries, Inc., k.
Nucleor Corp. of Americo, n, p.
Nuclear-Chicago Carp., m, n, p.
Ohia Semicanductars, Inc., h.
Omega Labs., Inc., r.
Optimized Devices, Inc., t.
Potterson, Moas Div.-Universol Winding Co., Inc., d, m, n, p.
Penn Keystone Carp., t.
Perkin-Elmer Corp., g, m.
Peschel Electranics, Inc., e, a, t.
Photobell Co., Inc., e, q.
Phatamotion, Inc., q.
Pilot Chemicals, Inc., p.
Patter Aeronautical Corp., g, u.
Precise Development Corp., p.
Radar Design Corp., b, l.
Radiation Instrument Development Lab., Inc., n, p.
Rinco, Inc., k.
Sage Labs., Inc., b.
St. John X-Ray Lab., m, n.
Scientific-Atlanta, Inc., b, l, r.
H. H. Scott, Inc., k, s.
Servomechanisms, Inc., k.
Shallcross Mfg. Co., k, a.
Simpson Electric Co., k.
Speciol Projects Lab., Food Machinery & Chemical Corp., g.
Specialty Engrg. & Electronics Co., d, j, m, n.
Sperry Microwove Electronics Co., Div.-Sperry Rand Corp., f, r.
Sperry Products, Inc., a, e.
Stanley Aviation Corp., n, p.
Strand Engrg. Co., n.
Tel-Instrument Electronics Corp.
Telonic Industries, Inc., b, l.
Thiokol Chemicol Corp., d, i.
Turco Products, Inc., a, g, u.
Twenty-First Century Electronics, Inc., e, h, n.
U. S. Industries, Inc., m.
Vacuum Tube Products, Div.-Hughes Aircraft Co., g.
Varian Associates, g, h.
Veeco Vacuum Corp., g.
Victor R. F. & Microwove Co., r.
Woveline, Inc., r.
Weinschel Engrg., b, f, k, r.
Weston Instruments, Div.-Doystrom, Inc., e.
Wheeler Laboratories, Inc., b.
Warner Electronic Devices, q.

DEVELOPERS, CHEMICAL

Bios Labs., Inc.
E. I. Du Pont de Nemaurs & Co. Inc.
Eastman Kadak Co.
Electronic Tube Carp.
General Electric Co., X-Ray Dept.
Gordon Enterprises
Matheson Co., Inc., The
Natianal Spectragraphic Labs., Inc.
Turca Products, Inc.

DIAGNOSTIC EQUIPMENT-COMPUTER

American Machine & Foundry Co., Government Products Group
Di-An Controls, Inc.
General Electric Co., Computer Dept.
Land-Air Inc.
Matarala Inc., Military Electranics Div.
*PACKARD-BELL ELECTRONICS CORP.
Philco Carp., Government & Industriol Div.
Transistor Electronics Carp.
Vitra Labs.

DIAL ACCESS TABS
See TABS, DIAL ACCESS

DIAL CRYSTALS

Homolite Corp., The
Lancaster Glass Corp.
Jas. P. Marsh Carp.
Sterling Glass Corp.
Sun Electric Carp., Aeranautical Div.
Waterbury Companies, Inc.
Zenith Optical Laboratory

DIAL DRIVE BELTS
See BELTS, DIAL DRIVE

DIAL POINTERS
See POINTERS, DIAL

DIALS

Ackerman Engravers, Inc.
Acramark Co., The
Adept Industries Inc.
Allied Plastics Supply Corp.
Amerac Inc.
Atlas Precision Products, Co.
Birnbach Radio Co., Inc.
Borg Equipment Div., Amphenol-Barg Electronics Corp.
W. H. Brady Co.
Canadian Radium & Uronium Carp.
Carmody Carp.
Cann-Croft Co.
Croname Inc.
Henry G. Dietz Co., Inc.
Durolith Corp.
Electricol Insulotion Co., Inc.
Eljay Corp.
Emelaid Co., Inc., The
Emersan Plastics Corp.
Etched Products Corp.
General Communicatian Co.
Helipat Div.-Beckman Instruments Inc.
Homalite Corp., The
Industrial Engravers, Inc.
E. F. Johnson Co.
Jas. P. Morsh Carp.
Marylond Etching Co. Inc.
Mica Insulatar Div.-Minnesota Mining & Mfg., Co.
Miller Dial & Nomeplate Co.
New England Etching & Ploting Co., Inc.
North Electric Co.
PIC Design Carp., Sub.-Benrus Watch Co., Inc.
Panel Engrg. Corp.
Pork Nameplate Co., Inc.
Plasteck, Inc.
Q-Circuits, Div.-Etching Co. of Colif.
Scientific Instrument Co.
Servomechanisms, Inc., Mechotrol Div.
Sterling Glass Corp.
Sun Dial Corp.
Sun Electric Corp., Aeronauticol Div.
Technology Instrument Corp.
Teiner Engrg. Corp.
United Stotes Rodium Corp.
Vemoline Products Co.
Virginio Plak Co.
Woldam Electronics Inc.
Wilks Precision Instrument Co., Inc.

DIALS, COMPLETE

Ackerman Engravers, Inc.
Acramark Co., The
Adept Industries Inc.
Atlas Precision Products, Co.
Borg Equipment Div., Amphenol-Borg Electronics Corp.
Canadian Radium & Uranium Corp.
Carmody Corp.
Dayton Aviation Radio & Equipment Corp.
Electricol Insulation Co., Inc.
Eljay Carp.
Etched Products Corp.
Helipot Div.-Beckman Instruments Inc.
Homolite Corp., The
E. F. Johnson Co.
Jos. P. Marsh Corp.
Marylond Etching Co. Inc.
Miller Dial & Nameplate Co.
New England Etching & Plating Co., Inc.
North Electric Co.
Pic Design Corp., Sub.-Benrus Watch Co., Inc.
Panel Engrg. Corp.
Scientific Instrument Co.
Servomechanisms, Inc., Mechotrol Div.
Sun Dial Corp.
Sun Electric Corp., Aeranauticol Div.
Theta Instrument Corp.
Vemaline Products Co.
Waldam Electronics Inc.
Waterbury Companies, Inc.
Wilks Precision Instrument Co., Inc.

DIALS, INSTRUMENT

Ackerman Engravers, Inc.
Adept Industries Inc.
Aero Gasket Carp.
Aerolite Electronics Corp.
Atlas Precision Products, Co.
Borg Equipment Div., Amphenal-Borg Electranics Corp.
Carmody Carp.
Croname Inc.
Duralith Carp.
Electrical Insulotian Co., Inc.
Eljay Corp.
Emeloid Co., Inc., The
Etched Products Corp.
Graflex Inc.
Helipat Div.-Beckman Instruments Inc.
Homolite Corp., The
Industrial Engravers, Inc.
E. F. Johnsan Co.,
Kerrco Products
Jos. P. Marsh Corp.
Miller Dial & Nameplate Co.
New England Etching & Plating Co., Inc.
North Electric Co.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Panel Engrg. Corp.
Plasteck, Inc.
Reeves Instrument Corp.
Scientific Instrument Co.
Servomechanisms, Inc., Mechatrol Div.
Smith-Morris Corp.
Sterling Glass Corp.
Sun Dial Carp.
Teiner Engrg. Carp.
Theta Instrument Carp.
United States Rodium Corp.
Vemoline Products Co.
Woldom Electronics Inc.
Wilks Precision Instrument Co., Inc.

DIAMOND NEEDLES
See NEEDLES, DIAMOND

DIAPHRAGMS, JET ENGINE

Aero Gasket Carp.
Anchor Metal Spinning Co., The
Bellofram Corp.
Chicago Rawhide Mfg. Co.
Chicago-Allis Mfg. Carp.
Curtiss-Wright Corp.-Wright Aeronautical Div.

Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Haveg Industries, Inc.
Joclin Mfg. Co.
C. B. Kaupp & Sons, Inc.
Kelsey-Hayes Co.
Kolcast Industries-Div. Thompson-Ramo-Wooldridge Inc.
Mercury Tool & Mfg. Corp.
Portland Copper & Tank Works Inc.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Ryan Aeronouticol Co.
Smith-Morris Corp.
Salar Aircroft Co.
Tapco Group, Thompsan-Ramo-Wooldridge Inc.
Turbo Products, Inc.
United States Rubber Co.
Waltham Engrg. Corp.
Westinghouse Electric Corp.
Wilks Precision Instrument Co., Inc.
Zalleo Brothers

DIAPHRAGMS, JET ENGINE NOZZLE

Aerolab Development Co.
Bodger Die Costing Corp.
Christie Machine Works
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Gordon Enterprises
Haveg Industries, Inc.
Jorvis Corp.
Joclin Mfg. Co.
Kolcast Industries-Div. Thompson-Romo-Waoldridge Inc.
Lee Co., The
Mercury Tool & Mfg. Corp.
Portland Copper & Tank Warks Inc.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Ryan Aeronauticol Co.
Schellens-True Corp.
Smith-Morris Corp.
Salar Aircraft Co.
Tapco Group, Thampsan-Romo-Woaldridge Inc.
Teiner Engrg. Corp.
Turbo Products, Inc.
Twigg Industries
United Stotes Rubber Co.
Woltham Engrg. Corp.
Westinghouse Electric Corp.
Wilks Precision Instrument Co., Inc.

DIE CASTINGS

Aluminum Co. of Americo
American Aeroparts
Anchor Metal Co. Inc.
Belmont Smelting & Refining Works, Inc.
Bendix Foundries, Bendix Aviotion Corp.
Bridgeport Brass Co.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Divisian Lead Co.
Doehler-Jorvis Div., Nationol Lead Co.
Dow Chemical Co., The
Electric Auta-Lite Co., The
Hydro Malding Co., Inc.
Kanarr Corp.
Minneapolis-Honeywell Regulotor Co., Drdnonce Div.
Minnesota Mining & Mfg. Co.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Milton Ross Metols Co., The
Stanley-Judd Div.-The Stonley Works
Wayne Pump Co., The, Div.-Symington Wayne Corp.

ELECTRIC HEATING EQUIPMENT

Astravoc Corp.
Erdco Engrg. Corp.
Firth Sterling Inc.
Furane Plostics, Inc.
General Electrodynomics Corp.
Induction Heating Corp.
Integrated Mica Corp.
Reeve Electronics, Inc.
Resdel Engrg. Corp.
Shermon Industriol Electronics, Div.-Engrg. Design Inc.
Telectro Industries Corp.
Westinghouse Electric Corp.
Young Brothers Co.

IES

ACF Industries Inc.
Abolon Precision Mfg. Corp.
Accurate Electronics Corp., Dept. D
Acromark Co., The
Amatom Electronic Hordware Co. Inc.
Americon Cor & Foundry, Div.-ACF Industries, Inc.
Bergen Carbide Co.
E. W. Bliss Co.
Brown Engrg. Co., Inc.
Californio Spring Co., Inc.
Capitol City Mfg. Co.
Clark-Aiken Co., The
East Doyton Tool & Die Co., The
Electro-Mechonicol Products Co.
Forsberg Mfg., Co., The
Furone Plostics, Inc.
GAR Mfg. Corp.
Greenfield Tap & Die, Div.-United-Greenfield Corp.
Lemert Engrg. Co., Inc.
Mercury Tool & Mfg. Corp.
Metol Corbides Corp.
Metal-Glass Products Co.
J. I. Morris Co.
D'Neil-Irwin Mfg. Co.
Miltan Ross Metols Co., The
Sheffield Corp., The, Sub.-Bendix Aviotion Carp.
C. Sjoberg & Son
A. O. Smith Corp.
Squiers Gage Co.
Teiner Engrg. Corp.
Therm, Inc.
Thermal Refractories Corp.
Wales Strippit Inc., Unit of Houdaille Industries, Inc.
Woyne Foundry & Stamping Co.
Wellman Bronze & Aluminum Co.
Western Tool & Mfg. Co., The
Wilks Precision Instrument Co., Inc.

DIFFERENTIAL PRESSURE FLOWMETERS

See FLOWMETERS, DIFFERENTIAL PRESSURE

DIFFUSERS, GAS TURBINE ENGINE

Curtiss-Wright Corp., Research Div.
Ingersall Kalomazoo Div., Barg-Worner Corp.
Kaiser Aircraft & Electronics, Div.-Koiser Industries Corp.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Ryon Aeronouticol Co.
Smith-Morris Corp.
Solar Aircraft Co.
Topco Group, Thompson-Ramo-Wooldridge Inc.
Teiner Engrg. Corp.
Thermal Refractories Corp.
Turbo Products, Inc.
Westinghouse Electric Corp.

DIODES

a. Crystal
b. Germanium
c. Microwave Mixer
d. Silicon
e. Silicon Power

American Elite, Inc., b.
Audio Devices, Inc.-Rectifier Div., d.
Bendix Aviation Corp.-Semiconductor Products, Red Bonk Div., e.
Bogue Electric Mfg., Co., d.
Brodley Semiconductor Corp., a, d, e.
CBS-Hytron, Div.-Columbio Broodcosting System, Inc., b, c, d.
Clevite Transistor Products, Div.-Clevite Corp., a, b, d.
Columbus Electronics Corp., d, e.
Eitel-McCullough, Inc.
Erie Resistar Corp., b, d.
Ferronti Electric Inc., d, e.
Finney Co., The, a, b, d.
Gahagan Inc., a, b, c.
Genalex Div.-British Industries Corp., a thru e.
General Transistor Corp., b.
Green Rectifier Co.
Hoffmon Electronics Corp., Semiconductor Div., c, d, e.
Hughes Aircraft Co., b, d.
Internationol Rectifier Corp., d, e.
Internotional Research Associotes, e.
International Resistance Co.
Kemtron Electron Products Inc., a thru e.
Microwove Associotes, Inc., a, c, d.
Minneapolis-Honeywell Regulator Co., Ordnonce Div., b.
Motorola Inc., Military Electronics Div., a thru e.
Narda Microwave Corp., The, c.
North American Electronics Inc., d, e.
Pocific Semiconductors, Inc., d, e.
Philco Corp., Government & Industrial Div., a thru e.
Philco Corp., Lansdale Tube Co. Div, b, c, d.
Qutronic Semi Conductor Corp., a, b, d.
Roytheon Mfg. Co., a, b, d, e.
Sequoia Wire & Cable Co., Div.-Mandrel Industries, Inc., d.
Shockley Transistor Corp., d.
Silicon Tronsistor Corp., d.
Sperry Semiconductor Div., Sperry Rand Corp., d, e.
Sylvania Electric Products Inc., Semiconductor Div., a thru d.
Syntron Co., d, e.
Technicol Apporatus Builders, b, d, e.
Tronsitron Electronic Corp., b, d, e.
U. S. Science Corp., Div.-Topp Industries, Inc., d.
U. S. Semiconductor Products, Inc., d.
United Stotes Dynamics Corp., a, b, d, e.
Warren Components, Div. El-Tronics, Inc., b.
Wesrep Corp., d.
Westinghouse Electric Corp., a thru e.

DIRECTION FINDERS

Aetna Electronics Carp.
Allied International Co.
*AVCO MFG. CORP., CROSLEY DIV.
Bendix Rodio Div., Bendix Aviotion Corp.
Centronix Inc.
Collins Rodio Co.
Doyton Aviotion Rodio & Equipment Corp.
Emerson Rodio & Phonograph Corp.
Generol Devices, Inc.
ITT Federal Div., Internationol Telephone & Telegraph Corp.
ITT Labs.
Jonsky & Bailey, Inc.
*KEARFOTT CO., INC.
Lane Electronics Mfg. Corp.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Littan Industries, Maryland Div.
Magnavox Co., The
W. L. Maxson Corp., The
Motorolo Inc., Military Electronics Div.
Munston Mfg. & Service, Inc.
National Pneumotic Co., Inc., Holtzer-Cobot Divs.
Philco Corp., Government & Industrial Div.
Precise Development Corp.
Roytheon Mfg. Co.
Roytheon Mfg. Co., Government Equipment Div.
Robot Industries Inc.
Royal Industries, Inc.
Ryan Aeronauticol Co.
Servo Corp. of America
Sperry Piedmont Co. - Div.-Sperry Rand Corp.
Telectro Industries Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Woldorf Electronics, Div.-F. C. Huyck & Sons
Webcor, Inc., Government Div.

DIRECTION FINDERS, RADIO

See RADIO DIRECTION FINDERS

DISCHARGE EQUIPMENT, LOW TEMPERATURE

Edw. Renneburg & Sons Co.

DISCHARGERS, STATIC

American Aeroports
Best Aircroft Corp.
Goodyeor Tire & Rubber Co., The, Aviation Products Div.

DISCONNECTS, CONTROL SYSTEMS

Aerotec Carp., The
Alden Products Co.
Anton Electronic Labs., Inc.
Arrow-Hart & Hegemon Electric Co., The
Assembly Products, Inc.
Cormoc Aviotion
Components Corp.
Dresser Mfg. Div., Dresser Industries, Inc.
Generol Electric Co., Apporotus Sales Div.
Hydromatics, Inc.
Integrol Corp.
Lundy Mfg. Corp.
Dn Mark Couplings, Inc.
Pyle-National Co., The
Reinhold Engrg. & Plostics Co.
Stanley Aviation Corp.
Western Gear Corp.

DISCONNECTS, IGNITION SYSTEMS

Alden Products Co.
Anton Electronic Labs., Inc.
Auburn Spark Plug Co., Inc.
Cole-Hersee Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Hallett Mfg., Co.
Litton Industries, Inc.
J. E. Menaugh Co.
On Mark Couplings, Inc.
Rochester Mfg. Co. Inc.
Stanley Aviotion Corp.

DISCRIMINATORS

Amelco, Inc.
Borker & Williomson Inc.
Bell & Gossett Co.
Bendix-Pacific Div., Bendix Aviation Corp.
Beva Lob., Inc.
Brush Instruments, Div.-Clevite Corp.
Centronix Inc.
Collins Rodio Co.
Doto-Control Systems, Inc.
Electro-Mechonicol Research, Inc.
FXR, Inc.
Freed Transformer Co. Inc.
Hollomare Electronics Co.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
W. L. Maxson Corp., The
Meridion Metolcroft, Inc.
Minneapolis-Haneywell Regulotor Co.-Dovies Labs. Div.
Motorola Inc., Military Electronics Div.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Optimized Devices, Inc.
Portchester Instrument Corp.
Systron Corp.
Telectro Industries Corp.
Transonic, Inc.

DISCS, COMPUTER

Adept Industries Inc.
Emeloid Co., Inc., The
Monogram Precision Industries
Telectro Industries Corp.
United Stotes Chemicol Milling Corp.

DISSIPATORS, HEAT

Bud Rodio Inc.

Eitel-McCullough, Inc.
Metal Textile Corp., Electronics Div.
Minnesota Mining & Mfg. Co.
National Beryllia Corp.
Edw. Renneburg & Sons Co.
Stover Co., Inc., The
Thompson Engrg. Co., The, Missile Products Div.
Tranter Mfg., Inc.
United Aircraft Products, Inc.

DISTANCE MEASURING EQUIPMENT

***AVCO MFG. CORP., CROSLEY DIV.**
Avien, Inc.
Beaver Precision Products Inc.
Bendix Radio Div., Bendix Aviation Corp.
Benson-Lehner Corp.
Collins Radio Co.
Communications Research Co.
Dorsett Labs., Inc.
Ferranti Electric Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Precision Lab. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Land-Air Inc.
Lear, Inc .
Litton Industries, Maryland Div.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Motorola Inc., Military Electronics Div.
Northrop Corp., The, Nortronics Div.
Ralph M. Parsons Co., The, Electronics Div.
Radiation, Inc.
Ryan Aeronautical Co.

DISTRIBUTORS, FUEL

American Bosch Arma Corp.
***BENDIX AVIATION CORP., HAMILTON DIV.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Chandler Evans Corp.
Dresser Mfg. Div., Dresser Industries, Inc.
Korda Industries
United Aircraft Products, Inc.

DISTRIBUTORS, IGNITION

Electric Auto-Lite Co., The
Gordon Enterprises
Hallett Mfg., Co.

DOLLIES

Acco Equipment Div., American Chain & Cable Co., Inc.
Air Logistics Corp.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Anchor Metal Spinning Co., The
Arnolt Corp.
Associated Engineers, Inc.
Bil-Jax Inc.
Blowers Inc.
Bowser, Inc., Defense Dept.
Brooks & Perkins, Inc.
Capital City Mfg. Co.
Albert H. Cayne Equipment Corp.
Champion Co., The
C. B. Christiansen Co.
Cleveland Pneumatic Industries, Inc.
Colonial Aircraft Corp.
Colson Corp., The
Columbia Research & Development Corp.
Consolidated Diesel Electric Corp.
Consolidated Diesel Electric Corp., Western Div.
Continental Technical Service, Inc.
Crane Carrier Corp.
Cromer Mfg. & Engrg., Inc.
Eidal Mfg. Co., Inc.
FWD Corp.
Fairbanks Co., The
Gremco, Inc.
Ludwig Honold Mfg. Co.
Hufford Corp., The
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Machine Products Div., New Haven Trap Rock Co.
Magline Inc.
Marquardt Aircraft Co.
Mercury Tool & Mfg. Corp.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
Opelika Welding, Machine & Supply Inc.
Ordnance Div.-Food Machinery & Chemical Corp.
Precision Sheet Metal, Inc.
R & R Engrg. Co.
Ravenna Metal Products, Div.-Standard Screw Co.
Red Lion Cabinet Co., Redco Tool Div.
Regent Jack Mfg. Co., Inc.
Roberts Industries Inc.
Royal Industries, Inc.
Santa Anita Engrg. Co.
Schaffer Air Industries, Inc.
Seamless Products Co., Inc.
Skyline Products, Inc.
Technical Service Corp.
Teiner Engrg. Corp.
Thiokol Chemical Corp.
Trailmobile Inc.
United Mfg. Co., The
United States Chemical Milling Corp.
Weaver Mfg. Co.
Welded Construction Inc.
Albert Wesling & Sons Inc.
Wheland Co., The
Wickfield, Inc.

DOMES, NAVIGATION

See NAVIGATION DOMES

DOSIMETERS

American Machine & Foundry Co., Government Products Group
***BAUSCH & LOMB OPTICAL CO.**
Cambridge Instrument Co., Inc.
Corning Glass Works
Eastman Kodak Co.
FXR, Inc.
General Electric Co., X-Ray Dept.
Land-Air Inc.
Menlo Research Lab.
Minnesota Mining & Mfg. Co.
Nuclear-Chicago Corp.
Patterson, Maas Div. - Universal Winding Co., Inc.
St. John X-Ray Lab.

DOWELS

Allen Mfg. Co.
Baldwin Mfg. Co. Inc., The
Capital City Mfg. Co.
Corbin Products Div.
***HARTFORD MACHINE SCREW CO., DIV.-STANDARD SCREW CO.**
Standard Pressed Steel Co.
Stanley-Judd Div.-The Stanley Works
Wilmington Fibre Specialty Co.

DRAFTING EQUIPMENT

Barber-Colman Co.
Dolgorukov Mfg. Co.
E-Z Way Templates
Emmert Mfg. Co.
Faber Pencil Co., Eberhard
Fisher & Crome
Gordon Enterprises
Joseph E. Podgor Co., Inc.
E. F. Twomey Co., Inc.
Universal Drafting Machine Corp.

DRAFTING PAPER

Pic Design Corp., Sub.-Benrus Watch Co., Inc.
Joseph E. Podgor Co., Inc.

DRIFTMETERS

Air Logistics Corp.
Ryan Aeronautical Co.

DRILL PRESSES

Barrett-Christie Co.
Beaver Precision Products Inc.
Burg Tool Mfg. Co., Inc.
Clausing Div.-Atlas Press Co.
Continental Technical Service, Inc.
High Speed Hammer Co., Inc., The
Carl Hirschmann Co., Inc.
Motch & Merryweather Machinery Co., The, Avey Div.
Joseph T. Ryerson & Son, Inc.
Sibley Machine & Foundry Corp.
Transmares Corp.
Veet Industries

DRILL PRESSES, PRECISION

Barrett-Christie Co.
Beaver Precision Products Inc.
Burg Tool Mfg. Co., Inc.
Burgmaster Corp.
Clausing Div.-Atlas Press Co.
High Speed Hammer Co., Inc., The
Carl Hirschmann Co., Inc.
Louis Levin & Son, Inc.
Mico Instrument Co.
Motch & Merryweather Machinery Co., The, Avey Div.
Transmares Corp.
Veet Industries

DRILLS, ELECTRIC

Barrett-Christie Co.
Black & Decker Mfg. Co., The
Chicago Pneumatic Tool Co.
Joseph T. Ryerson & Son, Inc.
Snap-On Tools Corp.
Stanley-Judd Div.-The Stanley Works
U. S. Electrical Tool Co.

DRILLS, HAND

Barrett-Christie Co.
Forsberg Mfg., Co., The
Gardner-Denver Co.
Joseph T. Ryerson & Son, Inc.
Stanley-Judd Div.-The Stanley Works

DRILLS, TWIST

Barrett-Christie Co.
Continental Drill Corp.
Greenfield Tap & Die, Div.-United-Greenfield Corp.
Louis Levin & Son, Inc.
New York Twist Drill Co., Inc.
Joseph T. Ryerson & Son, Inc.
Servwell Products Co.
Snap-On-Tools Corp.
Sphinx-American Co.
Stanley-Judd Div.-The Stanley Works

DRIVES

a. Hydraulic
b. Small Electric Drive Mechanisms
c. Tachometer
d. Torque Tube

Actuator Products Div., Geartronics Corp., **c.**
Adel Precision Products of California, Div.-General Metals Corp., **a.**
American Aeroparts, **a, c.**
American Bosch Arma Corp., **a, b.**
American Brake Shoe Co.
American Machine & Foundry Co., Government Products Group, **a.**
American Machine & Foundry Co., Greenwich, **a, b, d.**
American Measurement & Control, Inc., **a**
Ardmore Products, **a.**
Arnolt Corp., **a.**
Astronautics Engrg. Co., **a.**
Atlas Precision Products, Co., **b.**
***BENOIX AVIATION CORP., HAMILTON DIV., a.**
Bendix-Pacific Div., Bendix Aviation Corp., **b.**
Bendix Utica Div., Bendix Aviation Corp.
E. W. Bliss Co., **a.**
Breeze Corporations, Inc., **b.**
Cadillac Gage Co., **a.**
Capital City Mfg. Co., **a.**
Conoflow Corp., **b.**
Cornelius Co., The, Aero Div., **a.**
Crane Carrier Corp., **a.**
Curtiss-Wright Corp., Research Div., **b.**
Denison Engrg. Div., American Broke Shoe Co., **a.**
Eastern Industries Inc., **a.**
Electric Auto-Lite Co., The, **a, b.**
Electronic Communications, Inc., **b.**
Gabriel Co., The, Gabriel Electronics Div., **b.**
General Electric Co., Apparatus Sales Div., **a, b, c.**
Globe Industries, Inc., **b, c.**
Haskel Engrg. & Supply Co., **a.**
***A. W. HAYDON CO., THE, b, c.**
Hoover Electric Co., **b, d.**
Hufford Corp., The, **a.**
Walter J. Hyatt Co., The, **a, b.**
Hydra-Power Corp., **a.**
Insco Co., Div.-Barry Controls Inc., **b.**
Integral Corp., **a.**
Javelin Aircraft Co. Inc., **a, b.**
Jordan Co., Inc., The, **b.**
Kelsey-Hayes Co., **a.**
Kemp Aero Products, **a.**
Lear, Inc., Grand Rapids Div., **b.**
Lyndon Aircraft, Inc., **b.**
Minneapolis-Honeywell Regulator Co., Ordnance Div., **a.**
National Pneumatic Co., Inc., Holtzer-Cabot Divs., **b, c.**
Oil-Dyne, Inc., **a.**
Pioneer Tool & Engrg. Co., **a, b.**
Power-Tronic Systems Inc., **b, c.**
Racine Hydraulics & Machinery Inc., **a.**
Reflectone Corp., The, **b.**
Sargent Engrg. Corp., **a, b, d.**
Servomechanisms, Inc., Mechatrol Div., **b.**
Stratos, Div.-Fairchild Engine & Airplane Corp., **a.**
Tapco Group, Thompson-Ramo-Wooldridge Inc., **a, b.**
Vard Inc., **b.**
Variety Aircraft Corp., **b.**
Vickers Inc., Div.-Sperry Rand, **a, b.**
Vickers Inc., Marine & Ordnance Dept., Machinery Hydraulics Div., **a.**
Wacline, Inc., **b.**
Washington Machine & Tool Works, Inc., **b.**
Waste King Corp., Technical Products Div., **b, d.**
Watertown Div., The New York Air Brake Co., **a.**
Western Design, Div.-U. S. Industries, Inc.; Santa Barbara Div., **b.**
Western Gear Corp., **a thru d.**

DRIVES, CONSTANT SPEED

***LYCOMING DIV., AVCO MFG. CORP.**

DRIVES, VARIABLE SPEED

***LYCOMING DIV., AVCO MFG. CORP.**

DROP FORGINGS

Aircraft Mechanics, Inc.
Aluminum Co. of America
American Aeroparts
American Brake Shoe Co.
American Car & Foundry, Div.-ACF Industries, Inc.
Billings & Spencer Co., The
Bridgeport Brass Co.
***CAMERON IRON WORKS, INC.**
Capewell Mfg. Co.
Consolidated Industries, Inc.
Corbin Products Div.
Crucible Steel Co. of America
Dirilyte Co. of America, Inc.
Kelsey-Hayes Co.
Ladish Co.
Lofstrand Co., The
Opelika Welding, Machine & Supply Inc.
Pettibone Mulliken Corp.
H. K. Porter Co., Inc.

Rockwell-Standard Corp.
Solar Aircraft Co.
Steel Improvement & Forge, The
Transue & Williams Steel Forging Corp.
Vichek Tool Co., The
Wilcox-Crittenden Div., North & Judd Mfg. Co.
J. H. Williams & Co.

UCTS, EXHAUST

Aeronca Mfg. Corp.
American Agile Corp.
American Tube Bending Co., Inc.
Anaconda Metal Hose Div., The American Brass Co.
Anchor Metal Spinning Co., The
B. H. Aircraft Co., Inc.
Basic Tool Industries, Inc.
***BEATON & CORBIN MFG. CO., THE**
Breeze Corporations, Inc.
Carmac Aviation
Colonial Aircraft Corp.
Components Corp.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
D K Mfg Co.
Diversey Engrg. Co.
Dunbar-Kapple Inc.-Aircraft Components Div.
Elzee Metal Products Co., Inc.
Ferris-Mfg. Co., The
Fletcher Mfg. Co., Inc., The
Flexible Metal Hose Mfg. Co.
Flexible Tubing Corp.
***FLEXONICS CORP., AERONAUTICAL DIV.**
Ludwig Honold Mfg. Co.
Hufford Corp., The
Hupp Aviation Co.
Intercontinental Mfg. Co., Inc.
Koiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kaiser Metal Products, Inc. - Fleetwings Div.
Kirk & Blum Mfg. Co., The
***LAVELLE AIRCRAFT CORP.**
Langren Aircraft Co., Inc.
Mercury Tool & Mfg. Corp.
Monogram Precision Industries
Normco Mfg. Co.
Orchard Industries, Inc., Actionflex Div.
Parts Engrg. Co., Inc.
Penn-Michigan Mfg. Corp.
Portland Copper & Tank Works Inc.
Precision Sheet Metal, Inc.
Raybestos-Manhattan, Inc., Pa.
Edw. Renneburg & Sons Co.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
C. F. Roark Welding & Engrg. Co., Inc.
Rohr Aircraft Corp.
Ryan Aeronautical Co.
Shaw Metal Products Corp.
Smith-Morris Corp.
Solar Aircraft Co.
Stainless Steel Products, Inc.
Turbo Products, Inc.
Twigg Industries
United Aircraft Products, Inc.
Universal Metal Products Inc.
Variety Aircraft Corp.
Waste King Corp., Technical Products Div.
Wiremold Co., The
Zippertubing Co., The

CTS, FLEXIBLE & COMPRESSIBLE

American Aeroparts
American Air Filter Co., Defense Products Div.
Anaconda Metal Hose Div., The American Brass Co.
Anchor Metal Spinning Co., The
***BEATON & CORBIN MFG. CO., THE**
Blowers Inc.
Breeze Corporations, Inc.
Carmac Aviation
Components Corp.
Consolidated Diesel Electric Corp.
Cordo Chemical Corp.
Cromer Mfg. & Engrg., Inc.
D K Mfg. Co.
L. R. Daniels, Inc.
Dayton Rubber Co., The
Dresser Mfg. Div., Dresser Industries, Inc.
Dunbar-Kapple Inc.-Aircraft Components Div.
Flexible Metal Hose Mfg. Co.
Flexible Tubing Corp.
***FLEXONICS CORP., AERONAUTICAL DIV.**
B. F. Goodrich Aviation Products
Huntington Rubber Mills
Kaiser Metal Products, Inc. - Fleetwings Div.
Lofstrand Co., The
Lone Star Plastics Co. Inc.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
Orchard Industries, Inc., Actionflex Div.
Parts Engrg. Co., Inc.
Precision Sheet Metal, Inc.
Raybestos-Manhattan, Inc., Pa.
Reinhold Engrg. & Plastics Co.
Edw. Renneburg & Sons Co.
C. F. Roork Welding & Engrg. Co., Inc.
Fred T. Roberts & Co.
Rubbercraft Corp. of California
Ryan Aeronautical Co.
Smith-Morris Corp.
Solar Aircraft Co.
Southwest Products Co.
Stainless Steel Products, Inc.
Standard-Thamson Corp., Cliffard Mfg. Co. Div.
Taylor Electric Inc.
Turbo Products, Inc.
United Aircraft Products, Inc.
U. S. Flexible Metollic Tubing Co.
United States Rubber Co.
Waste King Corp., Technical Products Div.
Wiremold Co., The
Zippertubing Co., The

DUCTS, NON-FLEXIBLE

American Aeroparts
American Agile Corp.
American Tube Bending Co., Inc.
Anchor Metal Spinning Co., The
B. H. Aircraft Co., Inc.
***BEATON & CORBIN MFG. CO., THE**
Carmac Aviation
Colonial Aircraft Corp.
Cromer Mfg. & Engrg., Inc.
D K Mfg. Co.
Dunbar-Kapple Inc.-Aircraft Components Div.
Fletcher Mfg. Co., Inc., The
Flexible Metal Hose Mfg. Co.
***FLEXONICS CORP., AERONAUTICAL DIV.**
Intercontinental Mfg. Co., Inc.
Koiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kirk & Blum Mfg. Co., The
Lamtex Industries, Inc.
Lone Star Plastics Co., Inc.
Longren Aircraft Co., Inc.
Mercury Tool & Mfg. Corp.
Monogram Precision Industries
Normco Mfg. Co.
Parts Engrg. Co., Inc.
Portland Copper & Tank Works Inc.
Precision Sheet Metal, Inc.
Reinhold Engrg. & Plastics Co.
Edw. Renneburg & Sons Co.
C. F. Roark Welding & Engrg. Co., Inc.
Rohr Aircraft Corp.
Ryan Aeronautical Co.
Shaw Metal Products Corp.
Silicone Insulation, Inc.
Stainless Steel Products, Inc.
Taylor Electric Inc.
Texas Metal & Mfg. Co., Inc.
Turbo Products, Inc.
Twigg Industries
United Aircraft Products, Inc.
Universal Metal Products Inc.
Variety Aircraft Corp.
Waste King Corp., Technical Products Div.
Woolf Aircraft Products, Inc.

DUPLEXERS

Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
Andrew Corp.
Budd Stanley Co., Inc.
Bulow Electric Co.
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
Eljay Corp.
Genalex Div.-British Industries Corp.
J-V-M Microwave Co.
***KEARFOTT CO., INC., MICROWAVE DIV.**
Lieco, Inc.
Microwave Associates, Inc.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
N. R. K. Mfg. & Engrg. Co.
Portchester Instrument Corp.
Sage Labs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Telerad Mfg. Corp.
Victor R. F. & Microwave Co.
Waveline, Inc.

DUST ENCLOSURES
See ENCLOSURES, DUST

DYNAMOMETERS

American Electronics, Inc., Taller & Cooper Div.
Consolidated Diesel Electric Corp.
Dalmotor Div., Yuba Consolidated Industries, Inc.
W. C. Dillon & Co., Inc.
Eaton Mfg. Co.
Eder Engrg. Co., Inc.
General Electric Co., Apparatus Sales Div.
Hoover Electric Co.
Hunter Spring Co., Div.-American Machine & Metals, Inc.
Industrial Engrg. Corp.
L. A. B. Corp.
Leeds & Northrup Co.
Magtrol, Inc.
George L. Nankervis Co.
Radiation, Inc.
Schaevitz Engrg.
Standard Electric Time Co., The
Statham Instruments, Inc.
Talley Corp., The
Thwing-Albert Instrument Co.

DYNAMOTORS

American Aeroparts
Bendix Aviation Corp.-Montrose Div.
Bogue Electric Mfg., Co.
Continental Electric Co., Inc.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Dayton Aviation Radio & Equipment Corp.
Eicor Div.-Scranton
General Electric Co., Apparatus Sales Div.
Hoover Electric Co.
Inductian Motors Corp.
Heinz Mueller Eng. Co. Inc.
National Pneumatic Co., Inc., Haltzer-Cabot Divs.
Redmond Co., Inc.
Safety Electrical Equipment Corp.
Songama Electric Co.
Talley Corp., The
Task Corp.
Wincharger Corp., Sub.-Zenith Radio Corp.

EJECTION SEAT ACCESSORIES, CARTRIDGE ACTUATED

***PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.**

EJECTION SYSTEMS

Aerojet-General Corp.
Aerolab Development Co.
American Machine & Foundry Co., Government Products Group
Bendix Aviation Corp., Red Bank Div.
Californio Aircraft Products
Consolidoted Diesel Electric Corp.
Diversey Engrg. Co.
Fulton-Irgon Corp., The
Gabriel Co., The-Talco Engrg. Co. Div.
Goodyear Aircraft Corp.
Paul Hardeman, Inc.
Hardman Tool & Engrg., Co.
Holex, Inc.
Horkey-Moore Associates
Hughes Tool Co., Aircraft Div.
***MC CORMICK SELPH ASSOCIATES**
Pacific Scientific Co.
Patterson, Moos Div. - Universal Winding Co., Inc.
***PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.**
Red Lion Cabinet Co., Redco Tool Div.
Reinhold Engrg. & Plastics Co.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Royal Industries, Inc.
Skinner Precision Products
Stanley Aviation Corp.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Washington Technological Associates Inc.
Western Gear Corp.

ELECTRIC DRILLS
See DRILLS, ELECTRIC

ELECTRIC PANEL BOARDS
See PANEL BOARDS, ELECTRIC

ELECTRIC POWER SYSTEMS

Aerolab Development Co.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allied International Co.
American Bosch Arma Corp.
American Machine & Foundry Co., Greenwich
Bendix Aviation Corp., Red Bank Div.
Bendix Utica Div., Bendix Aviation Corp.
Consolidated Diesel Electric Corp.
Consolidated Diesel Electric Corp., Western Div.
Cummins Engine Co., Inc.
Delco-Remy Div., General Motors Corp.
Du Kane Corp.
General Electric Co., Apparatus Sales Div.
Georator Corp.
Hamilton Standard, Div.-United Aircraft Corp.
Hoover Electric Co.
International Fermont Machinery Co., Inc.
Jack & Heintz, Inc.
Jeta, Inc.
Land-Air Inc.
Leach Corp.
Leland Airborne Products, Div.-American Machine & Foundry Co.
Monogram Precision Industries
Mullenbach Div.-Electric Machinery Mfg. Co.
D. W. Onan & Sons Inc.
Patterson, Moos Div. - Universal Winding Co., Inc.
Perkin Engrg. Corp.
RS Electronics Corp.
Safety Electrical Equipment Corp.
Standard Electric Time Co., The
Technical Apparatus Builders
Telectro Industries Corp.
U. S. Relay Co.
Westinghouse Electric Corp.
Winpower Mfg. Co.

ELECTRIC VALVE OPERATOR
See VALVE OPERATOR, ELECTRIC

ELECTRICAL CABLE ASSEMBLIES
See CABLE ASSEMBLIES, ELECTRICAL

ELECTRICAL FIREWALL CONNECTORS
See CONNECTORS, ELECTRICAL FIREWALL

ELECTRICAL MEASURING INSTRUMENTS
See INSTRUMENTS, ELECTRICAL MEASURING

ELECTRICAL MEASURING METERS, INSTRUMENTS
See INSTRUMENTS, ELECTRICAL MEASURING METERS

ELECTRO MAGNETS
See MAGNETS, ELECTRO

ELECTROCARDIOGRAPHS

American Cystoscope Makers, Inc.
Cambridge Instrument Co., Inc.
Ensco, Inc.
FXR, Inc.
General Electric Co., X-Ray Dept.
Jansky & Bailey, Inc.
Levinthal Electronic Products, Inc.
Offner Electronics Inc.
Sanborn Co.
Winzen Research Inc.

ELECTRO-CHEMICAL ANALYSIS EQUIPMENT
See ANALYSIS EQUIPMENT, ELECTRO-CHEMICAL

ELECTRON MICROSCOPES
See MICROSCOPES, ELECTRON

ELECTRONIC AUTOMATIC PILOTS
See AUTOMATIC PILOTS, ELECTRONIC

ELECTRONIC BREADBOARD KITS
See BREADBOARD KITS, ELECTRONIC

ELECTRONIC COOKERS
See COOKERS, ELECTRONIC

ELECTRONIC COOLING SYSTEMS
See COOLING SYSTEMS, ELECTRONIC

ELECTRONIC DENSITOMETERS
See DENSITOMETERS, ELECTRONIC

ELECTRONIC EQUIPMENT PACKAGING, SERVICE ONLY
See PACKAGING, ELECTRONIC EQUIPMENT, SERVICE ONLY

ELECTRONIC GENERATORS
See GENERATORS, ELECTRONIC

ELECTRONIC IGNITION SYSTEMS
See IGNITION SYSTEMS, ELECTRONIC

ELECTRONIC INTEGRATORS
See INTEGRATORS, ELECTRONIC

ELECTRONIC LANDING AIDS
See LANDING AIDS, ELECTRONIC

ELECTRONIC MEGAPHONES
See MEGAPHONES, ELECTRONIC

ELECTRONIC METEOROLOGICAL EQUIPMENT
See METEOROLOGICAL EQUIPMENT, ELECTRONIC

ELECTRONIC MICROMETERS
See MICROMETERS, ELECTRONIC

ELECTRONIC PHOTOFLASH EQUIPMENT
See PHOTOFLASH EQUIPMENT, ELECTRONIC

ELECTRONIC TACHOMETERS
See TACHOMETERS, ELECTRONIC

ELECTROPLATING EQUIPMENT

Allied Research Products, Inc.
Briscoe Mfg. Co.
Dean Products, Inc.
Electronic Parts Mfg. Co., Inc.
Grant Chemical Co., Inc.
Kanthal Corp., The
NRC Equipment Corp.
George L Nankervis Co.
Rosemount Engrg. Co.
Sanborn Co.
Sel-Rex Corp.
Technical Apparatus Builders
Western Coating Co.
Westinghouse Electric Corp.
Wildberg Bros. Smelting & Refining Co.

ELECTROSTATIC PRECIPITATORS
See PRECIPITATORS, ELECTROSTATIC

ELEMENTS, HEATING

B & H Instrument Co., Inc.
Blue M Electric Co.
Carborundum Co., Refractories Div.
Cole Electric Co.
Corning Glass Works
Cox & Co., Inc.
Deon Products, Inc.
Diversey Engrg. Co.
Wilbur B. Driver Co.
Eagle Electric Mfg. Co., Inc.
Electric Heater Co., The
Electro-Flex Heat, Inc.
Electro-Tech Equipment Co.
General Electric Co., Apparatus Sales Div.
Globar Plant, Refractories Div.-The Carborundum Co.
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Hevi-Duty Electric Co.
Integrated Mica Corp.
Kanthal Corp., The
Mica Fabricating Co.
Miskella Infra-Red Co., The
Norton Co.
Precision, Inc.
Rosemount Engrg. Co.
States Co., The
Statikil, Inc., Div.-The J. E. Dayle Co.
Syntron Co.
Temperature Engrg. Corp.
Thermal Refractaries Corp.
H. I. Thompson Fiber Glass Co.
Tranter Mfg., Inc.
Waste King Corp., Technical Products Div.
Edwin L. Wiegand Co.

ELEMENTS, HEATING, CRYSTAL OVEN

American Printed Circuits Co., Inc.
Bendix Aviation Corp., York Div.
Cox & Co., Inc.
Electro-Flex Heat, Inc.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
Piasecki Aircraft Corp.
Milton Ross Metals Co., The
Telectra Industries Corp.
United States Dynamics Corp.

ELIMINATORS, STATIC
See STATIC ELIMINATORS

EMBEDDED ASSEMBLIES

Adept Industries Inc.
Advanced Electranics, Inc.
Aerolite Electronics Corp.
Airflyte Electronics Co.
American Printed Circuits Co., Inc.
Bacon Industries, Inc.
Bernco Engrg. Corp.
C & K Components, Inc.
Cleveland Metal Specialties Co., Electronics Div.
Control Circuits Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Daty Acoustica Electronic Labs.
Dresser Industries, Inc.
Edgerton, Germeshausen & Grier, Inc.
Electro-Mechanical Products Co.
Eljay Corp.
Emerson & Cuming, Inc.
Erie Resistor Corp.
Good Electronic Corp.
Green Rectifier Co.
Hamilton Standard, Div.-United Aircraft Corp.
Hardman Tool & Engrg. Co.
Houghton Laboratories, Inc.
ITT Federal Div., International Telephone & Telegraph Corp.
Joclin Mfg. Co.
La Pointe Industries Inc.
MF Electronics Co.
Metaplast Corp.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
Mutran Corp.
National Coil Co.
Networks Electronic Corp.
New York Coil Co.
Piasecki Aircraft Corp.
Precision, Inc.
Projects Unlimited Inc.
Reinhold Engrg. & Plastics Co.
Miltan Ross Metals Co., The
Telectro Industries Corp.
Tapper Mfg. Co., Inc.
Tarwica Electranics, Inc.
Transistor Electronics Corp.
Trionics Corp.
United States Chemical Milling Corp.
Virginia Electranics Co., Inc.
Warren Transformer Co., Inc.

EMBEDDED COMPONENTS

Adept Industries Inc.
Aerolite Electronics Corp.
Airflyte Electronics Co.
Americon Latex Products Corp.
Bacon Industries, Inc.
Double E Products Co.
Dresser Industries, Inc.
Edgerton, Germeshausen & Grier, Inc.
Electro-Mechanical Products Co.
Eljay Corp.
Emerson & Cuming, Inc.
Erie Resistor Corp.
Good Electronic Corp.
Green Rectifier Co.
Hamilton Standard, Div.-United Aircroft Corp.
Hardman Tool & Engrg. Co.
Houghton Laboratories, Inc.
International Resistance Co.
Metaplast Corp.
Minitron Corp.
Molding Corp. of Americo
Motorola Inc., Military Electronics Div.
Mutron Corp.
National Coil Co.
Networks Electranic Corp.
New York Coil Co.
Precision, Inc.
Reinhold Engrg. & Plastics Co.
Silicane Insulation, Inc.
Topper Mfg. Co., Inc.
Torwico Electranics, Inc.
Trionics Corp.
Unison Products, Inc.
Virginia Electronics Co., Inc.
Warren Transformer Co., Inc.

EMERGENCY LIGHTING EQUIPMENT
See LIGHTING EQUIPMENT, EMERGENCY

ENAMEL, INSULATION

George C. Borthig Co. Inc.
Dennis Chemical Co.
***DOW CORNING CORP.**
Metallizing Co. of Las Angeles Inc.
Midland Industrial Finishes Co.
Permacel
Polymer Corp., The
Vorac Co., The

ENCLOSURES, DUST

A&P Metal Products Mfg. Corp.
***AIRESEARCH MFG. CO. OF ARIZ.**
Alpitec, Inc.
Anchor Metal Spinning Co., The
Brooks & Perkins, Inc.
Delta Products Div.-Air Accessaries, Inc.
Fletcher Mfg. Co., Inc., The
Kaiser Metal Products, Inc. - Fleetwings Div.
Mid-West Metal Products, Inc.
Monogram Precision Industries
Smith-Morris Corp.
Strang Scott Mfg. Co., The
United States Rubber Co.
Waldorf Fluid Systems Div.-F. C. Huyck & Sons

ENGINE ACCESSORIES & COMPONENTS

Accessary Products Co., Div.-Textran Inc.
Actuator Products Div., Geartronics Corp.
Adel Precision Products of California, Div.-General Metals Corp.
Aero Supply Mfg. Inc.
Aerodex, Inc.
Aerojet-General Corp.
***AIRESEARCH MFG. CO. OF ARIZ.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allen Tool Corp.
American Aeraparts
American Bosch Arma Corp.
American Non Gran Branze Co.
American Standard Products, Inc.
American Tube Bending Co., Inc.
Arnolt Corp.
Astronautics Engrg. Co.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Auburn Spark Plug Co., Inc.
B G Corp., The
B. H. Aircraft Co., Inc.
Beaver Precision Products Inc.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Bendix Aviation Corp., Mantrose Div.
Bendix Aviatian Corp., Red Bank Div.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Bernco Engrg. Corp.
California Aircraft Products
***CAMERON IRON WORKS, INC.**
Capital City Mfg. Co.
Caterpillar Tractor Co., Engine Div.
Centrax Ltd., American Sales Office
Century Fasteners Corp.
Chandler Evans Corp.
Christie Machine Works
Clark-Aiken Co., The
Canax Corp.
Consolidoted Contrals Corp.
Consolidated Diesel Electric Corp.
Cummins Engine Co., Inc.
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Delco-Remy Div., General Motors Corp.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Dunbar-Kapple Inc.-Aircraft Components Div.
Dynamic Controls Corp.
Dynomic Devices, Inc.
Electric Regulator Corp.
Electrical & Mechonical Design Co.
Essex Mfg., Co., Inc.
Federol Mfg. & Engrg. Corp.
***FLEXONICS CORP., AERONAUTICAL DIV.**
Generol Electric Co., Apparatus Sales Div.
B. H. Hadley, Inc.
Hallett Mfg., Co.
Homilton Stondard, Div.-United Aircraft Corp.
***A. W. HAYDON CO., THE**
Holley Carburetor Co.
Hoover Electric Co.
Hupp Aviation Co.
Hydra-Power Corp.
***HYDRO-AIRE CO., DIV.-CRANE CO.**

Hydrodyne Corp., Skinner Seal Div.
Jack & Heintz, Inc.
Joclin Mfg. Co.
C. B. Kaupp & Sons, Inc.
Koynar Mfg. Co., Inc.
M. W. Kellogg Co., The
Kelsey-Hayes Co.
Koehler Aircraft Products Co.
Karda Industries
*LYCOMING DIV., AVCO MFG. CORP.
J. E. Menough Co.
Mercury Tool & Mfg. Corp.
Monagram Precision Industries
Natl. Water Lift Co., Div.-Clevelond Pneumotic Industries, Inc.
Ports Engrg. Co., Inc.
Pesco Products Div.-Borg-Worner Corp.
Pneu-Hydro Volve Corp.
Portland Copper & Tank Works Inc.
Reaction Motors Div., Thiokol Chem. Corp.
Reinhold Engrg. & Plastics Co.
Revere Corp. of America
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Rohr Aircraft Corp.
Ryon Aeronouticol Co.
Sargent Engrg. Corp.
Servomechanisms, Inc.
Simmonds Aerocessories, Inc.
Smith-Morris Corp.
Solar Aircraft Co.
Southwest Products Co.
Stainless Steel Products, Inc.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
A. U. Stone & Co., Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
T–C Div., Dyna-Empire, Inc.
Topco Group, Thompson-Ramo-Wooldridge Inc.
Thiokol Chemical Corp., Hunter-Bristol Div.
Turbo Products, Inc.
United Aircroft Products, Inc.
Vard Inc.
Vickers Inc., Div.-Sperry Rand
Waste King Corp., Technical Products Div.
*WEATHERHEAD CO., THE
Western Gear Corp.

IGINE BREATHERS
See BREATHERS, ENGINE

NGINE CONTROL SYSTEMS

ACF Industries Inc.
Adel Precision Products of California, Div.-General Metals Corp.
Aero Supply Mfg. Inc.
Aerojet-General Corp.
Air Logistics Corp.
*AIRESEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
American Bosch Arma Corp.
Avien, Inc.
Beaver Precision Products Inc.
*BENDIX AVIATION CORP., HAMILTON DIV.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bristol Co., The
Bulow Electric Co.
Capital City Mfg. Co.
Chandler Evans Corp.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Curtiss-Wright Corp., Reseorch Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Delco-Remy Div., General Motors Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
General Electric Co., Apparatus Sales Div.
Hamilton Standard, Div.-United Aircraft Corp.
*A. W. HAYDON CO., THE
Hoover Electric Co.
Kelsey-Hayes Co.
Karda Industries
Lear, Inc., Grand Rapids Div.
Marquardt Aircraft Co.
Morse Instrument Co., The
Pneu-Hydro Valve Corp.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Rocketdyne Div.-North American Aviation, Inc.
Sorgent Engrg. Corp.
Servomechanisms, Inc.
Simmonds Aerocessories, Inc.
Southwest Products Co.
Space Corp.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
T–C Div., Dyna-Empire, Inc.
Topco Group, Thompson-Ramo-Wooldridge Inc.
Teleflex Inc.
Twin Coach Co., Aircraft-Missiles
United Aircroft Products, Inc.
United Electric Controls Co.
Waldorf Electronics. Div.-F.C. Huyck & Sons
Waste King Corp., Technical Products Div.
Western Design, Div.-U.S. Industries, Inc., Santa Barbara Div.

IGINE CONTROL SYSTEMS, AUTOMATIC

Aerojet-General Corp.
Air Logistics Corp.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Americon Bosch Arma Corp.
Avien, Inc.
*BENDIX AVIATION CORP., HAMILTON DIV.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bendix Utico Div., Bendix Aviation Corp.
Bristol Co., The
Chondler Evons Corp.
Consolidated Controls Carp.
Consolidated Diesel Electric Corp.
Curtiss-Wright Corp.-Wright Aeronouticol Div.
Dalmotor Div., Yubo Consolidoted Industries, Inc.
Edgerton, Germeshousen & Grier, Inc.
Electric Regulatar Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
General Electric Co., Apparatus Sales Div.
Homilton Standord, Div.-United Aircraft Corp.
*A. W. HAYDON CO., THE
Holley Carburetor Co.
Hoover Electric Co.
Kordo Industries
Morquardt Aircraft Co.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Pneu-Hydro Volve Corp.
Reaction Motors Div., Thiokol Chem. Corp.
Rocketdyne Div.-North American Aviation, Inc.
Ryan Aeronautical Co.
Sargent Engrg. Corp.
Servomechanisms, Inc.
Southwestern Industrial Electronics Co.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Topco Group, Thompson-Ramo-Wooldridge Inc.
Twin Coach Co., Aircroft-Missiles
United Aircraft Products, Inc.
United Electric Controls Co.
Waldorf Electronics. Div.-F.C. Huyck & Sons
Waste King Corp., Technical Products Div.

ENGINE CONTROLS, MECHANICAL & VACUUM

ACF Industries Inc.
Aero Supply Mfg. Inc.
Aerojet-General Corp.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Americon Bosch Arma Corp.
Applied Dynamics Corp.
Arens Controls, Inc.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Atlas Precision Products, Co.
*BENDIX AVIATION CORP., HAMILTON DIV.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bristol Co., The
Capital City Mfg. Co.
Chandler Evans Corp.
Components Corp.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Hamilton Standard, Div.-United Aircraft Corp.
Holley Carburetor Co.
Hoover Electric Co.
*HYDRO-AIRE CO., DIV.-CRANE CO.
Marquardt Aircraft Co.
Morse Instrument Co., The
Pocific Scientific Co.
Sargent Engrg. Corp.
Simmonds Aerocessories, Inc.
Southwest Products Co.
Southwestern Industrial Electronics Co.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
United Aircraft Products, Inc.
United Electric Controls Co.
Vard Inc.
Waldorf Fluid Systems. Div.-F.C. Huyck & Sons
Waste King Corp., Technical Products Div.
Western Gear Corp.

ENGINE MOUNTS
See MOUNTS, ENGINE

ENGINE STARTERS, GAS TURBINE
See STARTERS, GAS TURBINE ENGINE

ENGINE STARTERS, ROCKET
See STARTERS, ROCKET ENGINE

ENGINE STARTING SYSTEMS & CONTROLS, GAS TURBINE ENGINE

Accessory Products Co., Div.-Textron Inc.
Aerojet-General Corp.
*AIRESEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
American Bosch Arma Corp.
Avien, Inc.
Bendix Aviation Carp., Red Bank Div.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bendix Utico Div., Bendix Aviotion Corp.
Capital City Mfg. Co.
Chandler Evons Corp.
Christie Machine Works
Consolidated Diesel Electric Corp.
Consolidated Diesel Electric Corp., Western Div.
Curtiss-Wright Corp.-Santa Barbara Div.
Curtiss-Wright Corp.-Utica Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Delco-Remy Div., General Motors Corp.
Dresser Industries, Inc.
Electric Regulotor Corp.
General Electric Co., Apparotus Soles Div.
Hamilton Standard, Div.-United Aircraft Carp.
Hoover Electric Co.
Hughes Tool Co., Aircraft Div.
*HYDRO-AIRE CO., DIV.-CRANE CO.
Jack & Heintz, Inc.
Lear, Inc., Grand Rapids Div.
George L. Nonkervis Co.
Northeastern Engrg. Inc.
Perfection Industries, Div.-Hupp Corp.
Pre-Flite Industries Corp.-Sub. – Avco Corp.
Rondall Engrg. Corp.
Sargent Engrg. Corp.
Solar Aircraft Co.
Southwestern Industrial Electronics Co.
Spoce Corp.
Standord-Thomson Corp., Clifford Mfg. Co. Div.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Topco Group, Thompson-Ramo-Wooldridge Inc.
Varo Mfg. Co., Inc.
Vickers Inc., Div.-Sperry Rand
Waldorf Fluid Systems. Div.-F.C. Huyck & Sons
Watertown Div., The New York Air Broke Co.
Western Gear Corp.
Weston Hydraulics Ltd.-Sub., Borg-Worner Corp.

ENGINE-COOLING RADIATORS
See RADIATORS, ENGINE–COOLING

ENGINES

a. Auxiliary Jet
b. Auxiliary Rocket
c. Diesel
d. Gas Turbine
e. Nuclear Rocket
f. Nuclear Turbine
g. Pulse Jet
h. Ramjet
i. Rocket
j. Rocket, Liquid
k. Rocket, Solid

ACF Industries Inc., e.
Aerojet-General Corp., b, i, j, k.
Aerolab Development Co., k.
*AIRESEARCH MFG. CO. OF ARIZ., c, e.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, d.
Alco Products, Inc., c, e, k.
Allied International Co., c.
Allis-Chalmers, c.
American Rocket Co., a, j, k.
Arde-Portland, Inc., k.
Astrodyne, Inc., b, k.
Atlantic Research Corp., b, i, k.
Bell Aircraft Corp., Niagara Frontier Div., a, b, i, j, k.
Bridgeport Brass Co., i, k.
Caterpillar Tractor Co., Engine Div., c.
Chicago Pneumatic Tool Co., c.
Christie Machine Works, d, j, k.
Continental Aviation & Engrg. Corp., a, c, d, h.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., b, i, k.
Cooper-Bessemer Corp., The, c.
Cummins Engine Co., Inc., c.
Curtiss-Wright Corp., Research Div., d thru h.
Curtiss-Wright Corp., Santa Barboro Div., d.
Curtiss-Wright Corp., Utica Div., c, d.
Curtiss-Wright Corp., Wright Aeronautical Div., a, b, d, e, h, i, j.
Detroit Diesel Engine Div.-General Motors Corp., c.
Diversey Engrg. Co., a, b, d, e, f, h thru k.
Dresser Industries, Inc., c, d.
Dynamic Devices, Inc., b, h thru k.
Edgerton, Germeshausen & Grier, Inc., e, f.
Food Machinery & Chemical Corp., h thru k.
Fulton-Irgon Corp., The, b, i, j, k.
General Electric Co., Apparatus Sales Div., a, b, d, f, h thru k.
Giannini Plasmadyne Corp.
Hicks Corp., The, i.
Hoover Electric Co., c, d.
Hughes Tool Co., Aircraft Div., a, b, d, h.
Intercontinental Mfg. Co., Inc., a, k.
Kaiser Metal Products, Inc. – Fleetwings Div., a, b, h thru k.
M. W. Kellogg Co., The, a, b, g thru k.
Kennedy Van Saun Mfg. & Engrg. Corp., k.
*LYCOMING DIV., AVCO MFG. CORP., d.
Mack Trucks, Inc., Government Div., c.
Marquardt Aircraft Co., h.
*MC CORMICK SELPH ASSOCIATES, b, i, k.
Newbrook Machine Corp., a, b, i, j, k.
Nordberg Mfg. Co., c.
Norris-Thermador Corp., b, h, k.
Oerlikon Tool & Arms Corp. of America, k.
Olin Mathieson Chemicol Corp., Energy Div., k.
Oliver Corp., The, c.
D. W. Onan & Sons Inc., c.
Parts Engrg. Co., Inc., j, k.
Patterson, Moos Div. – Universal Winding Co., Inc., c.
Pressed Steel Tank Co., a, b, i, k.
*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP., k.
Reaction Motors Div., Thiokol Chem. Corp., b, i, j, k.
Red Lion Cabinet Co., Redco Tool Div., k.
C. F. Roark Welding & Engrg. Co., Inc., f.

Rocketdyne Div.-North American Aviation, Inc., b, e, i, j.
Rohm & Haas Co., Redstone Arsenal Research Div., b, i, k.
Solar Aircraft Co., d, i.
Southwestern Industrial Electronics Co.
Special Projects Lab., Food Machinery & Chemical Corp., b, i, j.
Stanley Aviation Corp., i, j.
Strong Scott Mfg. Co., The, j.
Thiokol Chemical Corp., a, b, e, f, i, j, k.
Topper Mfg. Co., Inc., k.
Universal Moulded Products Corp., a, b, h thru k.
Veet Industries, j.
Western Arc Welding, Inc., k.
Westinghouse Electric Corp., d.
Wheland Co., The, k.
*WHITE DIESEL ENGINE DIV., THE WHITE MOTOR CO., c.
Wilks Precision Instrument Co., Inc., k.

ENVIRONMENTAL TEST CHAMBERS
See TEST CHAMBERS, ENVIRONMENTAL

EXCITERS, FIELD
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
Green Rectifier Co.
Heinz Mueller Eng. Co. Inc.

EXHAUST ASSEMBLIES
Aircraft Precision Products, Inc.
American Agile Corp.
American Machine & Foundry Co., Government Products Group
American Tube Bending Co., Inc.
Anaconda Metal Hose Div., The American Brass Co.
Anchor Metal Spinning Co., The
Associated Engrg. & Mfg. Corp.
B. H. Aircraft Co., Inc.
*BEATON & CORBIN MFG. CO., THE
Benson Mfg., Co., The
Colonial Aircraft Corp.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dresser Industries, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
*FLEXONICS CORP., AERONAUTICAL DIV.
Hanlon & Wilson Co., The
Hufford Corp., The
Hupp Aviation Co.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kaiser Metal Products, Inc. – Fleetwings Div.
M. W. Kellogg Co., The
Kelsey-Hayes Co.
Mercury Tool & Mfg. Corp.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
Norton Co., New Products Dept.
Parts Engrg. Co., Inc.
Penn-Michigan Mfg. Corp.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.
Red Lion Cabinet Co., Redco Tool Div.
Edw. Renneburg & Sons Co.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
C. F. Roork Welding & Engrg. Co., Inc.
Rohr Aircraft Corp.
Ryan Aeronautical Co.
Smith-Morris Corp.
Solar Aircraft Co.
Stainless Inc.
Stainless Steel Products, Inc.
Stalker Corp., The
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Task Corp.
Turbo Products, Inc.
Twigg Industries
Twin Coach Co., Aircraft-Missiles
Union Asbestos & Rubber Co.
United Aircraft Products, Inc.
Waste King Corp., Technical Products Div.
Wilks Precision Instrument Co., Inc.

EXHAUST CONES
See CONES, EXHAUST

EXHAUST CONES, GAS TURBINE ENGINE
Aircraft Mechanics, Inc.
Aircraft Precision Products, Inc.
Anchor Metal Spinning Co., The
B. H. Aircraft Co., Inc.
Benson Mfg., Co., The
Christie Machine Works
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp., Santo Barbara Div.
Diversey Engrg. Co.
Dresser Industries, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
Fletcher Mfg. Co., Inc., The
Hanlon & Wilson Co., The
Hoveg Industries, Inc.
Hupp Aviation Co.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kaiser Metal Products, Inc. – Fleetwings Div.
M. W. Kellogg Co., The
Kelsey-Hayes Co.
Lodish Co.
*LAVELLE AIRCRAFT CORP.
Lodge & Shipley Co., The
Mercury Tool & Mfg. Corp.
National Beryllio Corp.
Newbrook Machine Corp.
Norton Co., New Products Dept.
Parts Engrg. Co., Inc.
Penn-Michigan Mfg. Corp.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
C. F. Roark Welding & Engrg. Co., Inc.
Ryan Aeronautical Co.
Silicone Insulation, Inc.
Smith-Morris Corp.
Solar Aircraft Co.
Stainless Steel Products, Inc.
Thermal Refractories Corp.
C. W. Torngren Co., Inc.
Turbo Products, Inc.
Twigg Industries
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
Westinghouse Electric Corp.

EXHAUST
a. Ducts
b. Heat Exchangers
c. Muffs
d. Stacks
e. Systems

Aeronca Mfg. Corp., a, b.
Aeroscience, Inc.
Aircraft Mechanics, Inc., a, d.
Aircraft Precision Products, Inc., a thru d.
*AIRESEARCH MFG. CO. DIV.-THE GARRETT CORP., b.
American Air Filter Co., Defense Products Div., b.
American Machine & Foundry Co., Government Products Group, a.
American Tube Bending Co., Inc., d.
Anaconda Metal Hose Div., The American Brass Co., a.
Anchor Metal Spinning Co., The, a, d.
B. H. Aircraft Co., Inc., a.
Basic Tool Industries, Inc., a, b, c.
*BEATON & CORBIN MFG. CO., THE, a.
Benson Mfg., Co., The, a, c, d.
Blowers Inc., e.
Byrne Doors Inc., a, d.
California Aircraft Products, a, b.
Carmac Aviation, a, c, d, e.
Christie Machine Works
Colonial Aircraft Corp., a thru e.
Cromer Mfg. & Engrg., Inc., a, c, d.
Curtiss-Wright Corp., Research Div., a, b, c.
Dean Products, Inc., b.
Diversey Engrg. Co., a thru d.
Doyle & Roth Mfg. Co., Inc., b.
Dresser Mfg. Div., Dresser Industries, Inc., a thru e.
Dunbar-Kapple Inc.-Aircraft Components Div., a.
Eastern Industries Inc., b.
Finn Aeronautical Div., T. R. Finn & Co., Inc., a.
Fletcher Mfg. Co., Inc., The, a.
Flexible Metal Hose Mfg. Co., a.
*FLEXONICS CORP., AERONAUTICAL DIV., a.
Griscom-Russell Co., The, b.
Hanlon & Wilson Co., The, a thru e.
Hoveg Industries, Inc., a thru e.
Hewitt-Robins, Inc., a.
Ludwig Honold Mfg. Co., a.
Houston Fearless Corp., a, b.
Hupp Aviation Co., a thru e.
Intercontinental Mfg. Co., Inc., a.
*JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP., a, b, e.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., a thru e.
Kentucky Metal Products Co., a.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc., a.
Lamtex Industries, Inc., a.
*LAVELLE AIRCRAFT CORP., a.
Mercury Tool & Mfg. Corp., a thru d.
Minnesota Mining & Mfg. Co., a.
Monogram Precision Industries, a thru d.
Narmco Mfg. Co., a.
National Beryllio Corp., b.
Newbrook Machine Corp., a thru d.
Opelika Welding, Machine & Supply Inc., a thru d.
Orchard Industries, Inc., Actionflex Div., a.
Parts Engrg. Co., Inc., a, d, e.
Penn-Michigan Mfg. Corp., d, e.
Portland Copper & Tank Works Inc., a.
Precision Sheet Metal, Inc., a.
Project Fabrication Corp., b.
Red Lion Cabinet Co., Redco Tool Div., b.
Reinhold Engrg. & Plastics Co., a.
Edw. Renneburg & Sons Co., a thru e.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV., d, e.
C. F. Roork Welding & Engrg. Co., Inc., a, b.
Ryan Aeronautical Co., a thru e.
Silicone Insulation, Inc., a.
Smith-Morris Corp., a thru d.
Solar Aircraft Co., a thru e.
South Wind Div., Stewart Warner Corp., b.
Stainless Inc., a, d.
Stainless Steel Products, Inc., a, c, d, e.
Standard-Thomson Corp., Clifford Mfg. Co., Div., a, b.
Task Corp., b.
Teiner Engrg. Corp., a, b.
Thompson Engrg. Co., The, Missile Products Div., b.
Trane Co., The, b.
Twigg Industries, a, b, c.
Twin Cooch Co., Aircraft-Missiles, a, b, d.
United Aircraft Products, Inc., a, b.
Universal Metal Products Inc., a, d.
Waste King Corp., Technical Products Div., a thru e.
Western Iron & Foundry Co., Inc., d.

EXPLOSIVE BOLT CARTRIDGES
See BOLT CARTRIDGES, EXPLOSIVE

EXPLOSIVE METAL FORMING & SIZING
*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.

EXPLOSIVE RIVETS
See RIVETS, EXPLOSIVE

EXPLOSIVES, METAL FORMING
*AMERICAN POTASH & CHEMICAL CORP.

EXTENSIONS, SHAFT
Actuator Products Div., Geartronics Corp.
Amatom Electronic Hardware Co. Inc.
Capital City Mfg. Co.
Diversey Engrg. Co.
Hoover Electric Co.
Vard Inc.

EXTRUSIONS, METALLIC
Adam Metal Supply Inc.
Allegheny Ludlum Steel Corp.
Aluminum Co. of America
American Aeroparts
American Brass Co., The
Bram Metallurgical & Chemical Co.
*CAMERON IRON WORKS, INC.
Chase Brass & Copper Co., Inc.
Curtiss-Wright Corp., Research Div.
Division Lead Co.
Dow Chemical Co., The
Etched Products Corp.
H. M. Harper Co.
Harvey Aluminum
Hufford Corp., The
International Nickel Co., The
Kaiser Aluminum & Chemical Sales, Inc.
Ladish Co.
Mueller Brass Co.
National Tube Div.,-United States Steel Corp.
Norris-Thermador Corp.
Precision Shapes, Inc.
Pressed Steel Tank Co.
Standard Metals Corp.
Teiner Engrg. Corp.
Titanium Metals Corp. of America
Tube-Turns Div., Chemetron Corp.

EXTRUSIONS, NON-METALLIC
Allied Plastics Supply Corp.
American Aeroparts
American Agile Corp.
Auburn Mfg. Co., The
Centralab, Div.-Globe-Union
Chemplast, Inc.
Continental Rubber Works
Curtiss-Wright Corp., Research Div.
Electrical Refractories Co., The
Emerson Plastics Corp.
Gladding, McBean & Co.
Huntington Rubber Mills
Isolantite Mfg. Corp.
Jessall Plastics
Jodee Plastics Co.
Luzerne Rubber Co.
M & Q Plastic Products
Metals & Controls Corp., General Plate Div.
Minnesota Mining & Mfg. Co.
National Beryllia Corp.
National Tube Div.,-United States Steel Corp.
New England Tape Co., Div.-United-Carr Fastener Corp.
Norton Co.
Norton Co., New Products Dept.
Ohio Carbon Co., The
Polymer Corp., The
Raybestos-Manhattan, Inc.
Resistoflex Corp.
Roberts Toledo Rubber Co., The
Milton Ross Metals Co., The
Rubbercraft Corp. of California
Saylor Electric Products Corp.
Schlegel Mfg. Co.
Sporto Mfg. Co., Div.-U. S. Ceramic Tile Co.
Taylor Electric Inc.
Thermal Refractories Corp.
Turbo Products, Inc.
United States Rubber Co.
Wilmington Fibre Specialty Co.
Yardley Plastics Co.

EYELETS
Abbott Screw & Mfg. Co.
Aloc, Inc.
Amatom Electronic Hardware Co. Inc.
American Brass Co., The

Eyelet Tool Co. Inc.
Foe Engrg. Co.
. E. Menough Co.
Prospect Screw Machine Products
Edward Segal
Stanley-Judd Div.-The Stanley Works
Staver Co., Inc., The
Edwin B. Stimpson Co., Inc.
Sylvonia Electric Products Inc., Ports Div.
United Minerol & Chemical Corp.
United Shoe Machinery Corp., Ordnonce Dept.
Waterbury Companies, Inc.
Waterbury Pressed Metal Co., The

FABRICATORS, POWDERED METAL PARTS

Aluminum Co. of America
American Aeroports
Bassick Co., The, Div.-Stewart-Worner
Bergen Carbide Co.
Curtiss-Wright Corp., Research Div.
Delta Chemicol Works, Inc.
Double E Products Co.
Engelhard Industries, Inc.
Globe Industries, Inc., Supermet Div.
Gordon Enterprises
Monogram Precision Industries
Motorolo Inc., Military Electronics Div.
Buckle Mfg. Co.
Mueller Brass Co.
Raybestos-Manhattan, Inc.
Raybestos-Manhatton, Inc., Po.
Schw. Renneburg & Sons Co.
S. Morys Corbon Co.
Seamless Products Co., Inc.
Specialty Engrg. & Electronics Co.
Sylvanio Electric Products Inc., Chemicol & Metallurgicol Div.
United Mineral & Chemicol Corp.

FACSIMILE RECORDING PAPER
See PAPER, FACSIMILE RECORDING

FANS

AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
American Aeroports
American Agile Corp.
American Air Filter Co., Defense Products Div.
Ashland Electric Products, Inc.
Bensan Mfg., Co., The
Borage Fan Co.
Buppus Engrg. Corp.
Dean & Benson Reseorch, Inc.
Dehl Mfg. Co.
Garden City Fon Co.
Hoover Electric Co.
IG Electric Ventilating Co.
Ivy Mfg. Co.
Joppers Co., Inc.
J-Lean Engrg. Laboratories
Monogram Precision Industries
Kinz Mueller Eng. Co. Inc.
Peerless Electric Co., The
Pesco Products Div.-Borg-Warner Corp.
Schw. Renneburg & Sons Co.
Stran Mfg. Co.
Torrington Mfg. Co. inc., The, Specialty Blower Div.
Western Design, Div.-U.S. Industries, Inc., Sonta Borbara Div.

FANS, TURBO
See TURBO FANS

FASTENERS

a. Blind
b. Cowl
c. Self-Locking
d. Slide
e. Snap

Abbott Screw & Mfg. Co.
Adam Metal Supply Inc., a.
Adams Rite Mfg. Co., b.
Aero Bolt & Screw Co., Inc., c.
Aero Leather Products Co., e.
Allen Mfg. Co.
Ametal Screw Products Co., Inc., c.
Americon Aeroports, a thru e.
Americon Screw Co., b.
Americon Standard Products, Inc., a thru e.
Anti-Corrosive Metal Products Co., Inc., c.
Auto-Valve Inc., a, b, c.
Bost Aircroft Corp., a thru e.
Bond Burner Co., The, b.
Bots Aircroft Nut Corp., a, c.
Brush Nail Expansion Bolt Co., a, c.
Brooklyn Co.
Cadinoy-Div.-Illinois Tool Works, a thru e.
Cincar Screw & Mfg. Co., Div.-Textron Industries, Inc., b.
Cinloc Fastener Corp., b, c.
Cosewell Mfg. Co., e.
Cramac Aviotion
Century Fasteners Corp., b, e.
Case Brass & Copper Co., Inc.
Chicago Screw Co., The, Div.-Standord Screw Co.
Chmar Products Corp., d.
Continentol Screw Co., c.
Cubin Products Div., c.
Dutsch Fastener Corp., a, b, d.
Elco-Gray Co., c.
R. C. Dudek & Co., a, c.
Eaton Mfg. Co., c.
Eaton Mfg. Co., Reliance Div., c, e.
Elostic Stop Nut Corp. of America, a, b, c.
Fasteners, Inc., c.
Federal Screw Products Inc., a.
George K. Garrett Co., Inc., c.
General American Transportation Corp.
B. F. Goodrich Aviation Products, a, d.
Groov-Pin Corp., a, c.
H. M. Harper Co.
*HARTFORD MACHINE SCREW CO., DIV.-STANDARD SCREW CO.
Heli-Coil Corp., c.
HI-Shear Rivet Tool Co., a, c.
Huck Mfg. Co., a, c.
Jacobson Nut Mfg. Corp., c.
Kaynor Mfg. Co., Inc., e.
Klincher Locknut Corp., c.
H. Koch & Sons, c.
Lion Fastener Co., Inc., b, c.
Lucas Aircroft Supply Co., a thru e.
Monogram Precision Industries, a thru e.
Notional Lead Co.
National Screw & Mfg. Co., The, a, c.
Nelson Stud Welding, Div.-Gregory Industries, Inc., e.
D. W. Price Corp., c.
Republic Steel Corp., c.
Rosan, Inc., a thru e.
Schlegel Mfg. Co., c, d.
Scovill Mfg. Co., b, d, e.
Servwell Products Co., c.
Shur-Lok Corp., c.
Simmons Fastener Corp., a, b, c.
Southco Div., South Chester Corp., a, b, c.
Standard Locknut & Lockwasher Inc., c.
Standard Pressed Steel Co., a, c.
Stanley-Judd Div.-The Stanley Works, a thru e.
Star Expansion, a.
Stic-Klip Mfg., Co., c.
Edwin B. Stimpson Co., Inc., d, e.
TA Mfg. Corp., a.
Talon, Inc., d.
Tinnerman Products, Inc., a, b, c.
*TOWNSEND CO., CHERRY RIVET DIV., a, c.
United States Chemicol Milling Corp., a, b, d.
United Supply Co., a thru d.
Woldes Kohinoor, Inc., b thru e.
Waldom Electronics Inc.
Waltham Precision Instrument Co., c.
Waterbury Pressed Metal Co., The, c.
Zippertubing Co., The, d.

FEED SYSTEMS

Ainslie Corp.
Americon Machine & Foundry Co., Greenwich
Associated Engineers, Inc.
Chondler Evans Corp.
Diamond Antenna & Microwove Corp.
Dresser Mfg. Div., Dresser Industries, Inc.
Eyelet Tool Co. Inc.
Radiotronics, Inc.
Teiner Engrg. Corp.
Telerad Mfg. Corp.

FEED SYSTEMS, ANTENNA
See ANTENNA FEED SYSTEMS

FEEDERS, ASSEMBLERS
See ASSEMBLERS, FEEDERS

FIBRE GROMMETS
See GROMMETS, FIBRE

FIELD EXCITERS
See EXCITERS, FIELD

FILES

Barrett-Christie Co.
Bergen Carbide Co.
Deluxe Metal Products Co.
Handicroft Tools, Inc., Div.-X-Acto, Inc.
Simonds Saw & Steel Co.

FILM, MAGNETIC STRIPE

Bell & Howell Co.
Eastman Kodok Co.
Minnesoto Mining & Mfg. Co.
Vitro Labs.

FILMS, CAPACITOR

Aerovox Corp.
Allied Plastics Supply Corp.
Continental Diamond Fibre Corp.
Dilectrix Corp.
Double E Products Co.
E. I. Du Pont De Nemours & Co. Inc.
Mica Fabricating Co.
Natvar Corp.
Permacel
Topco Group, Thompson-Romo-Wooldridge Inc.
Vitro Labs.

FILMS, PLASTIC FOR WOUND INSULATION

*ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.
Chemplast, Inc.
Continentol Diomond Fibre Corp.
Dilectrix Corp.
E. I. Du Pont De Nemours & Co. Inc.
Franklin Fibre-Lamitex Corp.
Joclin Mfg. Co.
Mico Fabricoting Co.
Minnesota Mining & Mfg. Co.
Orbitron Co., Inc.
Permocel
Picker X-Ray Corp.
Polyken Sales Div., The Kendall Co.
Polymer Corp., The
Sanford Plastics Corp.
Sparta Mfg. Co., Div.-U.S. Ceromic Tile Co.
Turbo Products, Inc.
United States Rubber Co.

FILTERS

a. Air
b. Antenna
c. Audio
d. Band Elimination
e. Band Pass
f. Continuously Variable
g. Crystal
h. Detonation
i. Electric
j. Electric Wave Sectian
k. Equalizer
l. Fuel & Oil
m. High Pass
n. Hydraulic
o. IF
p. Interference
q. Line
r. Law Pass
s. Measurement
t. Mechanical
u. Microwave
v. Needle Scratch
w. Noise Suppressing
x. Optical
y. Pneumatic System
z. Polarizing
a1. Radia
b1. Radia Noise
c1. Radia Range
d1. Radia Tower Lighting
e1. RF
f1. Telemetering
g1. UHF & VHF
h1. Vacuum System
i1. Variable Electronic
j1. Vestigial Sideband
k1. Wave Trap

ACF Industries Inc., a, l, n. y.
Accessory Products Co., Div.-Textron Inc., a, l, n.
Actuotion Reseorch Corp.
R. P. Adams Co., Inc., a, y.
Adler Electronics, Inc., b, d, e, m, r, u, g-1.
Aero Supply Mfg. Inc., a, l, n.
Aerovox Corp., c, d, h, i, j, m, o, q, r, c-1, e-1.
Air Filter Corp., a.
Airoterra, l, n.
Airborne Accessories Corp., i, w, b-1.
Aircom Inc., b, u.
Aircroft Porous Medio, Inc., a, l, n, y.
*AIRESEARCH MFG. CO. OF ARIZ., v, b-1.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., b-1.
Air-Maze Corp., a, l, n, t, y.
Airtron Inc., Div.-Litton Industries, u.
Airtronics International Corp., d, e, m, r.
Alford Mfg. Co., r, j-1.
R. C. Allen Aircroft Instr. Div., R. C. Allen Bus. Mochines, Inc., b-1.
Allied Witan Co. Inc., a.
Allison Labs., c thru f, m, r.
All-Tronics, Inc., p, w, b-1, e-1.
Alsop Engrg. Corp., l, n.
Alto Scientific Co., Inc., d, e, o, e-1, g-1.
Amelco, Inc., e.
Amerac Inc., u.
American Aeroports, a, b, l, n, o-1, b-1.
American Air Filter Co., Defense Products Div., a.
American Bosch Arma Corp., l, w, b-1, e-1.
American Electronics, Inc., t.
Americon Electronics, Inc., Toller & Cooper Div., f-1.
American Mochine & Foundry Co., Government Products Group, b, n.
American Missile Products Co., Inc., f-1.
American Optical Co., Instrument Div., x.
Andrew Corp., b.
Antenno & Radome Research Associates, u, e-1.
Astron Corp., e, m, p, r, w, b-1, e-1.
Atlantic Reseorch Corp., x.
Audio Development Co., c, d, e, i, j, k, m, r, w, f-1.
Automation Dynamics Corp., f-1.
Axel Electronics, i, p, q, r, w, o-1, b-1, e-1.
Axler Associates Inc., p.
B & K Instruments, Inc., c, e.
Borker Sales Co., f-1, g-1, i-1, j-1, k-1.
Borker & Williamson Inc., b thru e, j, m, r, o-1, e-1, f-1, k-1.
Bornebey-Cheney Co., a.
Barrett-Christie Co., a, y.
*BAUSCH & LOMB OPTICAL CO., x, z.
Beoch-Russ Co., h-1.
Bendix Filter Div., Bendix Aviation Corp., a, l, n, q, t, y.
Bendix-Pacific Div., Bendix Aviotion Corp., e, r, f-1.
Bendix Utica Div., Bendix Aviation Corp., a, l, n, y.
Blonder-Tongue Labs., Inc., c thru f, q, r, w, o-1, b-1, e-1, g-1, i-1.
Bogort Mfg. Corp., u.

Bawser, Inc., Defense Dept., l, n, s, t, y.
Briggs Associates, Inc., e.
Briggs Filtration Co., The, a, l, n.
Budd Stanley Co. Inc., u.
Buhl Optical Co., x.
Bulova Watch Co., Electronics Div., d, e, g, m, o, p, r, s, w, a-1, b-1, c-1, e-1, f-1, j-1.
Burnell & Co., Inc., c, d, e, g, j, k, m, o, r, f-1, j-1, k-1.
Cable Electric Products Inc., l.
Combridge Filter Corp., a, h-1.
Carruthers & Fernandez, Inc., c, e, q, r.
Celco (Constantine Engrg. Labs. Co.) a thru j, l, n thru q.
Centronix Inc., c, f-1.
Chicago Electronic Engrg. Co., Inc., e, r.
Chicago Standard Transformer Corp., c, d, e, m, r.
Christie Machine Works, l, n.
Cinema Engrg., c, e.
David Clark Co., Inc., w.
Clippard Instrument Lab., Inc., b, o, r, e-1.
Coil Co. of America, c.
Collins Radio Co., b thru e, t, u, d-1.
Commercial Filters Corp., a, l, n, t, y.
Communications Research Co., b, f-1.
Conoflow Corp., o, y.
Consolidated Diesel Electric Corp., l, n, y.
Consolidated Diesel Electric Corp., Test Equip. Div., n, y.
Coppus Engrg. Corp., o.
Cornelius Co., The, Aero Div., y.
Cornell-Dubilier Electric Corp., b thru f, m, o thru r, w, a-1, b-1, e-1.
Corning Gloss Works, l, x.
Cuno Engrg. Corp., The, a, l, n, t, y.
Curtiss-Wright Corp., Research Div., f-1.
D. & R. Ltd., c, e, m, r.
Data-Control Systems, Inc., e, r, f-1.
Daven Co., The, c, d, e, g, m, o, r, e-1.
Dayton Aviation Radio & Equipment Corp., a, b-1, e-1, g-1.
Dayton Rubber Co., The, o, k.
Demornay-Bonardi, e, u.
Denison Engrg. Div., American Brake Shoe Co., n.
Diamond Antenna & Microwove Corp., b, e, g, r, u.
Dietz Design & Mfg. Co., c, d, e, i, j, k, m, o thru s, v, w, a-1, b-1, c-1, e-1, f-1, g-1, j-1, k-1.
Donner Scientific Co., c.
Double E Products Co., b thru e, m, o thru s, u, w, a-1, b-1, c-1, e-1, g-1, k-1.
Douglas Microwave Co., Inc., e, r, u.
Dresser Industries, Inc., c, d, e, i, j, m, p, q, r, f-1.
Dresser Mfg. Div., Dresser Industries, Inc.
Dumont Aircraft Fitting Co., i, n, t, y.
Dynamic Filters Inc., a, l, n, q, t.
Dynomics Instrumentation Co., Div.-Alherhill Corp., j-1.
Dytronics Co., c, e, f.
ESC Corp., d, e, i, j, k, r, f-1.
Eastman Kodak Co., p, x, z.
Edmund Scientific Co., x, z.
Electricol Windings, Inc., c.
Electro-Mechanical Products Co., b, f-1.
Electro-Mechanicol Research, Inc., e, r, f-1.
Electron Products Co., p, b-1.
Electronic Communications, Inc., b, f, p, u, b-1, e-1, g-1, i-1.
Electronic Research Associates, Inc., r, b-1.
Electronic Specialty Co., d, e, r, t, g-1.
Electronic Transformer Co., Inc., b thru e, r.
Emerson Radio & Phonograph Corp., e, p, u, a-1, e-1, g-1.
Empire Products Sales Corp., d, e, r, u, g-1.
Entron, Inc., b, d, e, f, k, m, e-1, g-1, k-1.
FXR, Inc., e, u, e-1, g-1.
J. W. Fecker, Inc., x.
Ferrotran Electronics Co., Inc., d, e, i, o, r.
Filtron Co., Inc., b, d, e, i, m, o thru r, u, w, a-1, b-1, e-1, g-1.
Fisher Governor Co., o.
Fisher Scientific Co., h-1.
Fish-Schurmon Corp., p, x.
Flow Corp., r.
Forbes & Wagner, Inc., c, d, e, m, r, e-1.
Foster Transformer Co., c, d, e, m, q, r.
Foto-Video Labs., Inc., e.
Fram Corp., o, l, n, q, x.
Freed Transformer Co. Inc., c, d, e, i, k, m, p, r, c-1, f-1.
Fugle-Miller Labs. Inc., d, e, j, m, o, r, e-1, k-1.
Gabriel Co., The, Gabriel Electronics Div., b, u, g-1.
Gardner-Denver Co., o, y.
General Devices, Inc., f-1.
General Filters, Inc., l, n.
Genistron, Inc., c, m, p, q, r, w, b-1, e-1.
Geotronic Labs. Inc.,c, d, e, i, j, q.
Gits Brothers Mfg. Co., o.
John Gombos Co., Inc., u.
Gordon Enterprises, x.
Gray Co., Inc., o, q.
Green Rectifier Co., r, x.
Greer Hydraulics, Inc., n.
Grimes Mfg. Co., x.
Gulton Industries, Inc., r.
Gyrex Corp., The, c, t.
Hagan Chemicals & Controls, Inc., o, l.
Hallamore Electronics Co., f-1.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co., b, d, e, e-1.
Hallett Mfg., Co., p, b-1.
Hallicrafters, b, e-1, j-1.
Hammorlund Mfg., Co., Inc., c, d, e, m, r.
Hannifin Co., Div.-Parker-Hannifin Corp., y, h-1.
Harman Equipment Co., o, l, n, y, h-1.
Haskel Engrg. & Supply Co., o, l, n, y.
Haveg Industries, Inc., o.
Hayward Scientific Glass Corp., x.
Herlo Engrg. Corp.
Hewlett-Packard Co., e, r, s.
High Vacuum Equipment Corp., h-1.
Hill Electronics, Inc., c, d, e, g, i, m, o, p, r, w, e-1, f-1.
Hoke, Inc., q.
Hoover Electric Co., b-1, e-1.
Hughes Aircraft Co., g.
Hughey & Phillips, Inc., d-1.
Walter J. Hyatt Co., The, o, b, l, n, u, y, k-1.
Hydrodyne Corp., Skinner Seal Div., o, l, n, y.
ITT Federal Div., International Telephane & Telegraph Corp., b, u, e-1.
Imperial Brass Mfg. Co., The, l.
Instruments for Industry, Inc., b, d, e, i, j, k, m, o, p, r, o-1, b-1, e-1, f-1, g-1.
Interference Measurement Lobaratary, Inc., p, q, r, w, b-1.
International Research & Development Corp., f, i-1.
JFD Electronics Corp., d, e, m, e-1, f-1, g-1.
J–V–M Microwove Co., d, r, u.
Jonsky & Bailey, Inc., b-1.
Johnson Electronics Inc., d, n, p, q, z, e-1.
Kahn & Co., Inc., o, l, t, y.
Kauke & Co., r.
***KEARFOTT CO., INC., MICROWAVE DIV.**, e, u, e-1.
D. S. Kennedy & Co., b, u, z.
Kentucky Metal Products Co., b-1.
Keystone Products Co., c, d, e, i, j, m, r, k-1.
Kinney Mfg. Div., The New York Air Brake Co., h-1.
Koehler Aircraft Products Co., o, l, n, y.
Kopp Glass, Inc., x, d-1.
Lancaster Gloss Corp., x.
Land-Air Inc., c-1, f-1, i-1.
Langevin Div., W. L. Maxson Corp., The, c, d, e.
Lear, Inc., b thru e, m, r, f-1, g-1.
Lear, Inc., Grand Rapids Div., b, d, p, b-1.
Warner Lewis Co., Div.-Fram Corp., l, n.
Librascope Inc., p, x.
Lieco, Inc., u.
Ling Electronics, Inc., r.
Litton Industries, Inc., f-1.
Litton Industries, Maryland Div., b, d, e, m, r.
Livingston Electronic Corp., o.
Lynch Corrier Systems Inc., d, e, j, k, m, q, r, f-1.
Magnavox Co., The, g-1.
Marvel Engrg. Co., l, n.
Mason-Neilan, o.
McCoy Electronics Co., d, e, g, m, r, o-1.
McMillan Industrial Corp., q, u, b-1, g-1.
Meridian Metalcraft, Inc., b, d, e, r, u, g-1.
Metal Textile Corp., Electronics Div., o, l.
Michigan Wire Cloth Co., l, n.
Microlab, d, e, j, m, r, u, o-1, b-1, e-1, g-1, k-1.
Microwave Associates, Inc., e, u, e-1.
Microwave Development Labs., Inc.,
Midland Mfg. Co., Inc., g.
Midwestern Instruments, Inc., f-1.
J. W. Miller Co., b, d, e, m, o thru r, v, w, o-1, b-1, d-1, e-1, k-1.
Millipore Filter Corp., l, n, t.
Mine Safety Appliances Co., o, l.
Minitran Corp., c, d, e, k, m, r.
Minneapolis-Honeywell Regulator Co., Aeronautical Div., o.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, y.
Miratel, Inc., c, e, o, u, e-1, g-1, k-1.
Monogram Precision Industries, o, b, d, e, j, t, u, x, z.
Motorola Inc., Military Electronics Div., b thru g, i, m, o thru r, t, u, w, o-1, b-1, e-1, f-1, g-1, i-1, j-1.
Mutron Corp., o.
NYT Electronics, Inc., c, d, e, i, j, k, m, o, r, e-1, f-1.
Narda Microwave Corp., The, u.
Narmco Mfg. Co., b.
National Coil Co., c, d, e, m, o thru r, b-1, c-1.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., o thru e, g, i, m, o thru r, w, o-1, b-1, e-1, f-1, g-1.
Nationol Research Corp., h-1.
Networks Electronic Corp., c, d, e.
New York Transformer Co. Inc., c, d, e, i, j, k, m, r, f-1.
Newark Wire Cloth Co., l.
North Hills Electric Co., Inc., c, d, e, i, j, k, m, o, q, r, e-1, f-1, j-1, k-1.
O & S Research, Inc., x.
Optical Coating Lab., Inc., p, x.
Orbitran Co., Inc., r.
Ortho Filter Corp., b thru e, g thru k, m, o, q, r, s, u, b-1, c-1, e-1, f-1, g-1, j-1, k-1.
Palo Alto Engrg. Co., c, d, e, p, q, r, w.
Ralph M. Parsons Co., The, Electronics Div., b, e, e-1, f-1, j-1.
Philco Corp., Government & Industrial Div., o, b, e, o, p, q, u, o-1, b-1, e-1, f-1, g-1, i-1.
Polarod Electronics Corp., u.
Polaroid Corp., z.
Portchester Instrument Corp., b, d, m, r, u.
Potter Co., The, e, m, p, q, r, w, b-1.
Power-Tronic Systems Inc., c thru f, k, r, s, t.
Precise Development Corp., r, v.
Precision Equipment Co., Inc., o, l, n, t.
Puritan Compressed Gas Corp., Aviation Div., h-1.
Purolator Products Inc., o, l, n, q, t, y.
RS Electronics Corp., o, e-1.
Radar Design Corp., u.
Radar Reloy, Inc., b-1.
Radex Corp., o, i.
Radiation, Inc., f-1.
Radiatronics, Inc., b, d, e, r thru u, e-1, f-1, g-1.
Railway Communicatians Inc., e, m, r.
Raythean Mfg. Co., t.
Reeves-Haffman Div., d, e, g, k.
Research Products Corp., o.
Riverbank Labs., Dept.-Engrg., e.
Rixan Electronics Inc., c, d, e, m, p, r, j-1.
Rabbins Aviation, Inc., o.
Rollan Electric Co., o.
Royal Industries, Inc., f-1.
Raylyn Inc., l, n.
Rytron Co., Inc., d, e, k, m, o, r, e-1, f-1.
Sage Labs., Inc., e, g, m, r, u, e-1.
Sage-Craft, Inc., q, e-1, g-1.
St. Marys Carban Co., o, l, n, t.
San Fernando Electric Mfg., Co., p, w, b-1.
Sangama Electric Co., d, e, m, p thru s, w, k-1.
Sargent Engrg. Corp., n.
H. H. Scott, Inc., c, e, m, r, w.
Shannon Luminous Materials Co., d, e.
Sioux Dil Co., l.
A. O. Smith Corp. – Smith-Erie Div., l.
Southwestern Industrial Electronics Co., d, e, f, m,
Sparkler-Filtrion Corp., l, n.
Spectrum Instruments, Inc., c thru f, i, r, w, f-1, i-1.
Superex Electronics Corp., b, q, r, o-1, e-1.
Superior Pneumatic & Mfg., Inc., o.
Systems Inc., g.
Technical Apparatus Builders, p, q, w, b-1.
Telechrome Mfg. Corp., d, e, k, m, o, r, u, e-1, f-1, g-1, i-1, j-1, k-1.
Telectro Industries Corp., b thru g, i, j, k, o thru s, w, o-1, b-1, c-1, e-1, f-1, g-1, j-1, k-1.
Telerad Mfg. Corp., e, u.
Telonic Industries, Inc., e, m, r, e-1.
Tinsley Labs., Inc., x.
Tobe Deutschmann Corp., b, d, e, i, j, k, m, o thru r, u, w, o-1, b-1, c-1, e-1, g-1, k-1.
Torwico Electronics, Inc., c, e, m, r.
Tower Mfg. Corp., l.
Transco Products, Inc., b, e-1.
Transonic, Inc., c, d, e, i, j, k, m, r, s, o-1, f-1.
Triad Transformer Corp., c, d, e, j, k, m, r, f-1, j-1
Turbo Machine Co., u.
United Aircraft Products, Inc., l, n.
United Electrodynamics, Inc., e, r, f-1.
United Transformer Co., c thru f, i, j, k, q, r, u, c-f-1, i-1, j-1, k-1.
Universal Dynamics Corp., y.
Universal Toroid Coil Winding, Inc., d, e, f, r, e-1.
University Loudspeakers, Inc., c.
Vanguard Electronics Co., b, d, e, m, o, r, e-1, k-1
Varo Mfg. Co., Inc., e, m, o, r, e-1.
Vickers Inc., Marine & Drdnance Dept., Machinery Hydraulics Div., n.
Victor R. F. & Microwave Co., u.
Warren Transformer Co., Inc., c, d, e, p, q, r, b-1, e-1.
Waveline, Inc., u.
Wenzlau Engrg. Co., l.
Westbury Electronics Inc., m, r.
Westinghouse Air Brake Co., Industrial Products I q, y.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., d, e, i.
Wheeler Laboratories, Inc., u.
Winslow Engrg. & Mfg. Co., l, n.
Winzen Research Inc., f-1.
Zenith Optical Laboratory, x.

FINDERS, RANGE

American Cystoscope Makers, Inc.
American Optical Co., Instrument Div.
***BAUSCH & LOMB OPTICAL CO.**
Bendix Radio Div., Bendix Aviation Corp.
J. W. Fecker, Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
Gordon Enterprises
Graflex Inc.
Kollmorgen Optical Corp.
Motorola Inc., Military Electronics Div.
Northrop Corp., The, Nortronics Div.
Philco Corp., Government & Industrial Div.
Telectro Industries Corp.
Webcor, Inc., Government Div.

FINDERS, VIEW

American Optical Co., Instrument Div.
***BAUSCH & LOMB OPTICAL CO.**
Buhl Optical Co.
Dockendorff & Co. Inc.
J. W. Fecker, Inc.
Gordon Enterprises
Graflex Inc.
Traid Corp.

FINISHERS, PLASTIC

Dennis Chemical Co.
Duralith Corp.
General Plastics Corp. of New Jersey
Hordman Tool & Engrg., Co.
Minnesota Mining & Mfg. Co.
Panel Engrg. Corp.
Perry Plastics, Inc.
Turbo Products, Inc.
Waterbury Companies, Inc.

FINISHES
a. Crystal
b. Luminous Materials
c. Ripple
d. Wrinkle

Bios Labs., Inc., b.
Canadian Radium & Uranium Corp., b.
Lofstrand Co., The, c, d.
Maas & Waldstein Co., c, d.
Minnesota Mining & Mfg. Co., b.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., b, d.
Panel Engrg. Corp., b.
Shannan Luminous Materials Co., b.
United States Radium Corp., b.
Vapar Blast Mfg. Co.

FINS

American Brake Shoe Co.
American Car & Foundry, Div.-ACF Industries, Inc.
Anchor Metal Spinning Co., The
***AVCO MFG. CORP., CROSLEY DIV.**
Brooks & Perkins, Inc.
Carmac Aviation
Clark-Aiken Co., The
Continentol Can Co., Inc.
Curtiss-Wright Corp., Santa Barbora Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Diversey Engrg. Co.
Ferris-Mfg. Co., The
Fletcher Mfg. Co., Inc., The
Graflex Inc.
Hardman Tool & Engrg. Co.
Haveg Industries, Inc.
Ludwig Honold Mfg. Co.
Hughes Tool Co., Aircraft Div.
Intercontinental Mfg. Co., Inc.
Jarvis Corp.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kaiser Metal Products, Inc.-Fleetwings Div.
Kanarr Corp.
Kelsey-Hayes Co.
***LAVELLE AIRCRAFT CORP.**
Lofstrand Co., The
Longren Aircraft Co., Inc.
Magline Inc.
Marlo Coil Co.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
Narmco Mfg. Co.
Norris-Thermador Corp.
Precision Shopes, Inc.
Precision Sheet Metal, Inc.
Red Lion Cabinet Co., Redco Tool Div.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Santa Anito Engrg. Co.
Solar Aircraft Co.
Sperry Piedmont Co. — Div.-Sperry Rand Corp.
Stanley-Judd Div.-The Stanley Works
Universal Moulded Products Corp.
Wheland Co., The
Winder Aircraft Corp. of Florida
Young Development Div., Hercules Powder Co.

FIRE
a. Alarm Systems
b. Detectors
c. Extinguishing Systems
d. Protection Systems

Accessory Products Co., Div.-Textron Inc., c.
Akron Brass Mfg. Co., Inc., c, d.
American Aeroports, a, b, c.
Ansul Chemicol Co., c.
***ARNOUX CORP.**, a, b.
Cardox Div., Chemetron Corp., c, d.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., a, b, d.
Electronic Control Corp., a, b, d.
***ETS-HOKIN & GALVAN**, a thru d.
Fenwal Inc., a thru d.
G. W. Galloway Co., c.
Gamewell Co., The, a.
General Fire Extinguisher Corp., The, c, d.
Grinnell Co., a thru d.
Hesco Engrg., a, b.
Hoffman Electronics Corp., Semiconductor Div., b.
ITT-Kellogg, a.
Iran Fireman Mfg. Co., Electronics Div., b.
Walter Kidde & Co., Inc., Aviation Div., a thru d.
Mack Trucks, Inc., Government Div., c, d.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., b.
Nationol Foam System, Inc., c.
North Electric Co., a.
Richards-Wilcox Mfg. Co., b.
Royal Industries, Inc., b, d.
Scaico Controls, Inc., b.
Space Corp., c, d.
Spraying Systems Co., c.
Sun Electric Corp., Aeronautical Div., a.
United Electric Controls Co., a.

FIRE STANDS, MISSILE

ACCD Equipment Div., American Chain & Cable Co., Inc.
Aerojet-General Corp.
American Aeroparts
American Machine & Foundry Co., Greenwich
Associated Engineers, Inc.
Astronautics Engrg. Co.
Basic Tool Industries, Inc.
Champian Co., The
C. B. Christiansen Co.
Conco Engrg. Works
Crane Carrier Corp.
Cromer Mfg. & Engrg., Inc.
Dresser-Ideco Co., Div.-Dresser Industries, Inc.
Dyna-Therm Chemical Carp.
G. W. Galloway Co.
Paul Hardeman, Inc.
Hardman Tool & Engrg., Co.
Intercantinental Mfg. Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Carp.
Monogram Precision Industries
Norton Co., New Products Dept.
Dpelika Welding, Machine & Supply Inc.
Philips & Davies Inc.
Space Corp.
Thiokol Chemical Carp., Hunter-Bristol Div.
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
Washington Aluminum Co., Inc.
Washington Technalogical Associates Inc.
Welded Construction Inc.
Whelond Co., The

FIRE WALLS

Basic Tool Industries, Inc.
Benson Mfg., Co., The
Colonial Aircraft Carp.
Fletcher Mfg. Co., Inc., The
G. W. Galloway Co.
Haveg Industries, Inc.
Johns-Manville
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kentucky Metal Products Co.
***LAVELLE AIRCRAFT CORP.**
Monogram Precision Industries
Narmco Mfg. Co.
Penn-Michigan Mfg. Carp.
Ryan Aeronautical Co.
Solar Aircraft Co.
Stainless Steel Products, Inc.
H. I. Thompson Fiber Glass Co.
Twin Coach Co., Aircraft-Missiles

FIRING PLATFORMS
See PLATFORMS, FIRING

FIRING STAND ACCESSORIES

Accessory Products Co., Div.-Textron Inc.
American Aeroparts
American Instruments Co., Inc.
American Machine & Foundry Co., Greenwich
Astronautics Engrg. Co.
Basic Tool Industries, Inc.
Capital City Mfg. Co.
Clark-Aiken Co., The
Consolidated Diesel Electric Corp.
Cromer Mfg. & Engrg., Inc.
Diversey Engrg. Co.
Paul Hardeman, Inc.
Hardman Tool & Engrg., Co.
Horkey-Moore Associates
Houston Fearless Corp.
Hufford Corp., The
***HYDRO-AIRE CO., DIV.-CRANE CO.**
Hydromatics, Inc.
Kelsey-Hayes Co.
Mercury Tool & Mfg. Corp.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
George L. Nankervis Co.
Philips & Davies Inc.
Space Corp.
Thermol Refractories Corp.
Tronter Mfg., Inc.
***R. D. WERNER CO., INC.**
Wheland Co., The

FITTINGS & ACCESSORIES, ANTENNA
See ANTENNA FITTINGS & ACCESSORIES

FITTINGS, COAXIAL CABLE

Aircom Inc. of New Jersey
Coaxiol Connector Co. Inc.
Dage Electric Co., Inc.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Hallett Mfg., Co.
Kling Metal Spinning & Stamping Co.
Lucas Aircraft Supply Co.
Stanley-Judd Div.-The Stanley Works
Tapco Group, Thompson-Ramo-Wooldridge Inc.
United Supply Co.
Victor R. F. & Microwave Co.

FITTINGS, METALLIC

Accessory Products Co., Div.-Textron Inc.
Aircraft Fitting Co., The
Airdome Parts Co.
American Instruments Co., Inc.
American Standard Products, Inc.
Ampco Metal, Inc.
Anchor Coupling Co. Inc.
Arnav Aircraft Associates, Inc.
Astronautics Engrg. Co.
Avica Corp.
Basic Taol Industries, Inc.
Best Aircraft Corp.
Breeze Corparations, Inc.
Bruce Engrg. Co.
Capewell Mfg. Co.
Capital City Mfg. Co.
Carmac Aviation
Century Fasteners Corp.
Chase Brass & Capper Co., Inc.
Clark-Aiken Co., The
Clippard Instrument Lab., Inc.
Callins Engrg. Carp.
Corbin Products Div.
Diversey Engrg. Co.
Dumont Aircraft Fitting Co.
***FLEXONICS CORP., AERONAUTICAL DIV.**
GAR Mfg. Carp.
Grinnell Co.
Hannifin Co., Div.-Parker-Hannifin Corp.
Hardman Tool & Engrg. Co.
Harvey Aluminum
International Nickel Co., The
Kaiser Aircroft & Electronics, Div.-Kaiser Industries Carp.
Kanarr Corp.
Kohler Co.
Lodish Co.
Lucas Aircraft Supply Co.
Mercury Tool & Mfg. Corp.
Mueller Brass Co.
Newton Hydraulic Tooling Co.
Norton Co., New Products Dept.
Parker Aircraft Co.
Parker Fittings & Hose Div., Parker-Hannifin Carp.
Peerless Machine Co.
Piasecki Aircraft Corp.
Precision Equipment Co., Inc.
Precision Shapes, Inc.
Rattan Mfg. Co., The
Shaw Metol Praducts Carp.
Smith-Marris Corp.
Stanley-Judd Div.-The Stanley Works
Tube-Turns Div., Chemetron Carp.
United Supply Co.
Voriety Aircraft Carp.
W—S Fittings Warks, Forge & Fittings Div., H. K. Porter Co. Inc.
***WEATHERHEAD CO., THE**
Western Arc Welding, Inc.

FITTINGS, NON-METALLIC

Airdome Parts Co.
American Standard Products, Inc.
Astronautics Engrg. Co.
Carmac Aviation
Chemplast, Inc.
Continental Rubber Works
Dresser Mfg. Div., Dresser Industries, Inc.
Gladding, McBean & Co.
Grinnell Co.
Haveg Industries, Inc.
Joclin Mfg. Co.
Johns-Manville
Keystone Electronics Corp.
Lomtex Industries, Inc.
Lucas Aircraft Supply Co.
Luzerne Rubber Co.
Mercury Tool & Mfg. Corp.
Mueller Brass Co.
National Beryllia Corp.
Piasecki Aircraft Corp.
Polymer Corp., The
Rottan Mfg. Co., The
Fred T. Roberts & Co.
Silicone Insulation, Inc.
United States Rubber Co.
United Supply Co.
Zippertubing Co., The

FLAMEHOLDERS, RAM JET

Aircraft Precision Products, Inc.
California Aircraft Products
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
Hupp Aviation Co.
Kolcast Industries-Div.-Thompson Ramo Wooldridge Inc.
***LAVELLE AIRCRAFT CORP.**
***LYCOMING DIV., AVCO MFG. CORP.**
Marquardt Aircraft Co.
Mercury Tool & Mfg. Corp.
National Beryllia Corp.
Portland Copper & Tank Works Inc.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
C. F. Roark Welding & Engrg. Co., Inc.
Ryan Aeronauticol Co.
Solar Aircraft Co.
Thermal Refractories Corp.

FLANGES, MICROWAVE

Ainslie Corp.
Aircom Inc.
Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
American Radar Components Inc.
Andrew Corp.
A. Biederman, Inc.

Carmac Aviation
Chase Brass & Copper Co., Inc.
Coaxial Connector Co. Inc.
Connector Corp. of America
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
FXR, Inc.
John Gombos Co., Inc.
Wolter J. Hyatt Co., The
I-T-E Circuit Breaker Co.
Lieco, Inc.
Mercury Tool & Mfg. Corp.
Microwave Associates, Inc.
Monogram Precision Industries
N.R.K. Mfg. & Engrg. Co.
Omega Labs., Inc.
Portchester Instrument Corp.
Telerad Mfg. Corp.
Turbo Machine Co.
United Aircraft Products, Inc.
Victor R. F. & Microwave Co.
Walworth Co. Electronics Div.
Waveline, Inc.
Western International Co.
Wilks Precision Instrument Co., Inc.

FLAT DIE FORGINGS
See FORGINGS, FLAT DIE

FLEXIBLE & COMPRESSIBLE DUCTS
See DUCTS, FLEXIBLE & COMPRESSIBLE

FLEXIBLE HEATING EQUIPMENT
See HEATING EQUIPMENT, FLEXIBLE

FLEXIBLE SHAFTS
See SHAFTS, FLEXIBLE

FLEXIBLE WAVEGUIDES
See WAVEGUIDES, FLEXIBLE

FLIGHT DIRECTORS

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Bendix Aviation Corp., Eclipse-Pioneer Div.
Centronix Inc.
Communications Research Co.
ITT Labs.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Motorola Inc., Military Electronics Div.
Ryan Aeronautical Co.
Waldorf Electronics, Div.-F. C. Huyck & Sons

FLIGHT SIMULATION TEST CHAMBERS
See TEST CHAMBERS, FLIGHT SIMULATION

FLIGHT SIMULATORS
See SIMULATORS, FLIGHT

FLIGHT TERMINATION DEVICES
Aerojet-General Corp.
Centronix Inc.
ITT Labs.
Land-Air Inc.
Motorola Inc., Military Electronics Div.
Ryan Aeronautical Co.
Thiokol Chemical Corp., Hunter-Bristol Div.

FLOWMETERS, DIFFERENTIAL PRESSURE
Aeroscience, Inc.
Astronautics Engrg. Co.
Barton Instrument Corp.
A. Biederman, Inc.
Bowser, Inc., Defense Dept.
Bristol Co., The
Brooks Rotameter Co.
Centronix Inc.
Clary Dynamics
Dresser Industries, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Dynametrics Corp.
Fischer & Porter Co.
Hagan Chemicals & Controls, Inc.
Hoke, Inc.
***WALLACE O. LEONARO, INC.**
Librascope Inc.
Litton Industries, Maryland Div.
Mason-Neilan
Meriam Instrument Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
George L. Nankervis Co.
National Instrument Laboratories, Inc.
Norwood Controls Unit Detroit Controls Div.
Rohm Instruments, Div.-American Machine & Metals, Inc.
Schutte & Koerting Co.
Southwestern Industrial Electronics Co.
Specialties, Inc.
Statham Instruments, Inc.
Textran Corp.
Trimount Instrument Co.
Wallace & Tiernan Inc.

FLOWMETERS, MASS RATE
Aero Research Instrument Co. Inc.
Aeroscience, Inc.
Astronautics Engrg. Co.
Avien, Inc.
Bendix Aviation Corp., Pioneer-Central Div.
Bowser, Inc., Defense Dept.
Bristol Co., The
Cox Instruments Div., George L. Nankervis Co.
Crescent Engrg. & Research Co.
Curtiss-Wright Corp., Electronics Div.
Decker Corp., The
Dresser Industries, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Dynametrics Corp.
Fischer & Porter Co.
Flow Measurements Corp.
General Electric Co., Apparatus Sales Div.
Hagan Chemicals & Controls, Inc.
Hoke, Inc.
Korda Industries
Land-Air Inc.
Librascope Inc.
Litton Industries, Maryland Div.
Matheson Co., Inc., The
Minneapolis-Honeywell Regulator Co., Industrial Product Group
National Instrument Laboratories, Inc.
Dhmart Corp., The
Potter Aeronautical Corp.
Precision Thermometer & Instrument Co.
Revere Corp. of America
A. D. Smith Corp. – Smith-Erie Div.
Standard Controls, Inc.
Trans-Sonics, Inc.
Turbo Products, Inc.
Wallace & Tiernon Inc.
Waugh Engrg. Co.

FLOWMETERS, VOLUMETRIC
Air Logistics Corp.
American Measurement & Control, Inc.
Astronautics Engrg. Co.
Barton Instrument Corp.
Bristol Co., The
Brooks Rotameter Co.
Henry G. Dietz Co., Inc.
Dresser Industries, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Dynametrics Corp.
Fischer & Porter Co.
Fisher Scientific Co.
Flow Measurements Corp.
Hagan Chemicals & Controls, Inc.
Hoke, Inc.
Litton Industries, Maryland Div.
Matheson Co., Inc., The
W. L. Maxson Corp., The
Meriam Instrument Co.
George L.Nankervis Co.
National Instrument Laboratories, Inc.
Potter Aeronautical Corp.
Revere Corp. of America
Selas Corp. of America
A. O. Smith Corp. – Smith-Erie Div.
Turbo Products, Inc.
Wallace & Tiernon Inc.
Waugh Engrg. Co.

FLUID METERING PUMP SYSTEMS
Adel Precision Products of California, Div.-General Metals Corp.
Aerojet-General Corp.
American Aeroparts
American Bosch Arma Corp.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Bendix Utica Div., Bendix Aviation Corp.
Bowser, Inc., Defense Dept.
Chandler Evans Corp.
Delsen Corp.
Denison Engrg. Div., American Brake Shoe Co.
Eastern Industries Inc.
Electric Auto-Lite Co., The
Fischer & Porter Co.
G. W. Galloway Co.
***HYORO-AIRE CO., DIV.-CRANE CO.**
Korda Industries
Lear Inc., Lear-Romec Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Drdnance Div.-Food Machinery & Chemical Corp.
Pesco Products Div.-Borg-Worner Corp.
Research Appliance Co.
Milton Roy Co.
A. O. Smith Corp.
A. D. Smith Corp. – Smith-Erie Div.
Walloce & Tiernan Inc.

FLUID MOTORS
Adel Precision Products of Californio, Div.-General Metals Corp.
American Bosch Armo Corp.
American Brake Shoe Co.
American Mochine & Foundry Co., Government Products Group
***BENDIX AVIATION CORP., HAMILTON DIV.**
Cornelius Co., The, Aero Div.
Denison Engrg. Div., American Broke Shoe Co.
Eastern Industries Inc.
Electric Auto-Lite Co., The
General Electric Co., Apparatus Sales Div.
Hamilton Stondard, Div.-United Aircraft Corp.
Hannifin Co., Div.-Parker-Hannifin Corp.
***HYORO-AIRE CO., DIV.-CRANE CO.**
Lear, Inc.
Lear Inc., Lear-Romec Div.
Dil-Dyne, Inc.
Pesco Products Div.-Borg-Warner Corp.
Reinhold Engrg. & Plastics Co.
Sargent Engrg. Corp.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Vickers Inc., Div.-Sperry Rand
Vickers Inc., Marine & Drdnance Dept., Machinery Hydraulics Div.
Watertown Div., The New York Air Brake Co.

FLUIDS, HYDRAULIC OILS, COOLANTS, ETC.
Anderson Oil & Chemical Co., Inc.
George Basch Co., The
***DOW CORNING CORP.**
E. I. DuPont de Nemours & Co. Inc.
R. M. Hollingshead Corp.
E. F. Houghton & Co.
ITT Labs.
MSA Research Corp.
Minnesota Mining & Mfg. Co.
Monsanto Chemical Co. - Drganic Chemicals Div.
Pennsalt Chemicals Corp.
Shannon Luminous Materials Co.
Silicones Div.-Union Carbide Corp.

FLUORESCENT COMPOUNDS, PHOSPHORS
***ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.**
Carl H. Biggs Co.
Bios Labs., Inc.
Borden Chemical Co.
Bram Metallurgical & Chemical Co.
Canadian Radium & Uranium Corp.
E. I. Du Pont De Nemours & Co. Inc.
General Electric Co., Lamp Metals & Components Dept.
Luminous Resins Inc.
Miller Dial & Nameplate Co.
Minnesota Mining & Mfg. Co.
Joseph E. Podgor Co., Inc.
Shannon Luminous Materials Co.
Sylvania Electric Products Inc., Chemical & Metallurgical Div.
Thomas Electronics, Inc.
***ULTRA-VIOLET PRODUCTS, INC.**
United Mineral & Chemical Corp.
United States Radium Corp.

FLUORINE, GAS & LIQUID
***ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.**

FLUOROMETERS
Belmont Smelting & Refining Works, Inc.
Epic, Inc.
Fisher Scientific Co.
Photovolt Corp.

FLUX, BRAZING OR SOLDERING
Accurate Specialties Co. Inc.
All-State Welding Alloys Co., Inc.
Alpha Metals, Inc.
Aluminum Co. of America
American Brazing Alloys Co.
American Silver Co.
American Solder & Flux Co.
Ampco Metal, Inc.
Anchor Metal Co. Inc.
Barrett-Christie Co.
Blackstone Corp.
Bow Solder Products Co., Inc.
Burnley Battery & Mfg. Co., The
Chase Brass & Copper Co., Inc.
Curtiss-Wright Corp., Princeton Div.
Curtiss-Wright Corp., Research Div.
Dalweld Co. Inc.
Division Lead Co.
Dow Chemical Co., The
M. W. Dunton Co. Inc., The
E. I. Du Pont De Nemours & Co. Inc.
Engelhard Industries, Inc.
Handy & Harman
International Nickel Co., The
Johnson Mfg. Co., Inc.
Linde Co., Div.-Union Carbide Corp.
London Chemical Co., Inc.
Metals & Controls Corp., General Plate Div.
Mico Instrument Co.
Mueller Brass Co.
National Lead Co.
Solar Aircraft Co.
Strong Scott Mfg. Co., The
Superior Flux & Mfg. Co., The
United Wire & Supply Corp.
***WALL COLMONOY CORP., STAINLESS PROCESSING DIV.**
Wildberg Bros. Smelting & Refining Co.

FLYWHEELS
Curtiss-Wright Corp.-Wright Aeronautical Div.
Lovejoy Tool Co., Inc.
Mercury Tool & Mfg. Corp.
Stover Co., Inc., The
Western Iron & Foundry Co., Inc.

FOCUSING MAGNETS
See MAGNETS, FOCUSING

OIL, ALUMINUM
Accurate Specialties Co. Inc.
Adept Industries Inc.
Alloys Unlimited Inc.
Aluminum Co. of America
American Silver Co.
Anchor Metal Co. Inc.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical & Chemicol Co.
Hamiltan Watch Co.-Industrial Div.
Kaiser Aluminum & Chemical Sales, Inc.
United Mineral & Chemical Corp.

OIL, LEAD
Accurate Specalties Co. Inc.
Alloys Unlimited Inc.
American Smelting & Refining Co.
Anchor Metal Co. Inc.
Bar-Ray Products, Inc.
Division Lead Co.
National Lead Co.
St. John X-Ray Lab.
United Mineral & Chemical Corp.

RCE MEASURING CELLS
B & F Instruments, Inc.
W. C. Dillon & Co., Inc.
Dynametrics Corp.
Revere Corp. of America
pace Corp.
tatham Instruments, Inc.

RGINGS, DROP
ee DROP FORGINGS

RGINGS, FLAT DIE
Alco Products, Inc.
Allegheny Ludlum Steel Corp.
Aluminum Co. of America
merican Aeroparts
merican Brake Shoe Co.
merican Car & Foundry, Div.-ACF Industries, Inc.
Billings & Spencer Co., The
Bridgeport Brass Co.
CAMERON IRON WORKS, INC.
apewell Mfg. Co.
lark Equipment Co.
onsolidated Industries, Inc.
orbin Products Div.
arvey Aluminum
arle M. Jorgensen Co.
elsey-Hayes Co.
adish Co.
harles E. Larson & Sons, Inc.
idvale-Heppenstall Co.
ational Forge Co.
ettibone Mulliken Corp.
ockwell-Standard Corp.
teel Improvement & Forge., The
pco Group, Thompson-Ramo-Wooldridge Inc.
anadium-Alloys Steel Co.

RGINGS, PRESS
CF Industries Inc.
lco Products, Inc.
llegheny Ludlum Steel Corp.
luminum Co. of America
merican Aeroparts
merican Brake Co., The
merican Brass Co., The
illings & Spencer Co., The
ridgeport Brass Co.
CAMERON IRON WORKS, INC.
hase Brass & Copper Co., Inc.
onsolidated Industries, Inc.
orbin Products Div.
resser Mfg. Div., Dresser Industries, Inc.
arvey Aluminum
arle M. Jorgensen Co.
aiser Aluminum & Chemical Sales, Inc.
elsey-Hayes Co.
ahler Co.
adish Co.
dvale-Heppenstall Co.
ueller Brass Co.
ational Forge Co.
ettibone Mulliken Corp.
ockwell-Standard Corp.
avill Mfg. Co.
lar Aircraft Co.
eel Improvement & Forge., The
pco Group, Thompson-Ramo-Wooldridge Inc.
tan Metal Mfg. Co.
ansue & Williams Steel Forging Corp.
be-Turns Div., Chemetron Corp.
nadium-Alloys Steel Co.
et Industries
S Fittings Works, Forge & Fittings Div., H. K.
Porter Co. Inc.

GINGS, SPECIAL ALLOYS
AMERON IRON WORKS, INC.

GINGS, UPSET
F Industries Inc.
co Products, Inc.
legheny Ludlum Steel Corp.
uminum Co. of America
erican Aeroparts
American Brake Shoe Co.
American Car & Faundry, Div.-ACF Industries, Inc.
American Steel Foundries, Hammond Div.
Billings & Spencer Co., The
Bridgeport Brass Co.
***CAMERON IRON WORKS, INC.**
Clark Equipment Co.
Commercial Shearing & Stamping Co.
Carbin Products Div.
Dresser Mfg. Div., Dresser Industries, Inc.
Endicott Forging & Mfg. Co., Inc.
Harvey Aluminum
Earle M. Jargensen Co.
Kelsey-Hayes Co.
Ladish Co.
Midvale-Heppenstall Co.
Pettibone Mulliken Corp.
Rockwell-Standard Corp.
Scovill Mfg. Co.
Steel Improvement & Forge., The
Topco Graup, Thampson-Ramo-Wooldridge Inc.
Transue & Williams Steel Forging Corp.
Tube-Turns Div., Chemetron Corp.
Vanadium-Alloys Steel Co.
W-S Fittings Works, Forge & Fittings Div., H. K. Porter Co. Inc.

FORMS, UPSET
American Aeroparts
Bowser, Inc., Defense Dept.
Kling Metal Spinning & Stomping Co.
Ladish Co.
Monogram Precision Industries
Stanley-Judd Div.-The Stanley Works
Teiner Engrg. Corp.

FORMS, ANTENNA
Ainslie Corp.
Intercontinental Mfg. Co., Inc.
Isolantite Mfg. Corp.
Meridian Metalcraft, Inc.
National Beryllia Corp.
Turbo Machine Co.

FOUNTAINS
a. Drinking
b. Eye Wash
c. Eye-Face Wash
d. Portable Eye Wash

***HAWS DRINKING FAUCET CO., a thru d.**

FRAMES, GRID
See GRID FRAMES

FRAMES, MISSILE
See MISSILE FRAMES

FREQUENCY CALIBRATION SERVICES
A. Biederman, Inc.
Budelman Electronics Corp.
Data-Control Systems, Inc.
FXR, Inc.
General Electric Co., Apparatus Sales Div.
Gyrex Corp., The
Land-Air Inc.
Northern Engrg. Laboratories, Inc.
Weinschel Engrg.

FREQUENCY METERS
Acromag Inc.
Adler Electronics, Inc.
Aero Instrument Co.
Aircom Inc. of New Jersey
Airpax Electronics Inc. Seminole Div.
Amelco, Inc.
American Aeroparts
American Machine & Foundry Co., Government Products Group
Avtron Mfg., Inc.
Beckman Instruments, Inc., Berkeley Div.
Bristol Co., The
Budelman Electronics Corp.
Diamond Antenna & Microwave Corp.
Divco-Wayne Electronics Div., Divco-Wayne Corp.
Douglas Microwave Co., Inc.
Electro Precision Corp.
Electronic Applications, Inc.
Electronics Div., Van Norman Industries Inc.
Electro-Tech Equipment Co.
Engrg. Associates
Erie Resistor Corp.
FXR, Inc.
Federal Mfg. & Engrg. Corp.
General Communication Co.
General Electric Co., Apparatus Sales Div.
Helipot Div.-Beckman Instruments Inc.
Hewlett-Packard Co.
Kahn & Co., Inc.
Lampkin Labs., Inc., M.R. Div.
Lavoie Laboratories Inc.
Meridian Metalcraft, Inc.
Micrometrical Mfg. Co.
Microwave Associates, Inc.
Minneapolis-Honeywell Regulator Co., Davies Labs. Div.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Narda Micrawave Corp., The
National Electronics
Polytechnic Research & Development Co., Inc.
Radar Design Corp.
Sanbarn Co.
Sperry Micrawave Electronics Co., Div.-Sperry Rand Corp.
Sun Electric Carp., Aeronautical Div.
Systran Carp.
Technolagy Instrument Corp.
Telectra Industries Corp.
Telerad Mfg. Carp.
Vara Mfg. Co., Inc.
Wacline, Inc.
Waltham Electronics Carp.
Woveline, Inc.
Weston Instruments, Div.-Daystram, Inc.
Wright Engrg. Co.

FUEL BLADDERS
See BLADDERS, FUEL

FUEL DISTRIBUTORS
See DISTRIBUTORS, FUEL

FUEL HANDLING EQUIPMENT
Aerojet-General Corp.
American Machine & Foundry Co., Government Products Group
Associated Engineers, Inc.
Bowser, Inc., Defense Dept.
Bruning Co., The
Buckeye Iron & Brass Works
Butler Mfg. Co.
J. C. Carter Co., The
Chandler Evans Corp.
Chrysler Corp., Defense Operations Div.
Components Corp.
Consolidated Diesel Electric Corp.
Consolidated Diesel Electric Corp., Western Div.
Crane Carrier Corp.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp., Research Div.
Dresser Industries, Inc.
Eastern Industries Inc.
FWD Corp.
Flight Refueling, Inc.
G. W. Galloway Co.
Goodyear Aircraft Corp.
Goodyear Tire & Rubber Co., The, Aviatian Products Div.
Hufford Corp., The
***HYDRO-AIRE CO., DIV.-CRANE CO.**
Hydromatics, Inc.
Jeffrey Mfg. Co., The
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Lear Inc., Leor-Romec Div.
Longren Aircraft Co., Inc.
Mack Trucks, Inc., Government Div.
DPW-Jordon
Drdnance Div.-Food Machinery & Chemical Corp.
Parker Aircraft Co.
Project Fabrication Corp.
Purolator Products Inc.
Reaction Motors Div., Thiokol Chem. Corp.
Charles Ross & Son Co., Inc.
A. O. Smith Corp. - Smith-Erie Div.
Space Corp.
Stearns-Roger Mfg. Co.
Texas Metal & Mfg. Co., Inc.
Vickers Inc., Div.-Sperry Rand
Washington Technologicol Associates Inc.
Wayne Pump Co., The, Div.-Symington Wayne Carp.
Welded Construction Inc.

FUEL INJECTION SYSTEMS
See INJECTION SYSTEMS, FUEL

FUEL LINES
Americon Tube Bending Co., Inc.
Anaconda Metal Hose Div., The American Brass Co.
Arnolt Corp.
Avica Corp.
Consolidated Electrodynamics Corp., Rochester Div.
Cromer Mfg. & Engrg., Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Flexible Metal Hose Mfg. Co.
***FLEXONICS CORP., AERONAUTICAL DIV.**
Flight Refueling, Inc.
G. W. Galloway Co.
Imperial Brass Mfg. Co., The
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Lewis & Saunders
Pesco Products Div.-Borg-Warner Corp.
Precision Sheet Metal, Inc.
Reaction Motors Div., Thiokol Chem. Corp.
Stainless Steel Products, Inc.
Stalker Corp., The
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Stearns-Roger Mfg. Co.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Woolf Aircraft Products, Inc.

FUEL PRESSURE WARNING UNITS
See WARNING UNITS, FUEL PRESSURE

FUEL SYSTEMS & EQUIPMENT

a. Balancing Controls
b. Flow Dividers or Distributors
c. Injection Equipment
d. Lines
e. Mixture Controls, Automatic
f. Pressure Gauges
g. Pressure Warning Units
h. Pumps
i. Ratio Controllers
j. Strainers

ACF Industries Inc., a, b, c, e thru j.
Accessory Products Co., Div.-Textron Inc., j.
Actuation Research Corp., j.
Adel Precision Products of California, Div.-General Metals Corp., h.
Aero Supply Mfg. Inc., a, b, e, j.
Aerojet-General Corp., a, h.
Aeroquip Corp., Jackson Div., d.
Aeroscience, Inc.
Airoterro, j.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., e, h, i.
American Bosch Arma Corp., b, c, h, j.
American Machine & Foundry Co., Government Products Group, a.
American Tube Bending Co., Inc., d.
Ardmore Products
Associated Engineers, Inc., h.
Avico Corp., d.
Avien, Inc., a.
Bodger Mfg. Co.
Barco Mfg. Co., d.
*BEATON & CORBIN MFG. CO., THE, d.
*BENDIX AVIATION CORP., HAMILTON DIV., b, c, e, h, i.
Bendix Aviation Corp., Montrose Div., g.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., b, c, e.
Bendix Utica Div., Bendix Aviation Corp., b, h.
Bowser, Inc., Defense Dept., b, e, h, j.
Brooks Rotometer Co., i.
Byron-Jackson Pumps Inc., h.
California Aircraft Products, c.
J. C. Carter Co., The, h.
Chandler Evans Corp., a, b, c, e, g, h, i.
Christie Machine Works, h.
Chrysler Corp., Defense Operations Div.
Clary Dynamics, b, e, j.
Cleveland Pneumatic Industries, Inc., h.
Cole-Hersee Co., g.
Collins Engrg. Corp., h.
Consolidated Controls Corp., f, g, i.
Consolidated Diesel Electric Corp., a, b, e, f, g, i, j.
Cromer Mfg. & Engrg., Inc., d.
Cuno Engrg. Corp., The, j.
Curtiss-Wright Corp., Santa Barbara Div., h.
Curtiss-Wright Corp., Wright Aeronautical Div., a thru e.
Delavan Mfg. Co., b, c.
Dresser Industries, Inc., c, h.
Dresser Mfg. Div., Dresser Industries, Inc.
Dumont Aircraft Fitting Co., b, e, g, j.
Dynamic Controls Corp., g, i.
Eastern Industries Inc., h.
Eddington Metal Specialty Co., b, c, j.
Engineered Products Co., The, b, c.
Essex Mfg., Co., Inc., g.
Fischer & Porter Co., i.
Flexible Metal Hose Mfg. Co., d.
*FLEXONICS CORP., AERONAUTICAL DIV., d.
Flight Refueling, Inc., a, b, d.
G. W. Galloway Co., a thru j.
General Electric Co., Apparatus Sales Div., h.
Hamilton Standard, Div.-United Aircraft Corp., a, e, i.
Paul Hardeman, Inc.
Harmon Equipment Co., j.
Holley Carburetor Co.
Hufford Corp., The, a thru j.
Hupp Aviation Co., h
*HYORO-AIRE CO., DIV.-CRANE CO., b, h.
Hydrodyne Corp., Skinner Seal Div., h, j.
Hydromatics, Inc., e, i.
Imperial Brass Mfg. Co., The, d.
Kemp Aero Products, b, h.
Koehler Aircraft Products Co., b, j.
Korda Industries, a, b, c, e, h, i.
Land-Air Inc., a, e.
Leor, Inc., h.
Lear, Inc., Grand Rapids Div., c, h.
Leor Inc., Leor-Romec Div., b, h.
Lee Co., The, b, c, e.
Marquardt Aircraft Co., a, b, c.
Michigan Wire Cloth Co., j.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, f.
National Airoil Burner Co., h.
Norwood Controls Unit Detroit Controls Div., f, g.
DPW-Jordan, j.
Orchard Industries, Inc., Actionflex Div., d.
Ordnance Div.-Food Machinery & Chemical Corp.
Parker Aircraft Co., b, c, e, g, i, j.
Ports Engrg. Co., Inc., c.
Pesco Products Div.-Borg-Warner Corp., h.
Pneu-Hydro Valve Corp., a, b, e.
Potter Aeronautical Corp., i.
Precision Sheet Metal, Inc., d.
Project Fabrication Corp., d, h.
Racine Hydraulics & Machinery Inc., h.
Rahm Instruments, Div.-American Machine & Metals, Inc., f.
Reaction Motors Div., Thiokol Chem. Corp., h.
Republic Mfg. Co., b, g.
Rocketdyne Div.-North American Aviation, Inc.
Roylyn Inc., j.
St. Marys Carbon Co., j.
Servomechanisms, Inc., a, f.
Simmonds Aerocessories, Inc., c, h.
A. D. Smith Corp., h.
Southwestern Industries, Inc., d.
Spraying Systems Co., j.
Stainless Steel Products, Inc., d.
Standard-Thomson Corp., Clifford Mfg. Co. Div., e, g.
A. U. Stone & Co., Inc., b.
Stratos, Div.-Fairchild Engine & Airplane Corp., a, b.
Systron Corp., i.
Tapco Group, Thompson-Ramo-Wooldridge Inc., b, h.
Turbo Products, Inc.
United Aircraft Products, Inc., b, c, e, h.
United Electric Controls Co., g.
Universal Metal Products Inc., j.
Valcor Engrg. Corp., b, c.
Vickers Inc., Div.-Sperry Rand, h.
Waldorf Fluid Systems. Div.-F. C. Huyck & Sons, b.
Wayne Pump Co., The, Div.-Symington Wayne Corp., h.
*WEATHERHEAD CO., THE, d.
Westronics Inc., a.
Wilks Precision Instrument Co., Inc., h.

FUELING LAOOERS

See LAOOERS, FUELING

FUELS, LIQUIO

*ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.

FUELS, SOLIO

Aerojet-General Corp.
*AMERICAN POTASH & CHEMICAL CORP.
American Rocket Co.
Astrodyne, Inc.
Atlantic Research Corp.
Bios Labs., Inc.
Callery Chemical Co.
Continental Aviation & Engrg. Corp.
Dynamic Devices, Inc.
Escambia Chemical Corp.
Food Machinery & Chemical Corp.
Foote Mineral Co.
Fulton-Irgon Corp., The
Gabriel Co., The-Tolco Engrg. Co. Div.
ITT Labs.
Kennedy Van Saun Mfg. & Engrg. Corp.
Derlikon Tool & Arms Corp. of America
Olin Mathieson Chemical Corp., Energy Div.
Pennsalt Chemicals Corp.
*REOEL INC.
Rohm & Haas Co., Redstone Arsenal Research Div.
Topper Mfg. Co., Inc.
Winder Aircraft Corp. of Florida

FURNACES

Airtemp Div., Chrysler Corp.
American Gas Furnace Co.
*AMERICAN POTASH & CHEMICAL CORP.
Astrovac Corp.
Blue M Electric Co.
Curtiss-Wright Corp., Santa Barbara Div.
Diversey Engrg. Co.
Engelhard Industries, Inc.
Fisher Scientific Co.
Gardner Laboratory, Inc.
General Electric Co., Apparatus Sales Div.
General Vacuum Corp.
Grieve-Hendry Co., Inc.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
High Vacuum Equipment Corp.
A. F. Holden Co., The
Huppert, K. H., Co.
Jet-Heet, Inc.
Konthol Corp., The
Lindberg Engrg. Co.
John Mohr & Sons
NRC Equipment Corp.
National Airoil Burner Co.
National Beryllio Corp.
National Research Corp.
Pacific Scientific Co.
Popesch & Kolstad, Inc.
Edw. Renneburg & Sons Co.
Selas Corp. of America
Surface Combustion Corp.
Temperature Engrg. Corp.
Thermal Refractories Corp.
Thompson Engrg. Co., The, Missile Products Div.
United States Dynamics Corp.
Westinghouse Electric Corp.
Young Brothers Co.
Zirconium Corp. of America

FUSE HOLDERS

See HOLDERS, FUSE

GALVANOMETERS

Associated Research, Inc.
B & H Instrument Co., Inc.
Beede Electrical Instrument Co. Inc.
James G. Biddle Co.
Bristol Co., The
Brush Instruments, Div.-Clevite Corp.
Cambridge Instrument Co., Inc.
Centronix Inc.
Century Electronics & Instruments, Inc.
Consolidated Electrodynamics Corp.
Epic, Inc.
Fisher Scientific Co.
G-M Labs. Inc.
General Electric Co., Apparatus Sales Div.
Gordon Enterprises
Greibach Instruments Corp.
Hamilton Watch Co.
Hamilton Watch Co., Hathaway Instrument Div.
Hamilton Watch Co.-Industrial Div.
Heiland Div.-Minneapolis-Honeywell
Kin Tel Div.-Cohu Electronics, Inc.
Leeds & Northrup Co.
Massa Div.-Cohu Electronics, Inc.
Meters Inc.
Midwestern Instruments, Inc.
Minneapolis-Honeywell Regulator Co., Boston Di
Minneapolis-Honeywell Regulator Co., Industrial
Minneapolis-Honeywell Regulator Co., Industrial Product Group
National Electronics
New England Scientific Instruments Co.
Offner Electronics Inc.
Pace Electrical Instruments Co., Inc.
Photron Instrument Co.
Physics Research Laboratories, Inc.
Precise Development Corp.
Sanborn Co.
Shollcross Mfg. Co.
Simpson Electric Co.
Southwestern Industrial Electronics Co.
H. W. Sullivan Ltd.
Sun Electric Corp., Aeronautical Div.
Technology Instrument Corp.
Weston Instruments, Div.-Daystrom, Inc.

GAS ANALYZERS

American Electronics, Inc., Taller & Cooper Div
Bristol Co., The
Combridge Instrument Co., Inc.
Central Scientific Co.
Consolidated Electrodynamics Corp.
Davis Instruments
Engelhard Industries, Inc.
Epic, Inc.
Fisher Scientific Co.
Gardner Laboratory, Inc.
Hallikainen Instruments
Industrial Instruments Inc.
Jarrell-Ash Co.
Johnson-Williams, Inc.
Harold Kruger Instruments
Leeds & Northrup Co.
Mine Safety Appliances Co.
NRC Equipment Corp.
Perkin-Elmer Corp.
Pioneer Industries Div., Almor-York Co. Inc.
Process & Instruments
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp.
Sperry Piedmont Co. - Div.-Sperry Rand Corp.
Sun Electric Corp., Aeronautical Div.
Thiokol Chemical Corp.
Victory Engrg. Corp.

GAS COMPRESSORS

See COMPRESSORS, GAS

GAS GENERATING DEVICES

Aerojet-General Corp.
Aro Equipment Corp.
Astrodyne, Inc.
Engelhard Industries, Inc.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
C. I. Hayes, Inc.
Hevi-Duty Electric Co.
Intercontinental Mfg. Co., Inc.
*JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.
MSA Research Corp.
*MC CORMICK SELPH ASSOCIATES
Mc Dowell-Wellman Companies, The
Olin Mathieson Chemical Corp., Energy Div.
Pressed Steel Tank Co.
Project Fabrication Corp.
*PROPELLEX CHEMICAL DIV., CHROMAL CORP.
Reaction Motors Div., Thiokol Chem. Corp.
*REOEL INC.
Rocketdyne Div.-North American Aviation, Inc
Special Projects Lab., Food Machinery & Che Corp.
Surface Combustion Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Waste King Corp., Technical Products Div.

GAS PRESSURE BOOSTERS

See BOOSTERS, GAS PRESSURE

GAS TURBINE ENGINE OIFFUSERS

See OIFFUSERS, GAS TURBINE ENGINE

GAS TURBINE ENGINE, ENGINE STARTING SYSTEMS & CONTROLS

See ENGINE STARTING SYSTEMS & CONTROLS, GAS TURBINE ENGINE

GAS TURBINE ENGINE EXHAUST CONES

See EXHAUST CONES, GAS TURBINE EN

AS TURBINE ENGINE ROTOR ASSEMBLIES
See ROTOR ASSEMBLIES, GAS TURBINE ENGINE

ASES, NITROGEN
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Engelhard Industries, Inc.
Linde Co., Div.-Union Corbide Corp.
Matheson Co., Inc., The
Puritan Compressed Gas Corp., Aviation Div.
Trionics Corp.

ASES, RARE
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Associated Engrg. & Mfg. Corp.
Linde Co., Div.-Union Carbide Corp.
Matheson Co., Inc., The

SKET PASTE & CEMENT
Anchor Packing Co., The
Armstrong Cork Co.
Barrett-Christie Co.
Borden Chemical Co.
Samuel Cabot Inc.
Cooper Industries, Inc.
Crane Packing Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Greene, Tweed & Co.
Johns-Manville
Johns-Manville Sales Corp.
Minnesota Mining & Mfg. Co.
Minnesota Mining & Mfg. Co.-Adhesives, Coating & Sealers Div.
Monogram Precision Industries
Motional Engrg. Products, Inc.
Parker Fittings & Hose Div., Parker-Hannifin Corp.
Permatex Co., Inc.
Products Research Co.
Laureisen Cements Co.
Smooth-On Mfg. Co.
Union Asbestos & Rubber Co.
Vopar Mills Inc.

SKETS, METALLIC
Abbott Screw & Mfg. Co.
Acme Mfg. & Gasket Co.
Advanced Products Co., The
Aero Gasket Corp.
Airtron Inc., Div.-Litton Industries
All Specs Corp.
Allied Plastics Supply Corp.
Alloys Unlimited Inc.
Alpha Metals, Inc.
Alpitec, Inc.
American Aeroparts
Anchor Metal Co. Inc.
Anchor Metal Spinning Co., The
Anchor Packing Co., The
Auburn Mfg. Co., The
Bergen Carbide Co.
Capital City Mfg. Co.
Carmac Aviation
Corbin Products Div.
Division Lead Co.
Fletcher Mfg. Co., Inc., The
Gasket Mfg. Co. Inc.
General Gasket Inc.
Greene, Tweed & Co.
Hydrodyne Corp., Skinner Seal Div.
Johns-Manville
Johns-Manville Sales Corp.
Kentucky Metal Products Co.
Metal Textile Corp., Electronics Div.
Metallo Gasket Co.
Microwave Development Labs., Inc.
Pacific Cut Washer Co.
Penn Fibre & Specialty Co., Inc.
Rubber Teck Inc.
Tower Co., Inc., The
United Aircraft Products, Inc.
Victor Mfg. & Gasket Co.

SKETS, NON-METTALIC
Acme Mfg. & Gasket Co.
Aero Gasket Corp.
Arcom Inc.
All Specs Corp.
Allied Plastics Supply Corp.
American Aeroparts
American Agile Corp.
American Felt Co.
Anchor Packing Co., The
Armstrong Cork Co.
Auburn Mfg. Co., The
Bergen Carbide Co.
Carma Mfg. Co. Inc.
Conny Mfg. Corp.
D. H. Brady Co.
Demplast, Inc.
Chicago Gasket Co.
Chicago Rawhide Mfg. Co.
Colonial Rubber Co.
Connecticut Hard Rubber Co., The
Continental Rubber Works
Cooper Industries, Inc.
Crane Packing Co.
Dresser Mfg. Div., Dresser Industries, Inc.
E. I. Du Pont De Nemours & Co. Inc.
Emerson Plastics Corp.
Excelsior Leather Washer Mfg. Co., Inc.
Felters Co., The
Fletcher Mfg. Co., Inc., The
Fluorocarbon Co., The
Fluorulon Labs., Inc.
Furane Plastics, Inc.
Gasket Mfg. Co. Inc.
General Gasket Inc.
Generol Plastics Corp. of New Jersey
B. F. Goodrich Industriol Products Co.
Goshen Rubber Co., Inc.
Greene, Tweed & Co.
Halogen Insulator & Seal Corp.
Hamilton Kent Mfg. Co.
Homalite Corp., The
E. F. Houghton & Co.
Integroted Mica Corp.
Jodee Plastics Co.
Johns-Manville
Johns-Manville Sales Corp.
Thomas J. Long, Inc.
M & Q Plastic Products
Metallo Gasket Co.
Mica Fabricating Co.
Mica Insulator Div.-Minnesota Mining & Mfg., Co.
Microwave Development Labs., Inc.
Minnesota Mining & Mfg. Co.
Minnesota Rubber Co.
New England Tape Co., Div.-United-Carr Fastener Corp.
Norton Co., New Products Dept.
Pacific Cut Washer Co.
Penn Fibre & Specialty Co., Inc.
Polymer Corp., The
Raybestos-Monhattan, Inc.
Raybestos-Manhatton, Inc., Pa.
Resistoflex Corp.
Rogers Corp.
Rubber Teck Inc.
Rubbercraft Corp. of Californio
Silicone Insulation, Inc.
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co.
Stover Co., Inc., The
Thermech Engrg. Corp.
Union Asbestos & Rubber Co.
Victor Mfg. & Gasket Co.
Waldom Electronics Inc.
Western Felt Works & Acadia Synthetic Products Div.
Westlake Plastics Co.
Wilmington Fibre Specialty Co.
Young Development Div., Hercules Powder Co.

GAUGES
a. Air Pressure
b. Compressian
c. Differential Pressure
d. Displacement Measuring
e. Fuel Pressure
f. Fuel Quantity
g. Hydraulic Pressure
h. Liquid Level
i. Manifold Pressure
j. Oil Level
k. Oil Pressure
l. Outside Air Temperature
m. Pressure
n. Quantity
o. Strain
p. Suctian
q. Tensian
r. Thickness, Electronic
s. Torque Pressure
t. Ultrasonic Thickness

Allegany Instrument Co., Inc., o.
American Aeroparts, a, e thru n, p, q.
American Felt Co., m, a, r.
American Instruments Co., Inc., g, m, a, r.
Aro Equipment Corp., a, c, h, m.
Atlantic Research Corp., c, d, m.
Automation Products, Inc., h, j.
Avien, Inc., f, h, j, l.
B & F Instruments, Inc., q.
Barrett-Christie Co., a, g thru k, m.
Barton Instrument Corp., c, h, m.
Bearing Inspection, Inc.
Bendix-Aviation Corp., Pioneer-Centrol Div., h.
Boston Auto Gage Co., The, f, h. j.
Branson Instruments, Inc., r, t.
Bristol Co., The, a, c, g, l, m, a, p.
Brush Instruments, Div.-Clevite Corp., c, d, e, g, m, a, q, s.
Cleveland Instrument Co., d, r.
Collins Engrg. Corp., j.
Consolidated Controls Corp., a, e, g, k, m, p, s.
Consolidated Diesel Electric Corp., a, c, e, g, i, k, l, m, p.
Consolidated Electrodynamics Corp., c, d, m, a.
Curtiss-Wright Corp., Research Div., r.
Curtiss-Wright Electronics Div., IMI Branch, a, c, e, g, k, m.
Daytronic Corp., d, n, q, r.
Decker Corp., The, c, d, r.
Delsen Corp., r.
Denison Engrg. Div., American Brake Shoe Co., h.
J. W. Dice Co., r, t.
Henry G. Dietz Co., Inc., a, c.
W. C. Dillon & Co., Inc., q, s.
Dynamic Instrument Co., Inc., a, c, d, g ,i, m, a.
Thomas A. Edison Ind. Instrument Div.-Mc Grow-Edison Co., a, c, k, l, m, s.
Electro Auto-Lite Co., The, a, e, g, j thru m.
Electronic Control Corp., r.
Federal Products Corp., r.
Fischer & Porter Co., a, c, e thru k, m, n.
Fisher Scientific Co., a, m.
Fleetwood Labs., Inc., r.
Gardner Laboratory, Inc., r.
General Electric Co., Apporatus Sales Div., r.
Generol Electric Co., X-Ray Dept., h, r.
General Scientific Equipment Co., a.
Gilmore Industries, Inc., m, a.
Gits Brothers Mfg. Co., a, h, j, m.
Glassco Instrument Co., a, b, c, e, g, i, k, m.
Gulton Industries, Inc., m, r.
Hagan Chemicals & Controls, Inc., a.
High Vacuum Equipment Corp., a.
E. Vernon Hill & Co., a, l.
Hoke, Inc., a, m.
Imtra Corp., q.
Industrial Control Co., a.
Instruments Div.-Philips Electronics, Inc., r.
International Register Co., g, k, m.
Jerguson Gage & Valve Co., h.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co., Inc., i, m, p.
Land-Air Inc., d, f, h, n.
*LEWIS ENGRG. CO., THE, l.
Liquidometer Corp., The, h, n.
Magnaflux Corp., a, r, t.
Magnetic Instrument Co. Inc., f, h.
Jas. P. Marsh Corp., a, b, e, g, i, k, m.
Matheson Co., Inr., The, a, m.
Meriam Instrument Co., c, h, m.
Merz Engrg., Inc., r.
Minneapolis-Honeywell Regulator Co., Aeronautical Div., a, c, f, h, j, l, m, n.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, a, c, e thru m, a, p, q.
NRC Equipment Corp., a, m.
National Research Corp., m.
Norwood Controls Unit Detroit Controls Div., a, b, c, g, h, i, k, m, a.
Ohio Semiconductors, Inc., d.
Dhmort Corp., The, h.
Dwatonna Tool Co., g.
Pacific Scientific Co., l, p.
Photocon Research Products, d, a.
Puritan Compressed Gas Corp., Aviation Div., a.
Pyles Industries, Inc.
Republic Mfg. Co., h, j.
Revere Corp. of America, f, h, j.
Rochester Mfg. Co. Inc., a, c, e thru p.
Rosemount Engrg. Co., l, m.
Milton Roy Co., h.
Sonborn Co., c, d, m.
Schauer Mfg. Corp., b.
Scientific Instrument Co., a, c, l, m.
Sheffield Corp., The, Sub.-Bendix Aviotion Corp., r.
Simmonds Aerocessories, Inc., d, f, h, j, n.
Snap-Dn-Tools Corp., b.
Sperry Products, Inc., t.
Squiers Gage Co., m, n, a.
Standard Controls, Inc., a, c, e, g, k, m.
Statham Instruments, Inc., a, c.
Sun Electric Corp., Aeronauticol Div., b, i.
Taft-Peirce Mfg. Co., The, d, r.
Telechrome Mfg. Corp., d, g, l, m, a, q, s.
Thomas Electronics, Inc., r.
Uehling Instrument Co., a, c, f, h, i, j, m, p.
Unit Process Assemblies, Inc., r.
Varion Associates, p.
Wallace & Tiernan Inc., a, c, f, g, m, n, p.
Weston Instruments, Div.-Doystrom, Inc., m, p. r.
Wye Industries, t.

GAUSSMETERS
Device Development Corp.
Electro-Tech Equipment Co.
General Electric Co., Apparatus Sales Div.
Magnaflux Corp.
Ohio Semiconductors, Inc.
Rawson Electrical Instrument Co.
T-C Div., Dyna-Empire, Inc.
Varian Associates
Wright Engrg. Co.

GEAR ASSEMBLIES, LANDING
See LANDING GEAR ASSEMBLIES

GEAR ASSEMBLIES REDUCTION
Actuotor Products Div., Geartronics Corp.
American Machine & Foundry Co., Government Products Group
Arch Gear Works Inc.
Atlantic Instrument Corp., Sub.-Americon Electronics, Inc.
Atlas Precision Products, Co.
Bendix-Pacific Div., Bendix Aviation Corp.
Boston Gear Works
Bowmor Instrument Corp.
Clark Equipment Co.
Consolidoted Diesel Electric Corp.
Control Circuits Inc.
Crane Carrier Corp.
Croname Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp.
Dynamic Gear Co., Inc.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Elgin Micronics Div.-Elgin National Watch Co.
Exact Engrg. & Mfg. Inc.

FWD Corp.
Fae Instrument Corp.
Feedback Controls, Inc.
Foote Bros. Gear & Machine Corp.
General Electric Co., Apparatus Sales Div.
Globe Industries, Inc.
Gordon Enterprises
Groflex Inc.
Grant Gear Works, Inc.
Hoffman Labs. Div., Hoffman Electronics Corp.
Hoover Electric Co.
Hupp Aviation Co.
Insco Co., Div.-Barry Controls Inc.
Instru-Lec Corp.
Juall Gear Co., Inc.
Kelsey-Hayes Co.
Link-Belt Co.
Lundy Mfg. Corp.
Lyndon Aircroft, Inc.
Merz Engrg., Inc.
Metron Instrument Co.
Newbrook Machine Corp.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Perkins Machine & Gear Co.
Phillips Aviation Co.-Marples Gears
Piosecki Aircraft Corp.
Sorgent Engrg. Corp.
Sier-Bath Gear & Pump Co., Inc.
Singer Mfg. Co., The, Military Products Div.
Southwestern Industries, Inc.
Spiroid Div., Illinois Tool Works
Sterling Precision Corp., Instrument Div.
Strong Scott Mfg. Co., The
Suffolk Products Corp.
Talley Corp., The
Telectro Industries Corp.
U. S. Gear Corp.
Vord Inc.
Vinco Corp.
Waldom Electronics Inc.
Washington Machine & Tool Works, Inc.
Western Design, Div.-U.S. Industries, Inc., Santa Barbara Div.
Western Geor Corp.
Westinghouse Electric Corp.
Wilks Precision Instrument Co., Inc.

GEARS, POWDERED METAL

American Aeroports
Amplex Div.-Chrysler Corp.
Bassick Co., The, Div.-Stewart-Warner
Bergen Carbide Co.
Forsberg Mfg., Co., The
Globe Industries, Inc.
Globe Industries, Inc., Supermet Div.
Lux Clock Mfg. Co., Inc.
Mueller Brass Co.
Raybestos-Manhatton, Inc., Pa.
Milton Ross Metals Co., The
St. Marys Carbon Co.
Sier-Bath Gear & Pump Co., Inc.
Spiroid Div., Illinois Tool Works
Walthom Engrg. Corp.
Western Geor Corp.

GEARS, PRECISION

*AC ELECTRONICS DIV., GENERAL MOTORS CORP.
American Aeroparts
American Machine & Foundry Co., Government Products Group
Arch Gear Works Inc.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Atlas Precision Products, Co.
Beaver Gear Works, Inc.
Belock Instrument Corp.
Bergen Carbide Co.
Boston Gear Works
Bowmar Instrument Corp.
Camdale Precision Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp.
Dockendorff & Co. Inc.
Dynomic Gear Co., Inc.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Eisler Engrg. Co., Inc.
Elgin Micronics Div.-Elgin National Watch Co.
Enterprise Tool & Gear Corp.
Exact Engrg. & Mfg. Inc.
Fae Instrument Corp.
Feedback Controls, Inc.
Foote Bros. Gear & Machine Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Apparatus Sales Div.
Gordon Enterprises
Graflex Inc.
Grant Gear Works, Inc.
Helipot Div.-Beckman Instruments Corp.
Hoffman Labs. Div., Hoffman Electronics Corp.
Hoover Electric Co.
Hupp Aviation Co.
Wolter J. Hyatt Co., The
Hydro Molding Co., Inc.
Instru-Lec Corp.
Juall Geor Co., Inc.
Kelsey-Hayes Co.
*LAVEZZI MACHINE WORKS
Lear, Inc., Grand Rapids Div.
Lear Inc., Lear-Romec Div.
Libroscope Inc.
Litton Industries, Maryland Div.
Lundy Mfg. Corp.
Lux Clock Mfg. Co., Inc.
*LYCOMING DIV., AVCO MFG. CORP.
Massachusetts Gear & Tool Co.-Div.-Geartronics Corp.
W. L. Maxson Corp., The
Mercury Tool & Mfg. Corp.
Micron Gear Co., Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Northrop Corp., The, Nortronics Div.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Perkins Machine & Gear Co.
Phillips Aviation Co.-Marples Gears
Reeves Instrument Corp.
Research Development Mfg. Inc.
Milton Ross Metals Co., The
Sorgent Engrg. Corp.
Sier-Bath Gear & Pump Co., Inc.
Sphinx-American Co.
Spiroid Div., Illinois Tool Works
Sterling Precision Corp., Instrument Div.
Talley Corp., The
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Telectro Industries Corp.
U. S. Gear Corp.
Vard Inc.
Vinco Corp.
Waltham Engrg. Corp.
Washington Machine & Tool Works, Inc.
Wesrep Corp.
Western Design, Div.-U.S. Industries, Inc.; Santa Barbara Div.
Western Gear Corp.
Wright Engrg. Co.

GEARS, RADIO & INSTRUMENT

Acton Labs. Inc.
Arch Gear Works Inc.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Atlas Precision Products, Co.
Beaver Gear Works, Inc.
Bergen Carbide Co.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp.
Dynamic Gear Co., Inc.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Elgin Micronics Div.-Elgin National Watch Co.
Exact Engrg. & Mfg. Inc.
Feedback Controls, Inc.
Groflex Inc.
Grant Gear Works, Inc.
Hoover Electric Co.
Hydro Molding Co., Inc.
Instru-Lec Corp.
Juall Gear Co., Inc.
*LAVEZZI MACHINE WORKS
Lear, Inc., Grand Rapids Div.
Massachusetts Gear & Tool Co.-Div.-Geartronics Corp.
Motorola Inc., Military Electronics Div.
National Pneumotic Co., Inc., Holtzer-Cabot Divs.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Perkins Machine & Gear Co.
Phillips Aviation Co.-Marples Gears
Research Development Mfg. Inc.
Sphinx-American Co.
Spiroid Div., Illinois Tool Works
Telectro Industries Corp.
U. S. Gear Corp.
Vard Inc.
Vinco Corp.
Waldom Electronics Inc.
Waltham Engrg. Corp.
Washington Machine & Tool Works, Inc.
Western Gear Corp.

GENERATING DEVICES, GAS
See GAS GENERATING DEVICES

GENERATOR CONTROLS
See CONTROLS, GENERATOR

GENERATOR & MOTOR STATORS
See STATORS, MOTOR & GENERATOR

GENERATORS
a. Electric AC
b. Electric DC
c. Engine Driven
d. Liquid Oxygen
e. Liquid Oxygen, Mobile
f. Tachometer
g. Timing Marker

Aerojet-General Corp., **a.**
*AIRESEARCH MFG. CO. OF ARIZ., **a, b.**
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., **a, b, d, e.**
Allied Internationol Co., **a, b, c.**
Allis-Cholmers, **a, b, c.**
American Aeroparts, **a, b, e.**
American Bosch Armo Corp., **b, c.**
American Electronics, Inc., Electric Machinery & Equipment Div., **a, c.**
American Machine & Foundry Co., Government Products Group, **a, b.**
Barber-Colman Co., **f.**
Barker Sales Co., **c.**
Beckman Instruments, Inc., Berkeley Div., **f.**
Bendix Aviation Corp., Montrose Div., **f.**
Bendix Aviotion Corp., Red Bank Div., **a, b, c.**
Bogue Electric Mfg., Co., **a, b.**
Caterpillar Tractor Co., Engine Div., **a, c.**
Cedor Engrg. Div.-Control Doto Corp., **a, b, f.**
Collins Engrg. Corp., **g.**
Columbia Electric Mfg. Co., **a, b.**
Consolidated Diesel Electric Corp., **a, b, c.**
Continental Electric Co., Inc., **a.**
Control Dota Corp., **a, b.**
Cummins Engine Co., Inc., **c.**
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Utica Div., **c.**
D. & R. Ltd., **a, f.**
Dalmotor Div., Yubo Consolidated Industries, Inc., **a, b, c, f, g.**
Daystrom Transicoil Div., Daystrom Inc., **f.**
Delco-Remy Div., General Motors Corp., **a, b.**
Detroit Diesel Engine Div.-Generol Motors Corp., **c.**
Diehl Mfg. Co., **f.**
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., **f.**
Eicor Div.-Scronton, **a.**
Electric Auto-Lite Co., The, **b.**
Electric Machinery Mfg. Co., **c.**
Electric Products Co., The, **a, b, c.**
Electro Products Laboratories, Inc., **f.**
*ETS-HOKIN & GALVAN, **a, b, c.**
G–M Labs, Inc., **f.**
G. W. Galloway Co., **e.**
Generol Crystal Co., Inc., **c.**
General Electric Co., Apparatus Sales Div., **a, b, c, f.**
Georator Corp., **a, b, c, f.**
Globe Industries, Inc., **a, b, f.**
Gordon Enterprises, **g.**
Graflex Inc., **a, b.**
Gremco, Inc., **c.**
Guided Missile Div.-De Havilland Aircroft of Canada, Ltd., **a.**
Hallamore Electronics Co., **a.**
*A. W. HAYDON CO., THE, **f. g.**
Hertner Electric Co., The, **a, b, c.**
Hewlett-Packard Co., **f.**
Homelite, Div.-Textron Inc., **a, b, c.**
Hoover Electric Co., **a, b, c, f.**
Hughes Tool Co., Aircraft Div.
Industrial Test Equipment Co., **a.**
Instrument Motors, **a, b, f.**
Instruments Div.-Philips Electronics, Inc., **d.**
Jack & Heintz, Inc., **a, b, c, f.**
Jeta, Inc., **a, b.**
Katolight Corp., **a, b, c.**
*KEARFOTT CO., INC., **a, b, f.**
Ketay Dept., Norden Div., United Aircraft Corp., **f.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **f.**
Land-Air Inc., **g.**
Leach Corp., **a, b, c.**
Leor, Inc., Grand Rapids Div., **a, c.**
Leland Airborne Products, Div.-American Machine & Foundry Co., **a, b, c.**
Linde Co.-Div.-Union Carbide Corp.
Luther Mfg. Co., **a, b, f.**
Meters Inc., **f.**
Microwave Development Labs., Inc.
Minneapolis-Honeywell Regulator Co., Industriol Product Group, **f.**
*MOTOR GENERATOR CORP., **a, b.**
Motoresearch Co., **a, b, c.**
Heinz Mueller Eng. Co. Inc., **a, b, f.**
National Pneumotic Co., Inc., Holtzer-Cabot Divs., **a thru f.**
Ernest Norrman Laboratories, **g.**
Oliver Corp., The, **c.**
D. W. Onan & Sons Inc., **a, b, c.**
Patterson, Moos Div. – Universal Winding Co., Inc., **b.**
Pesco Products Div.-Borg-Warner Corp.
Potter Aeronautical Corp., **f.**
Project Fabrication Corp., **d, e.**
Radionics, Inc., **g.**
Safety Electrical Equipment Corp., **a, b, c.**
Sangamo Electric Co. **a, b, c.**
Servomechanisms, Inc., Mechotrol Div., **f.**
Singer Mfg. Co., The, Military Products Div., **f.**
Small Motors Inc., **a, b, f.**
A. D. Smith Corp., **a, b.**
Stratos, Div.-Fairchild Engine & Airplane Corp., **d**
Superior Air Products Co., **d.**
TKM Electric Corp., **a.**
Tolley Corp., The, **a, b, c, f.**
Tapco Group, Thompson-Ramo-Wooldridge Inc., **a, f.**
Task Corp., **a.**
Telechrome Mfg. Corp., **b, c, d, h, j, l, n, q.**
Tempo Instrument Inc., **g.**
Wacline, Inc., **f.**
Western Design, Div.-U.S. Industries, Inc.; Santa Barbara Div., **a, b, g.**
Western Gear Corp., **a, b.**
Westinghouse Electric Corp., **a, b, c.**
Weston Instruments, Div.-Daystrom, Inc., **f.**
*WHITE DIESEL ENGINE DIV., THE WHITE MOTOR CO., **a, b.**
Wincharger Corp., Sub.-Zenith Radio Corp., **a, b, c.**
Winpower Mfg. Co., **a, b, c.**
Zenith Radio Corp., **c.**

GENERATORS, ELECTRONIC
a. AM & FM
b. Microwave
c. Noise
d. Picture Signal
e. Pulse

f. Signal, AF
g. Signal, FM
h. Signal, RF
i. Signal, SHF
j. Signal, Single Sideband
k. Signal, Sweeping
l. Signal, Television Synchronizing
m. Signal, UHF, VHF
n. Square Wave
o. Ultrasonic
p. Variable Frequency
q. Waveform

MP Inc., e.
dler Electronics, Inc., a, g, h, j, m, q.
eralab Development Co., e, n.
etna Electronics Corp., a.
irborne Instruments Lab., Div.-Cutler-Hammer, Inc., a, b, c, h, p.
ircom Inc., b, k.
ircom Inc. of New Jersey, b.
lfred Electronics, b, k.
llied International Co., a.
merac Inc., b, h.
merican Basch Arma Carp., e.
merican Machine & Foundry Co., Government Products Group, b.
ndersen Labs., a, j, a, p.
renberg Ultrasanic Lab., Inc., a.
vo Ltd., a, f, g.
& K Instruments, Inc., f.
bcock Radio Engrg., Inc., f, g, m.
rker & Williamson Inc., f.
eckman Instruments, Inc., Berkeley Div., e.
ell & Gossett Co., e.
endix Aviation Corp., Red Bank Div., b, c, p.
endix Aviation Corp., York Div., b, c, e, g, h, p.
ackstone Carp., a.
gue Electric Mfg., Co., p.
antan Radio Corp., a, g, h, m.
anson Ultrasonic Corp., a.
own Engrg. Co., Inc., h.
low Electric Co., b, e thru h, m.
rr-Brown Research Corp., f, n.
lifornia Technical Industries, Div.-Textran Inc., b.
ntral Electranic Mfrs., Div.-Nuclear Corp. of America, c.
ntranix Inc., a thru h, j thru q.
alca Engrg. Corp., p.
lorado Research Corp., p.
mmunications Research Co., j.
mmunity Engrg. Corp., k.
ntinental Electronics Mfg. Co., a, e.
osby Laboratories, Inc., j.
bic Corp., e, h, q.
rtiss-Wright Corp., Princeton Div., a.
rtiss-Wright Corp., Research Div., e, a.
to-Control Systems, Inc., f.
ven Co., The, a, f, h, k, a, p.
marnay-Bonardi, b, c.
nner Scientific Co., f, n, p, q.
sser Industries, Inc., f, p.
Kane Corp., f.
mec Inc., b.
gerton, Germeshausen & Grier, Inc., b.
lor, Inc., e, n.
lorado Electronics, e.
lectronic Communicatons, Inc., b, e.
lectronic Engrg. Co. of California, e, n, p, q.
lectronic Instrument Co., Inc. (EICO) f, h, j, l.
lectronic Tube Corp., n.
lectronics of Clearfield, Inc., e, p.
lectronics Div., Van Norman Industries Inc., a, b, g, h, i, k, m, p.
lenco, Inc., c.
lerson Electric Mfg. Co., The, Electronics & Avionics Div., b.
lsire Products Sales Corp., b, e, p.
lrg. Associates, a, b, c, e thru i, m thru p.
MR, Inc. b, c, e, h, m, n, p, q.
leral Mfg. & Engrg. Corp., b, e, g, h, a.
lo-Video Labs., Inc., d, h, l, p.
led Transformer Co. Inc., a.
leral Communication Co., a, b, e thru h, n.
lon Industries, Inc., a.
lex Corp., The, f.
ller, Raymond & Brown Inc. Div., Singer Mfg. Co., q.
llicrafters, e, h, i.
lltine Electronics Div.-Hazeltine Corp.. b, e, h, m.
lwlett-Packard Co., a, b, c, e thru i, m, n, p, q.
lver Electric Co., f, g, h.
lhes Tool Co., Aircraft Div.
lwer J. Hyatt Co., The, b.
lT Federal Div., International Telephone & Telegraph Corp., b, h, m.
lT Labs., a, b, c, f thru j, m.
lustrial Test Equipment Co., f, p.
lncontinental Dynamics Corp., c.
lnternational Research Associates, p.
lnstate Electronics Corp., e.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., b, j.
KB Electric Co., a thru i, k, l, m, a, p, q.
*KARFOTT CO., INC., b.
KATel Div.-Cohu Electronics, Inc., l, a.
Kavox Div.-Electromation Co., e.
Lapkin Labs., Inc., M. R. Div., h, m, p.
Ld-Air Inc., a.
Leie Laboratories Inc., e, m.
Lenthal Electronic Products, Inc., b, e.
Leon Industries, Marylond Div., f, g, h, l, k, m.
Lumatron Electronics, Inc., e, n, p.
Manson Labs., Inc., b, e, h, m, p.
Marconi Instruments, a, c, e, f, g, m, n, p.
Mc Kenna Labs., a.
Measurements Div., McGraw-Edison Co., a, e thru h, m, n.
Meridian Metalcraft, Inc., b.
Minneapolis-Honeywell Regulator Co., Ordnance Div., b, e thru h.
Miratel, Inc., a, b, f, g, h, j, l, m.
Motorola Inc., Military Electronics Div., a, b, c, e thru q.
Munston Mfg. & Service, Inc., g, h.
Narda Ultrasonics Corp., The, a.
National Pneumatic Co., Inc., Haltzer-Cabat Divs., a thru q.
National Ultrasonic Corp., a.
Navigation Computer Carp., e, q.
Ernest Narrman Laboratories, e.
Northeast Scientific Corp., n.
Orbitran Co., Inc., e.
Pacific Radionics, e, a, p.
Paco Electronics Co., Inc., h.
Piasecki Aircraft Carp., m.
Polarad Electronics Carp., a thru e.
Polytechnic Research & Development Co., Inc., b, c.
Power Supplies Inc., a.
Precise Development Carp., a, d thru h, k, l, n, p.
Precision Apparatus Co., Inc., a, f, g, h, k, n.
RS Electronics Corp., c.
Radiation, Inc.
Radiation Instrument Development Lab., Inc., e.
Radiatronics, Inc., b.
Radionics, Inc., a, q.
Raythean Mfg. Co., b.
Resdel Engrg. Carp., b, e, i, m.
Rese Engrg., Inc., e.
Rutherford Electronics Co., e.
Schaevitz Engrg., e.
Scientific-Atlanta, Inc., b, h.
H. H. Scott, Inc., c.
Singer Mfg. Co., The, Military Products Div., e.
Special Instruments Div., British Industries Carp., e.
Specialty Engrg. & Electronics Co., e, f, h.
Spectrum Instruments, Inc., q.
Sperry Microwave Electranics Co., Div.-Sperry Rand Carp., b.
Staddart Aircraft Radio Co., Inc., e.
Systems Inc., a, b, c, e thru k, p, q.
Systron Carp., p.
Talley Corp., The, a, b, c, e.
Tapco Group, Thompson-Ramo-Wooldridge Inc., p.
Technical Apparatus Builders, p.
Technitrol Engrg. Co., e, p.
Telechrome Mfg. Carp., a thru e, g thru j, l, m, n, q.
Telectro Industries Corp., a, d thru n.
Telerod Mfg. Carp., b.
Teletronics Lab. Inc., e.
Tel-Instrument Electronics Corp., d, h, k, l, m, p.
Telonic Industries, Inc., e, h, k, m.
Tempo Instrument Inc., e.
Transonic, Inc., f, n.
Twenty-First Century Electronics, Inc., h.
U. S. Industries, Inc., c, d.
U. S. Science Corp., Div.-Topp Industries, Inc., h, m.
Walkirt Co., e, n.
Waltham Electronics Corp., a, b, c, f thru i, m, n.
Wang Labs., Inc., e, p, q.
Waveline, Inc., b.
Weinschel Engrg., b, e, h, i, m, n.
Wright Engrg. Co., b, c, h, i, m.

GENERATORS, GAS

*McCORMICK SELPH ASSOCIATES

GENERATORS, STARTER

*ELECTRICAL ENGRG. & MFG. CORP.

GEOPHYSICAL APPARATUS

Aerolab Development Co.
Anton Electronic Labs., Inc.
Associated Research, Inc.
Benson-Lehner Corp.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
J. W. Fecker, Inc.
Fisher Research Lab., Inc.
General Devices, Inc.
Georotor Corp.
Geotronic Labs. Inc.
Gordon Enterprises
Instrumentation Div.-Ampex Corp.
Mast Development Co., Inc.
Midwestern Instruments, Inc.
Minneapolis-Honeywell Regulator Co., Boston Div.
Moran Instrument Corp.
Motorola Inc., Military Electronics Div.
Seiscor Mfg. Co.
Southwestern Industrial Electronics Co.
Spectrum Instruments, Inc.
Twenty-First Century Electronics, Inc.
United Electrodynamics, Inc.
U. S. Industries, Inc.
Varian Associates
Virginio Electronics Co., Inc.

GLASS JEWELS

See JEWELS, GLASS

GLASS, LOW MELTING POINT

*ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.

GOVERNORS, MISSILE CONTROL

*BENDIX AVIATION CORP., HAMILTON DIV.
Graflex Inc.
Guided Missile Div.-De Havilland Aircraft of Canada, Ltd.
Haaf Products Co.
Hoover Electric Co.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.

GRAPHIC RECORDING INSTRUMENTS

See INSTRUMENTS, GRAPHIC RECORDING

GRAPHITE ANODES

See ANODES, GRAPHITE

GRID FRAMES

Astronautics Engrg. Co.
Monogram Precision Industries
Staver Co., Inc., The

GRIDS

Astronautics Engrg. Co.
Jadee Plastics Co.
Monogram Precision Industries
Staver Co., Inc., The

GRILLES, METAL

A&P Metal Products Mfg. Carp.
Abalon Precision Mfg. Carp.
Adept Industries Inc.
Alpitec, Inc.
American Aluminum Co.
Anchor Metal Spinning Co., The
B. H. Aircraft Co., Inc.
Bendix Aviation Carp., York Div.
Cornell Deep Drawing Co., Div.-Lanes Industries Carp.
Croname Inc.
Etched Products Carp.
Flack Process Co., Inc.
Lofstrand Co., The
Mercury Tool & Mfg. Corp.
Mid-West Metal Products, Inc.
Monogram Precision Industries
Charles Mundt & Sons
Pioneer Industries Div., Almar-York Co. Inc.
Edw. Renneburg & Sons Co.
Rimak, Inc.
Rolock Inc.
Stainless Inc.
Teiner Engrg. Corp.

GRILLES, MOLDED PLASTIC

Adept Industries Inc.
American Insulator Corp.
Chemold Co.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Crystal-X Corp.
Erie Resistor Corp.
Haidman Tool & Engrg., Co.
Haveg Industries, Inc.
Hughes Tool Co., Aircraft Div.
Joclin Mfg. Co.
Lamtex Industries, Inc.
Lancaster Gloss Corp.
Minnesota Mining & Mfg. Co.
Perry Plastics, Inc.
Plastic Age Sales, Inc.
Milton Ross Metals Co., The
Universal Moulded Products Corp.

GRILLS, SPEAKER

Croname Inc.
Etched Products Corp.
Flock Process Co., Inc.
Charles Mundt & Sons
Pacific Cut Washer Co.
Peerless Products Industries
Perry Plastics, Inc.
Milton Ross Metals Co., The
Rubber Teck Inc.
Waterbury Companies, Inc.
Western Felt Works & Acodia Synthetic Products Div.

GRINDERS & BUFFERS

See BUFFERS & GRINDERS

GROMMETS

Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Brass Co., The
Auburn Mfg. Co., The
Auburn Spark Plug Co., Inc.
Calinoy-Div.-Illinois Tool Works
Century Fasteners Corp.
Colonial Rubber Co.
Continental Rubber Works
Eljay Corp.
Federal Screw Products Inc.
General Gasket Inc.
Goshen Rubber Co., Inc.
Hallett Mfg., Co.
Hoosier Torpaulin & Canvas Goods Co., Inc.
Joclin Mfg. Co.
Lord Mfg. Co.

Minnesota Rubber Co.
Molding Corp. of America
Orchard Industries, Inc., Actionflex Div.
Penn Fibre & Specialty Co., Inc.
Pneumafil Corp.
Roberts Toledo Rubber Co., The
Milton Ross Metals Co., The
Rubbercraft Corp. of California
Silicone Insulation, Inc.
Stanley-Judd Div.-The Stanley Works
Thermech Engrg. Corp.
Turbo Products, Inc.
United Shoe Machinery Corp., Ordnance Dept.
Waldom Electronics Inc.
Wasley Products, Inc.
Wilcox-Crittenden Div., North & Judd Mfg. Co.

GROMMETS, FIBRE

All Specs Corp.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Missile Products Co., Inc.
Auburn Mfg. Co., The
Comco Plastics Inc.
Continental Diamond Fibre Corp.
Eljay Corp.
Emerson Plastics Corp.
Federal Screw Products Inc.
General Gasket Inc.
Haveg Industries, Inc.
Heyman Mfg. Co.
Hoosier Tarpaulin & Canvas Goods Co., Inc.
Joclin Mfg. Co.
National Tel-Tronics Corp.
National Vulcanized Fibre Co.
***PACKARD-BELL ELECTRONICS CORP.**
Penn Fibre & Specialty Co., Inc.
Rogers Corp.
Waldom Electronics Inc.
Wilmington Fibre Specialty Co.

GROUND BASED MISSILE LAUNCHERS
See LAUNCHERS, GROUND BASED MISSILE

GROUND CHECK-OUT EQUIPMENT, MISSILES
See MISSILES, GROUND CHECK-OUT EQUIPMENT

GROUND HANDLING EQUIPMENT, MISSILES

ACF Industries Inc.
Accessory Controls & Equipment Corp.
Accessory Products Co., Div.-Textron Inc.
Acco Equipment Div., American Chain & Cable Co., Inc.
Aero Leather Products Co.
Aerojet-General Corp.
Aeroscience, Inc.
Air Logistics Corp.
Aircraft Armaments, Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Alad Aluminum Ladder Corp.
Alco Products, Inc.
***ALUMINUM SAFETY PRODUCTS, INC.**
Amelco, Inc.
American Air Filter Co., Defense Products Div.
American Car & Foundry, Div.-ACF Industries, Inc.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
American Missile Products Co., Inc.
American Steel Foundries, Hammond Div.
Anchor Metal Spinning Co., The
Applied Design Co.
Arnolt Corp.
Associated Engineers, Inc.
Astronautics Engrg. Co.
Atlas Precision Products, Co.
Austin-Western, Constr. Equip. Div., Baldwin-Lima-Hamilton Corp.
***AVCO MFG. CORP., CROSLEY DIV.**
Baker Industrial Trucks, Div.-Otis Elevator Co.
Basco Metal Products, Inc.
Bassick Co., The, Div.-Stewart-Warner
Beaver Precision Products Inc.
Belock Instrument Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Products Div.-Missiles, Bendix Aviation Corp.
Bendix Radio Div., Bendix Aviation Corp.
Benson Mfg., Co., The
Berger Brothers Co., The
Bil-Jax, Inc.
E. W. Bliss Co.
Bowser, Inc., Defense Dept.
Breeze Corporations, Inc.
Brooks & Perkins, Inc.
Brown Engrg. Co., Inc.
Bruce Engrg. Co.
Butler Mfg. Co.
Byron-Jackson Pumps Inc.
Capitol City Mfg. Co.
Chalco Engrg. Corp.
C. B. Christiansen Co.
Chrysler Corp., Defense Operations Div.
Clark Equipment Co.
Cleveland Pneumatic Industries, Inc.
Coleman Engrg. Co., Inc.
Colonial Aircraft Corp.
Columbia Research & Development Corp.
Conco Engrg. Works
Consolidated Diesel Electric Corp.
Consolidated Diesel Electric Corp., Test Equip. Div.
Consolidated Diesel Electric Corp., Western Div.
Continental Technical Service, Inc.
Control Engrg. Co., Div. Jervis B. Webb Co.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Cornelius Co., The, Aero Div.
Craig Systems, Inc.
Crane Carrier Corp.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., South Bend Div.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Data-Control Systems, Inc.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp.
Diversey Engrg. Co.
Double E Products Co.
Dresser Industries, Inc.
Dresser-Ideco Co., Div.-Dresser Industries, Inc.
Edgerton, Germeshausen & Grier, Inc.
Eidal Mfg. Co., Inc.
Electro-Mechanical Products Co.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Emerson Radio & Phonograph Corp.
FWD Corp.
Fairchild Astronics Div., Fairchild Engine & Airplane Corp.
Farrel Birmingham Co., Inc.
Federal Mfg. & Engrg. Corp.
Firestone Tire & Rubber Co., The, Guided Missile Div.
Food Machinery & Chemical Corp.
Fruehauf Trailer Co., Military Equipment Div.
Fulton-Irgon Corp., The
Gabriel Co., The-Talco Engrg. Co. Div.
G. W. Galloway Co.
General Electric Co., Missile & Space Vehicle Dept.
Globe Hoist Co.
Goodyear Aircraft Corp.
Gremco, Inc.
Griscom-Russell Co., The
Hallicrafters
***HARCO CONTAINERS DIV.-HARBOR BOAT BUILDING CO.**
Paul Hardeman, Inc.
Hardman Tool & Engrg. Co.
Haskel Engrg. & Supply Co.
Highland Rim Machine Works Inc.
Ludwig Honold Mfg. Co.
Hoover Electric Co.
Horkey-Moore Associates
Houston Fearless Corp.
Hufford Corp., The
Hughes Aircraft Co.
Hughes Tool Co., Aircraft Div.
Hussmann Aircraft Div.
Walter J. Hyott Co., The
Hydro-Power Corp.
***HYDRO-AIRE CO., DIV.-CRANE CO.**
ITT Federal Div., International Telephone & Telegraph Corp.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Integral Corp.
Intercontinental Mfg. Co., Inc.
Interstate Engrg. Corp.
Jack & Heintz, Inc.
Jeta, Inc.
Kohn & Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kaiser Steel Corp., Fabricating Div.
Kanarr Corp.
Kemp Aero Products
Land-Air Inc.
Lear, Inc., Grand Rapids Div.
R. G. Letourneau, Inc.
Liggett Supply & Equipment Co.
Link-Belt Co.
Longren Aircraft Co., Inc.
Machine Products Div., New Haven Trap Rock Co.
Mack Trucks, Inc., Government Div.
Marotta Valve Corp.
Marquardt Aircraft Co.
Mast Development Co., Inc.
Mc Dowell-Wellman Companies, The
Mechanics Universal Joint Div., Borg-Warner Corp.
Metronix, Inc., Sub.-Assembly Products, Inc.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Drdnance Div.
***MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.**
Monogram Precision Industries
Monrovia Aviation Corp.
George L. Nankervis Co.
Nebel Machine Tool Corp.
***NEWAY EQUIPMENT CO.**
Newbrook Machine Corp.
Northrop Corp., The, Nortronics Div.
Nuclear Products-Erco Div.-ACF Industries, Inc.
Opelika Welding, Machine & Supply Inc.
Optimized Devices, Inc.
Otis Elevator Co., Electronic Div.
Philco Corp., Government & Industriol Div.
Philips & Davies, Inc.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.
Precision Shapes, Inc.
Precision Sheet Metal, Inc.
Pre-Flite Industries Corp.-Sub. – AVCD Corp.
Project Fabrication Corp.
Pry Welding & Mfg., Inc.
Ramo-Wooldridge Div., Thompson-Ramo-Wooldridge of Calif.
Ravenna Metal Products, Div.-Standard Screw Co.
Red Lion Cabinet Co., Redco Tool Div.
Regent Jack Mfg, Co., Inc.
Republic Aviation Corp.
Research Controls
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Royal Industries, Inc.
Sancor Corp.
Sondberg-Serrell Corp.
Sargent Engrg. Corp.
Scaife Co.-Div.-Wilson Bros.
Schaffer Air Industries, Inc.
Seeburg Corp., The
Servo Corp. of America
Skyline Products, Inc.
Space Corp.
Special Projects Lab., Food Machinery & Chemical Corp.
Stainless Inc.
Stainless Steel Products, Inc.
Stanley Aviation Corp.
Stearns-Roger Mfg. Co.
A. U. Stone & Co., Inc.
Strong Scott Mfg. Co., The
Sun Electric Corp., Aeronautical Div.
Systron Corp.
Talley Corp., The
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Telectro Industries Corp.
Texas Metal & Mfg. Co., Inc.
Theto Instrument Corp.
Thiokol Chemical Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Trailmobile Inc.
Turbo Products, Inc.
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
United Mfg. Co., The
United Mfg. Co., Div., The W. L. Maxson Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
United States Chemicol Milling Corp.
Universal Metal Products Inc.
Van Zelm Associates, Inc.
Vard Inc.
Vickers Inc., Div.-Sperry Rond
Vitro Labs.
Washington Technological Associates Inc.
Wayne Pump Co., The, Div.-Symington Wayne Corp
Weber Aircraft Corp.
Welded Construction Inc.
Wenzlau Engrg. Co.
***R. D. WERNER CO., INC.**
Western Design, Div.-U. S. Industries, Inc.; Santa Barbara Div.
Western Gear Corp.
Westinghouse Air Brake Co., Industrial Products D
Westinghouse Electric Corp.
Whelond Co., The
Wickfield, Inc.
Winder Aircraft Corp. of Florida
Wintronics

GROUND HOISTS
See HOISTS, GROUND

GROUND LANDING SYSTEMS

Air Logistics Corp.
Associated Engineers, Inc.
Astronautics Engrg. Co.
Atlas Precision Products, Co.
***AVCO MFG. CORP., CROSLEY DIV.**
Bell Aircraft Corp., Niagara Frontier Div.
Belock Instrument Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Products Div.,-Missiles, Bendix Aviation Corp.
Bogue Electric Mfg., Co.
Brown Engrg. Co., Inc.
Cleveland Pneumatic Industries, Inc.
Collins Radio Co.
Craig Systems, Inc.
Dalmotor Div., Yuba Consolidated Industries, Inc
Data-Control Systems, Inc.
Gilfillon Bros. Inc.
ITT Federal Div., International Telephone & Telegraph Corp.
***KEARFOTT CO., INC.**
Land-Air Inc.
Litton Industries, Moryland Div.
Longren Aircraft Co., Inc.
Minneapolis-Honeywell Regulator Co.-Aeronautic Div.
Motorola Inc., Military Electronics Div.
National Pneumatic Co., Inc., Holtzer-Cabot Div
Otis Elevator Co., Electronic Div.
Philco Corp., Government & Industrial Div.
Raytheon Mfg. Co., Government Equipment Div.
Telectro Industries Corp.
U. S. Industries, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Washington Technologicol Associates Inc.
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida

UND NAVIGATION EQUIPMENT
e NAVIGATION EQUIPMENT, GROUND

UND POWER SOURCES
e POWER SOURCES, GROUND

UND REFRIGERATION EQUIPMENT
e REFRIGERATION EQUIPMENT, GROUND

UND STRIPS
e STRIPS, GROUND

RDS, SWITCH
e SWITCH GUARDS

DANCE EQUIPMENT, MISSILES

AC ELECTRONICS DIV., GENERAL MOTORS CORP.
CF Industries Inc.
erojet-General Corp.
AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
melco, Inc.
merican Bosch Arma Corp.
merican Machine & Foundry Co., Greenwich
stronautics Engrg. Co.
tlas Precision Products Co.
eaver Precision Products Inc.
ell Aircraft Corp., Niagara Frontier Div.
elock Instrument Corp.
endix Aviation Corp., Eclipse-Pioneer Div.
endix Aviation Corp., Friez Instrument Div.
endix-Pacific Div., Bendix Aviation Corp.
rown Engrg. Co., Inc.
urroughs Corp.
ameraflex Corp.
anago Div., Underwood Corp.
alco Engrg. Corp.
hicago Aerial Industries, Inc.
hrysler Corp., Defense Operations Div.
ollins Radio Co.
almotor Div., Yuba Consolidated Industries, Inc.
ato-Control Systems, Inc.
avidson Mfg., Co., Inc.
eyton Aviation Radio & Equipment Corp.
ivco-Wayne Electronics, Div.-Divco-Wayne Corp.
iversey Engrg. Co.
uble E Products Co.
agle-Picher Co., The
astern Industries Inc.
homas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
lectro Development Co.
lectro-Mechanical Products Co.
lectronic Communications, Inc.
merson Electric Mfg. Co., The, Electronics & Avionics Div.
merson Radio & Phonograph Corp.
airchild Astrionics Div., Fairchild Engine & Airplane Corp.
ederal Mfg. & Engrg. Corp.
ord Instrument Co., Div.-Sperry Rand Corp.
eneral Devices, Inc.
eneral Precision Lab. Inc.
ilfillon Bros. Inc.
oflex Inc.
uided Missile Div.-DeHovilland Aircroft of Conodo, Ltd.
ollamore Electronics Co.
ollicrofters
oyword Scientific Gloss Corp.
ozeltine Electronics Div.-Hozeltine Corp.
offmon Labs. Div., Hoffmon Electronics Corp.
G. Hokonson Co., Inc.
oover Electric Co.
ughes Aircroft Co.
unter J. Hyott Co., The
T Federol Div., Internationol Telephone & Telegroph Corp.
f Labs.
onsky & Boiley, Inc.
EARFOTT CO., INC.
elsey-Hayes Co.
imp Aero Products
ievox Div.-Electromotion Co.
and-Air Inc.
ear, Inc.
ear, Inc., Grond Rapids Div.
evoscope Inc.
ibton Industries, Marylond Div.
ifotto Volve Corp.
M. Moxson Corp., The
inneopolis-Honeywell Regulotor Co.-Aeronouticol Div.
inse Instrument Co., The
larolo Inc., Military Electronics Div.
ational Pneumotic Co., Inc., Holtzer-Cobot Divs.
ewton Co., The
orthrop Corp.
orthrop Corp., The, Nortronics Div.
erkin-Elmer Corp.
hilco Corp., Government & Industrial Div.
ioneer Tool & Engrg. Co.
recision Shopes, Inc.
reflation, Inc.
amo-Wooldridge Div., Thompson Romo Wooldridge Of Colif.
aytheon Mfg. Co., Government Equipment Div.
eeves Instrument Corp.
epublic Aviation Corp.
oyal Industries, Inc.
yan Aeronouticol Co., The
anto Barbora Research Center
eiscor Mfg. Co.
ervo Corp. of Americo
hannon Luminous Materiols Co.
inger Mfg. Co., The, Military Products Div.
kiatron Electronics & Television Corp.
mith-Marris Corp.
pecialties, Inc.
perry Farragut Co., Div.-Sperry Rand Corp.
perry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp.
perry Piedmont Co. — Div.-Sperry Rand Corp.
tavid Engrg., Inc.
tromberg-Carlson Div.-Generol Dynamics Corp.
ummers Gyroscope Co.
ystems Inc.
ele-Dynamics Inc.
elerad Mfg. Corp.
insley Labs., Inc.
opper Mfg. Co., Inc.
wenty-First Century Electronics, Inc.
. S. Industries, Inc.
nited States Time Corp.
arian Associates
oldorf Electronics. Div.-F.C. Huyck & Sons
oltham Engrg. Corp.
oshington Aluminum Co., Inc.
oste King Corp., Technicol Products Div.
ebcor, Inc., Government Div.
estinghouse Electric Corp.
hittaker Gyro. Div.-Telecomputing Corp.
inzen Reseorch Inc.

Servo Corp. of America
Servomechanisms, Inc.
Skiatron Electronics & Television Corp.
Sperry Farragut Co., Div.-Sperry Rand Corp.
Stainless Inc.
Summers Gyroscope Co.
Superior Carbon Products, Inc.
Telectro Industries Corp.
Telerad Mfg. Corp.
Twenty-First Century Electronics, Inc.
U. S. Industries, Inc.
United States Time Corp.
Varian Associates
Vinco Corp.
Washington Technological Associates Inc.
Waste King Corp., Technical Products Div.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Webcor, Inc., Government Div.
Westinghouse Electric Corp.
Whittaker Gyro. Div.-Telecomputing Corp.
Zenith Optical Laboratory

GUIDANCE SYSTEMS
a. Infrared
b. Inertial
c. Pilotless Aircraft
d. Radar
e. Radio
f. Stellar

*AC ELECTRONICS DIV., GENERAL MOTORS CORP., b, c.
ACF Industries Inc., a thru e.
Aerojet-General Corp., a.
Aeronca Mfg. Corp., d, e.
Amelco, Inc., c, e.
American Bosch Arma Corp., b.
American Machine & Foundry Co., Greenwich, a.
American Optical Co., Instrument Div., a.
Arma Div., American Bosch Arma Corp., b.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., a.
Atlas Precision Products, Co., c, d.
Babcock Radio Engrg., Inc., c.
*BAUSCH & LOMB OPTICAL CO., a.
Bell Aircraft Corp., Niagara Frontier Div., a thru d.
Belock Instrument Corp., a, b, d.
Bendix Aviation Corp., Eclipse-Pioneer Div., b, c.
Bendix Aviation Corp., Friez Instrument Div.
Bendix-Pacific Div., Bendix Aviation Corp., d.
Bendix Radio Div., Bendix Aviation Corp., c, d.
Blow-Knox Equipment, Div.-Blow-Knox Co., d, f.
Brown Engrg. Co., Inc., b.
Bulow Electric Co., a.
Burroughs Corp., a, d.
Canoga Div., Underwood Corp., d.
Cedar Engrg. Div.-Control Data Corp., a, b.
Centronix Inc., d, e.
Chicago Aerial Industries, Inc., a, c, f.
Collins Radio Co., c, e.
Communications Research Co., f.
Cooper Development Corp., Sub.-Marquardt Aircroft Co., a.
DBM Research Corp., d.
Dalmotor Div., Yuba Consolidated Industries, Inc., b, c.
Doto-Control Systems, Inc., e.
Dovidson Mfg., Co., Inc., a.
Doystrom Pacific Div.-Doystrom, Inc., a, b.
Doyton Aviation Rodio & Equipment Corp., e.
Divco-Woyne Electronics, Div.-Divco-Woyne Corp., d, e.
Donner Scientific Co., b.
Eostmon Kodok Co., a.
Thomos A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Electro Development Co., c, d.
Electronic Communicotions, Inc., a, c thru f.
Electronic Reseorch Associotes, Inc., e.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., a, b, d, e.
Emerson Rodio & Phonograph Corp., c, d, e.
Foirchild Astrionics Div., Foirchild Engine & Airplone Corp., b thru e.
Federol Mfg. & Engrg. Corp., c, d.
Feedbock Controls, Inc., c.
Ford Instrument Co., Div.-Sperry Rond Corp., b thru e.
Generol Devices, Inc., e.
Generol Precision Lob. Inc., a, b, d, f.
G. M. Giannini & Co., Inc., b.
Gilfillon Bros. Inc.
Goodyeor Aircroft Corp., c, d, f.
Guided Missile Div.-De Hovilland Aircroft of Conodo, Ltd., a.
Gulton Industries, Inc., b.
Hollomore Electronics Co., c.
Holler, Roymond & Brown Inc. Div., Singer Mfg. Co., a.
Hollicrofters, d, e.
Homilton Standord, Div.-United Aircroft Corp., a.
Hozeltine Electronics Div.-Hozeltine Corp., a thru e.
Hoover Electric Co., c.
Hughes Aircroft Co., a, d.
Wolter J. Hyott Co., The, a, b, d.
Hydro-Power Corp., b, c, f.
ITT Federol Div., Internotionol Telephone & Telegroph Corp., a, d, e.
ITT Lobs., a thru f.
ITT Lobs.-Ft. Wayne, a.
Internotionol Business Mochines Corp.-Military Products Div., b, f.
Jonsky & Boiley, Inc., e.

*KEARFOTT CO., INC., a, b, c, f.
Kelsey-Hayes Co.
Land-Air Inc., b, c.
Lear, Inc., a, b, c, e.
Lear, Inc., Grand Rapids Div., b, c, e.
Levinthal Electronic Products, Inc., d.
Librascope Inc., a.
Litton Industries, Inc., b.
Litton Industries, Maryland Div., d, e, f.
Lockheed Aircraft Corp., Missiles & Space Div., a, d, e.
W. L. Maxson Corp., The, b, c, d.
Mergenthaler Linotype Co., a.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., a, b, c.
Missouri Research Labs., Inc., c, d.
Monogram Precision Industries, a, d.
Morse Instrument Co., The, d.
Motorola Inc., Military Electronics Div., a thru e.
Narmco Mfg. Co.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., e.
Northrop Corp., a thru f.
Northrop Corp., The, Nortronics Div., a, b, c, f.
*PACKARD-BELL ELECTRONICS CORP., b, d.
Patterson, Moos Div. — Universal Winding Co., Inc., a.
Perkin-Elmer Corp., a, f.
Philco Corp., Government & Industrial Div., a thru f.
Piasecki Aircraft Corp., c, d, e.
Pioneer Tool & Engrg. Co., b.
Power-Tronic Systems Inc., b, c, f.
Radiation, Inc.
Ramo-Wooldridge Div., Thompson Ramo Wooldridge of Calif.
Raytheon Mfg. Co., d.
Raytheon Mfg. Co., Government Equipment Div., a, c, d, e.
Reeves Instrument Corp., b, d.
Republic Aviation Corp., a thru e.
Royal Industries, Inc., a.
Ryan Aeronouticol Co., b, c, d.
Santa Barbora Research Center, a, f.
Seiscor Mfg. Co., e.
Servo Corp. of Americo
Shannon Luminous Materiols Co., b.
Singer Mfg. Co., The, Military Products Div., a.
Skiatron Electronics & Television Corp., a, d, e, f.
Smith-Marris Corp.
Specialties, Inc., c.
Sperry Farragut Co., Div.-Sperry Rand Corp., b, d.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp., b.
Sperry Piedmont Co. — Div.-Sperry Rand Corp., b, d.
Stavid Engrg., Inc., d.
Stromberg-Carlson Div.-Generol Dynamics Corp., e.
Summers Gyroscope Co., b, c.
Systems Inc., a, c, d.
Tele-Dynamics Inc., c, e.
Telerad Mfg. Corp., d.
Tinsley Labs., Inc., a.
Topper Mfg. Co., Inc., a.
Twenty-First Century Electronics, Inc., a.
U. S. Industries, Inc., a, d.
United States Time Corp., a, b.
Varian Associates, d.
Woldorf Electronics. Div.-F.C. Huyck & Sons, d, e.
Woltham Engrg. Corp., b.
Woshington Aluminum Co., Inc., d.
Woste King Corp., Technicol Products Div., b, c.
Webcor, Inc., Government Div., a thru f.
Westinghouse Electric Corp., a thru e.
Whittaker Gyro. Div.-Telecomputing Corp., c.
Winzen Reseorch Inc., e.

GUIDED MISSILE TELEMETERING

*AC ELECTRONICS DIV., GENERAL MOTORS CORP.
ACF Industries Inc.
Adler Electronics, Inc.
Aerojet-Generol Corp.
Aeronco Mfg. Corp.
Aircom Inc.
American Missile Products Co., Inc.
Applied Science Corp. of Princeton
Atlas Precision Products, Co.
Borker Sales Co.
Beaver Precision Products Inc.
Bell Aircraft Corp., Niogoro Frontier Div.
Belock Instrument Corp.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix Aviation Corp., York Div.
Bendix-Pacific Div., Bendix Aviation Corp.
Brush Instruments, Div.-Clevite Corp.
Bulow Electric Co.
Centronix Inc.
Chrysler Corp., Defense Operations Div.
Clory Dynamics
Clevelond Metol Specialties Co., Electronics Div.
Communications Research Co.
Cooper Development Corp., Sub.-Marquardt Aircroft Co.
Curtiss-Wright Electronics Div., IMI Branch
Doto-Control Systems, Inc.
Edgerton, Germeshousen & Grier, Inc.
Electro-Mechanicol Products Co.
Electro-Mechanicol Reseorch, Inc.
Electro Tec Corp.
Electronic Communications, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Emerson Rodio & Phonograph Corp.

Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Federal Mfg. & Engrg. Corp.
Firestone Tire & Rubber Co., The, Guided Missile Div.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Devices, Inc.
Gilfillan Bros. Inc.
Graflex Inc.
Hallamore Electronics Co.
Hazeltine Electronics Div.-Hazeltine Corp.
Hogan Laboratories, Inc.
ITT Federal Div., International Telephone & Telegraph Corp.
Instrumentation Div.-Ampex Corp.
Kauke & Co.
Land-Air Inc.
Lear, Inc.
L E L, Inc.
Litton Industries, Inc.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Magnavox Co., The
Minneapolis-Honeywell Regulator Co.-Davies Labs. Div.
Minnesota Mining & Mfg. Co.
Motorola Inc., Military Electronics Div.
Narmco Mfg. Co.
Networks Electronic Corp.
Otis Elevator Co., Electronic Div.
***PACKARD-BELL ELECTRONICS CORP.**
Ralph M. Parsons Co., The, Electronics Div.
Philco Corp., Government & Industrial Div.
Polarad Electronics Corp.
Radiaphone Co. Inc.
Radiation, Inc.
Ramo-Wooldridge Div., Thompson Ramo Wooldridge of Calif.
Raytheon Mfg. Co., Government Equipment Div.
Republic Aviation Corp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Royal Industries, Inc.
Seeburg Corp., The
Servo Corp. of America
Servomechanisms, Inc.
Singer Mfg. Co., The, Military Products Div.
Skiatron Electronics & Television Corp.
Summers Gyroscope Co.
Sun Electric Corp., Aeronautical Div.
Talley Corp., The
Telechrome Mfg. Corp.
Telectro Industries Corp.
Tele-Dynamics Inc.
Telerad Mfg. Corp.
United Electrodynamics, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
United States Time Corp.
Washington Technological Associates Inc.
Webcor, Inc., Government Div.
Westinghouse Electric Corp.
Whittaker Gyro. Div.-Telecomputing Corp.
Winzen Research Inc.

GUIDES, VALVE
See VALVE GUIDES

GUN MOUNTS, TELEVISION
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Anchor Metal Spinning Co., The
Arma Div., American Bosch Arma Corp.
Bendix Aviation Corp., Friez Instrument Div.
Blander-Tongue Labs., Inc.
Capital City Mfg. Co.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Mercury Tool & Mfg. Corp.
Philco Corp., Government & Industrial Div.
Skiatron Electronics & Television Corp.
Stainless Inc.
Thomas Electronics, Inc.
U. S. Industries, Inc.

GUNS, SOLDERING
See SOLDERING GUNS

GYRDS
a. Attitude
b. Directional
c. Free
d. Integrating
e. Missiles
f. Rate

***AC ELECTRONICS DIV., GENERAL MOTORS CORP., b, d, e, f.**
Aeroflex Corp., The, Aeroflex Labs. Div., a, d, e, f.
Air Logistics Corp., f.
R. C. Allen Aircraft Instr. Div., R. C. Allen Bus. Machines, Inc., c, e, f.
American Aeroparts, a, b.
American Bosch Arma Corp.
Arma Div., American Bosch Arma Corp., c, d.
Bell Aircraft Corp., Niagara Frontier Div., b, e.
Belock Instrument Corp., a thru f.
Bendix Aviation Corp., Eclipse-Pioneer Div., a thru f.
Bendix Aviation Corp., Pioneer-Central Div., a, f.
Cedar Engrg. Div.-Control Data Corp., a thru f.
Clary Dynamics, a, b, c, e.
Collins Engrg. Corp., a.
Control Data Corp., a, b, e, f.
Daystrom Pacific Div.-Daystrom, Inc., a thru f.
Donner Scientific Co., a thru f.
Fairchild Controls Corp., Components Div., f.
Ford Instrument Co., Div.-Sperry Rand Corp., a thru f.
General Electric Co., Apparatus Sales Div., a, b, d, e, f.
G. M. Giannini & Co., Inc., a thru f.
Globe Industries, Inc., a, b, c, f.
Graflex Inc., e.
Greenleaf Mfg. Div., The, Mandrel Ind. Inc., c thru f.
Gyrex Corp., The
Hoffman Labs. Div., Hoffman Electronics Corp., a thru f.
Humphrey, Inc., a, b, c, e, f.
Iron Fireman Mfg. Co., Electronics Div., b, c, e.
***KEARFOTT CO., INC., a thru f.**
Ketay Dept., Norden Div., United Aircraft Corp., a thru f.
Lear, Inc., a, b.
Lear, Inc., Grand Rapids Div., a thru f.
W. L. Maxson Corp., The, c thru f.
Minneapolis-Honeywell Regulator Co., Aeronautical Div., a thru f.
Minneapolis-Honeywell Regulator Co., Boston Div., c, e, f.
Pacific Scientific Co., f.
Piasecki Aircraft Corp., a, f.
Pioneer Tool & Engrg. Co., a thru f.
Power-Tronic Systems Inc., d, f.
Reeves Instrument Corp., d, e.
Sanders Associates, Inc., a, e, f.
Solartron Inc., f.
Sperry Farragut Co., Div.-Sperry Rand Corp., b thru f.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp., b, f.
Sperry Piedmont Co. — Div.-Sperry Rand Corp., b, f.
Sterling Precision Corp., Instrument Div., d, f.
Summers Gyroscope Co., a thru f.
United States Time Corp., a thru f.
Waltham Precision Instrument Co., a, c, f.
Waste King Corp., Technical Products Div., a thru e.
Westinghouse Electric Corp., a thru f.
Whittaker Gyro. Div.-Telecomputing Corp., a, b, c, e, f.

GYRDSCOPES
Aeroflex Corp., The, Aeroflex Labs. Div.
R. C. Allen Aircraft Instr. Div., R. C. Allen Bus. Machines, Inc.
American Bosch Arma Corp.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Bell Aircraft Corp., Niagara Frontier Div.
Belock Instrument Corp.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Cedar Engrg. Div.-Control Data Corp.
Clary Dynamics
Control Data Corp.
Daystrom Pacific Div.-Daystrom, Inc.
Donner Scientific Co.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Apparatus Sales Div.
G. M. Giannini & Co., Inc.
Globe Industries, Inc.
Graflex Inc.
Hoffman Labs. Div., Hoffman Electronics Corp.
Humphrey, Inc.
Iron Fireman Mfg. Co., Electronics Div.
***KEARFOTT CO., INC.**
Ketay Dept., Norden Div., United Aircraft Corp.
Lear, Inc., Grand Rapids Div.
W. L. Maxson Corp., The
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Boston Div.
Pioneer Tool & Engrg. Co.
Power-Tronic Systems Inc.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp.
Sperry Piedmont Co. — Div.-Sperry Rand Corp.
Sterling Precision Corp., Instrument Div.
Summers Gyroscope Co.
United States Time Corp.
Waste King Corp., Technical Products Div.
Westinghouse Electric Corp.
Whittaker Gyro. Div.-Telecomputing Corp.

HAMMERS
Aircraft Tools, Inc.
Barrett-Christie Co.
Billings & Spencer Co., The
Black & Decker Mfg. Co., The
Capewell Mfg. Co.
Chicago Rawhide Mfg. Co.
Division Lead Co.
Greene, Tweed & Co.
High Speed Hammer Co., Inc., The
Hunter Tool Co.
Lemert Engrg. Co., Inc.
Owatonna Tool Co.
Simonds Saw & Steel Co.
Snap-On-Tools Corp.
Stanley-Judd Div.-The Stanley Works
Superior Pneumatic & Mfg., Inc.
TA Mfg. Corp.
Vlchek Tool Co., The

HAND DRILLS
See DRILLS, HAND

HAND OR MECHANICAL TOOLS
See TOOLS, HAND OR MECHANICAL

HAND SETS
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Perry Plastics, Inc.
Roanwell Corp.
J. H. Sessions & Son
Specialty Engrg. & Electronics Co.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

HANDLES
Abalon Precision Mfg. Corp.
Adams Rite Mfg. Co.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Aeroparts
American Insulator Corp.
Anchor Metal Spinning Co., The
***BALCRANK INC., MACHINE TOOL DIV.**
Barrett-Christie Co.
Bendix Aviation Corp., Friez Instrument Div.
Cambridge Thermionic Corp.
Dimco-Gray Co.
Double E Products Co.
Freeman Co., The
Goe Engrg. Co.
Lerco Electronics, Inc.
National Lock Co.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Rubbercraft Corp. of California
Schlegel Mfg. Co.
Specialty Engrg. & Electronics Co.
Stanley-Judd Div.-The Stanley Works
TA Mfg. Corp.
Vemaline Products Co.

HANDLES, LEATHER
Aero Leather Products Co.
Auburn Mfg. Co., The
TA Mfg. Corp.

HARDWARE
Abalon Precision Mfg. Corp.
Adams Rite Mfg. Co.
Aero Bolt & Screw Co., Inc.
All Specs Corp.
Alpine Electronic Components, Inc.
Amatom Electronic Hardware Co. Inc.
American Aeroparts
Anchor Metal Spinning Co., The
Anti-Corrosive Metal Products Co., Inc.
Arnav Aircraft Associates, Inc.
***AVCO MFG. CORP., CROSLEY DIV.**
***BEATON & CORBIN MFG. CO., THE**
Best Aircraft Corp.
Bland Burner Co., The
Burklyn Co.
Calinoy-Div.-Illinois Tool Works
Cambridge Thermionic Corp.
Capewell Mfg. Co.
Carmac Aviation
Century Fasteners Corp.
Cooper Industries, Inc.
Corbin Products Div.
Double E Products Co.
R. C. Dudek & Co.
Eddington Metal Specialty Co.
Emmco Plastic Fabricators - Div.-E. M. McCarthy Machine Co.
Federal Screw Products Inc.
Forsberg Mfg., Co., The
Goe Engrg. Co.
Gordon Enterprises
Helipot Div.-Beckman Instruments Inc.
Hobson Brothers, Inc.
Hoosier Tarpaulin & Canvas Goods Co., Inc.
Industrial Television Inc.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Jan Hardware Mfg. Co., Inc.
Kaynar Mfg. Co., Inc.
Keystone Electronics Corp.
H. Koch & Sons
Lerco Electronics, Inc.
Litton Industries, U. S. Engrg. Co., Div.
Lucas Aircraft Supply Co.
Mercury Air Parts Co., Inc.
Monogram Precision Industries
J. I. Morris Co.
National Lock Co.
Newbrook Machine Corp.
Raytheon Mfg. Co.
Richards-Wilcox Mfg. Co.
J. H. Sessions & Son
Shur-Lok Corp.
Solar Aircraft Co.
Stanley-Judd Div.-The Stanley Works
Stone City Products Co.
Thompson-Bremer & Co.
Vector Electronic Co.
Vemaline Products Co.
Waldom Electronics Inc.
Westfield Metal Products Co., Inc.
Wilcox-Crittenden Div., North & Judd Mfg. Co.
Yale & Towne Mfg. Co., The,-Government Defen Products Div.

HARDWARE, PARACHUTE
See PARACHUTE HARDWARE

RNESSES
a. Electric
b. Ignitian
c. Thermocauples
d. Wire

mp Inc., a.
dvanced Electronics, Inc., a, c, d.
ero Research Instrument Co. Inc., c.
erojet-General Corp., a thru d.
erolite Electronics Corp., a.
rcraft Tools, Inc., a, c, d.
rtronics International Corp., d.
den Products Co., d.
ta Scientific Co., Inc., a.
melco, Inc., a.
nerican Aeroparts, b.
nerican Bosch Arma Corp., a, d.
nerican Electric Cable Co., a, b, c.
nerican Machine & Foundry Co., Government Products Group, a.
nerican Missile Products Co., Inc., a, c.
mphenol Connector Div., Amphenol-Borg Electronics Corp., a thru d.
nchar Specialty Mfg. Co. Inc., a, b, d.
plas Coil Inc., a.
burn Spark Plug Co., Inc., b.
BEATON & CORBIN MFG. CO., THE, a, c.
. A. Beauchaine & Sons Inc., a.
endix Aviation Corp., Scintilla Div., a thru d.
ernco Engrg. Corp., a thru d.
rnbach Radio Co., Inc., d.
iss Electronic Corp., a, d.
ach Mfg. Corp., Div.-General Bronze, d.
lliam Brand & Co., Inc., a, c, d.
eeze Corporations, Inc., b.
istol Co., The, c.
able Electric Products Inc., a, d.
CANNON ELECTRIC CO., a.
alco Engrg. Corp., a.
rysler Corp., Defense Operations Div.
ippard Instrument Lab., Inc., a.
ntinental Technical Service, Inc., a, d.
-Operative Industries, Inc., a thru d.
rnish Wire Co. Inc., d.
lmotor Div., Yuba Consolidated Industries, Inc., a, d.
yton Aviation Radio & Equipment Corp., a, d.
tronic Industries, a, d.
uble E Products Co., a thru d.
esser Industries, Inc., d.
ectric Auto-Lite Co., The, a, b, d.
ectric Cords & Supply Corp., a, b, c.
ectromoth Corp., a, b.
ectro-Mechanical Products Co., a, d.
ectron Products Co., a, d.
herson Radio & Phonograph Corp., a, d.
hpire Electronics Co., Inc., a, d.
je Resistor Corp., d.
sex Wire Corp., a, d.
TS-HOKIN & GALVAN, a.
deral Mfg. & Engrg. Corp., a.
st Electronics Corp., The, a, b, d.
neral Electric Co., Apparatus Sales Div., c.
ud S. Gordon Co., c.
rdan Enterprises, a, c.
nar Laboratories, a.
llett Mfg., Co., a thru d.
co Labs., Inc., a, b, c.
Lo Manufacturing Corp., d.
ghes Tool Co., Aircraft Div., a, d.
lustrial Television Inc., c.
fferson Electronic Products Corp., a thru d.
a, Inc., a, d.
kka Electric Corp., a, d.
ud-Air Inc., a.
ds & Northrup Co., b.
EWIS ENGRG. CO., THE, a, c.
Leod & Hanopol, Inc., a.
E. Menaugh Co., b.
neapolis-Honeywell Regulator Co., Industrial Product Group, c.
neapolis-Honeywell Regulator Co., Ordnance Div., a.
nesota Mining & Mfg. Co., a, d.
lectric Products Corp., a, b.
brola Inc., Military Electronics Div., d.
on Corp., a thru d.
onal Pneumatic Co., Inc., Holtzer-Cabot Divs., b, d.
M. Newman, Corp., a, d.
ific Scientific Co., a, c, d.
kard Electric Div.-General Motors Corp., a, b, d.
plegics Mfg. Co., Inc., a, c.
ects Unlimited Inc., a, c, d.
re Corp. of America, a, c, d.
LEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV., a.
T. Roberts & Co., a.
on Ross Metals Co., The, a.
e Industries, a.
al Industries, Inc., a.
amo Electric Co., d.
oia Wire & Cable Co., Div.-Mandrel Industries, c, d.
ered Workshops, a, d.
er Corp., d.
cialty Engrg. & Electronics Co., a.
ley-Judd Div.-The Stanley Works
ulk Products Corp., a.
Mfg. Corp., a, b, c, d.
T. Div., Dyna-Empire, Inc., a thru d.
ctro Industries Corp., a thru d.
Thermo Electric Co., Inc., c.
Thomas Electronics, Inc., a thru d.
Titeflex, Inc., b.
Tricraft Products Corp., d.
Tri-Dex Co., a, d.
Twin Coach Co., Aircraft-Missiles, a.
Webcar, Inc., Government Div., a thru d.
Westbury Electronics Inc., d.
Western International Co., d.
Westwood Cable Corp., a.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., a, d.
Whitaker Cable Corp., a, d.
Winder Aircraft Corp. of Florida, a thru d.

HEADERS

Americon Aeroparts
Amphenol Connector Div., Amphenol-Borg Electronics Corp.
Cooper Industries, Inc.
Dage Electric Co., Inc.
Garde Mfg. Co.
Mercury Tool & Mfg. Corp.
Networks Electronic Corp.
Pilgrim Products Inc.
Precision Sheet Metal, Inc.
Miltan Ross Metals Co., The
Strat-O-Seal Mfg. Co.
Thomas Electronics, Inc.

HEADPHONES & HEADSETS

C. F. Cannon Co.
Electronic Applicatians, Inc.
ITT-Kellogg
Edwin A. Lipps Engrg.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Perry Plastics, Inc.
Roonwell Corp.
Superex Electronics Corp.
Telectro Industries Corp.

HEADS, COMPUTER

Alwac Corp.
General Transistor Western Corp.
Libroscope Inc.
Shure Brothers, Inc.
Soroban Engrg., Inc.

HEADSETS & HEADPHONES
See HEADPHONES & HEADSETS

HEAT DISSIPATORS
See DISSIPATORS, HEAT

HEAT TRANSFER CONTROL SYSTEMS

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Arde-Portland, Inc.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Bowser, Inc., Defense Dept.
Griscom-Russell Co., The
Hallicrafters
Hanlon & Wilson Co., The
Paul Hardeman, Inc.
***JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.**
Marlo Coil Co.
Monogram Precision Industries
Pneumafil Corp.
Project Fabrication Corp.
South Wind Div., Stewart Warner Corp.
Thiokol Chemical Corp.
Trane Co., The
Tronter Mfg., Inc.
United Aircraft Products, Inc.
Waste King Corp., Technical Products Div.

HEAT TREATING SERVICE

ACF Industries Inc.
Aerodex, Inc.
Aeronca Mfg. Corp.
Alco Products, Inc.
American Gas Furnace Co.
American Steel Foundries, Hammond Div.
Benson Mfg., Co., The
E. W. Bliss Co.
California Aircraft Products
Curtiss-Wright Corp.-Propeller Div.
Curtiss-Wright Corp.-South Bend Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dynacor, Inc.
Ferrotherm Co., The
Graflex Inc.
C. I. Hayes, Inc.
High Vacuum Equipment Corp.
Induction Heating Corp.
Jan Hardware Mfg. Co., Inc.
Kanarr Corp.
M. W. Kellogg Co., The
Kelsey-Hayes Co.
Klock Corp.
Charles E. Larson & Sons, Inc.
Longren Aircraft Co., Inc.
***LYCOMING DIV., AVCO MFG. CORP.**
Metal Treating Institute
Metal-Gloss Products Co.
Metallurgicol, Inc.
Norris-Thermador Corp.
Papesch & Kolstad, Inc.
Piasecki Aircraft Corp.
Precision Castings, Inc.
Red Lian Cabinet Co., Redca Taal Div.
Sargeant & Wilbur Heat Treating Corp.
Solar Aircraft Co.
Solon Foundry, Inc.
Taft-Peirce Mfg. Co., The
Teiner Engrg. Carp.
True Alloys Inc.
Twigg Industries
Veeet Industries

HEATER MUFFLER ASSEMBLIES

American Air Filter Co., Defense Products Div.
Colonial Aircraft Corp.
Hanlon & Wilson Co., The
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Norton Co., New Products Dept.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.

HEATERS

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
American Air Filter Co., Defense Products Div.
Bradford Components, Inc.
Briscoe Mfg. Co.
Bulow Electric Co.
Cole Electric Co.
Corning Glass Works
Cox & Co., Inc.
Cutler-Hammer Inc.
Dampp-Chaser, Inc.
Dean Products, Inc.
Electric Heater Co., The
Electro-Flex Heat, Inc.
Electro-Mechanical Products Co.
Electro-Tech Equipment Co.
Engelhard Industries, Inc.
General Electric Co., Apparatus Sales Div.
Giannini Plasmadyne Corp.
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Griscom-Russell Co., The
Haddam Mfg. Co., The
Hanlon & Wilson Co., The
Hussmann Aircraft Div.
Janco Corp.
***JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.**
Jet-Heet, Inc.
Minco Products, Inc.
Perfection Industries, Div.-Hupp Corp.
Edw. Rennebury & Sons Co.
Rome-Turney Radiator Co., The
Rosemount Engrg. Co.
Safeway Heat Elements, Inc.
Selas Corp. of America
South Wind Div., Stewart Warner Corp.
Special Projects Lab., Food Machinery & Chemical Corp.
Statikil, Inc., Div.-The J. E. Doyle Co.
Temperature Engrg. Corp.
Thermal Refractories Corp.
Therm-O-Lab Corp.
Trane Co., The
United Aircraft Products, Inc.
Universal Dynamics Corp.
Western Gear Corp.
Westinghouse Electric Corp.
Edwin L. Wiegand Co.

HEATING COILS
See COILS, HEATING

HEATING ELEMENTS
See ELEMENTS, HEATING

HEATING EQUIPMENT, DIELECTRIC
See DIELECTRIC HEATING EQUIPMENT

HEATING EQUIPMENT, FLEXIBLE

Briscoe Mfg. Co.
Cox & Co., Inc.
Dean Product, Inc.
Electro-Flex Heat, Inc.
Era Engrg. Inc.
General Electric Co., Apparatus Sales Div.
B. F. Goodrich Aviation Products
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Haddam Mfg. Co., The
A. F. Holden Co., The
***JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.**
Jet-Heet, Inc.
Marlo Coil Co.
Minco Products, Inc.
Monogram Precision Industries
Paul Nurches Co.
Rome-Turney Radiator Co., The
Safeway Heat Elements, Inc.
Stainless Steel Products, Inc.
Temperature Engrg. Corp.
United Aircraft Products, Inc.
Edwin L. Wiegand Co.

HEATING EQUIPMENT, INDUCTION
See INDUCTION HEATING EQUIPMENT

HEATING POTS & TANKS
See POTS & TANKS, HEATING

HERMETIC SEALING SERVICE
See SEALING SERVICE, HERMETIC

HERMETICALLY SEALED CANS
See CANS, HERMETICALLY SEALED

HIGH H PERMEAMETERS
See PERMEAMETERS, HIGH H

HIGH PRESSURE PLASTIC LAMINATORS
See LAMINATORS, PLASTIC, HIGH TEMPERATURE

HIGH TEMPERATURE ADHESIVES
See ADHESIVES, HIGH TEMPERATURE

HIGH TEMPERATURE CERAMICS
See CERAMICS, HIGH TEMPERATURE

HIGH TEMPERATURE COILS
See COILS, HIGH TEMPERATURE

HIGH VOLTAGE CONNECTORS
See CONNECTORS, HIGH VOLTAGE

HINGES

All American Engrg. Co.
American Aeroparts
Anchor Metal Spinning Co., The
Barrett-Christie Co.
Burklyn Co.
Century Fasteners Corp.
Corbin Products Div.
Electro-Flex Heat, Inc.
National Lock Co.
Precision Shapes, Inc.
Richards-Wilcox Mfg. Co.
Stanley-Judd Div.-The Stanley Works
TA Mfg. Corp.

HOISTS, AIRBORNE

Acco Equipment Div., American Chain & Coble Co., Inc.
Air Logistics Corp.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
All American Engrg. Co.
American Machine & Foundry Co., Greenwich
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Benson Mfg., Co., The
Breeze Corporations, Inc.
Crane Carrier Corp.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp.-South Bend Div.
Foote Bros. Gear & Machine Corp.
Jack & Heintz, Inc.
Hoover Electric Co.
Kelsey-Hayes Co.
Longren Aircraft Co., Inc.
Piasecki Aircraft Corp.
Red Lion Cabinet Co., Redco Tool Div.
Regent Jack Mfg, Co., Inc.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Sargent Engrg. Corp.
Silent Hoist & Crane Co.
Tolley Corp., The
Vard Inc.
Waste King Corp., Technical Products Div.
Western Design, Div.-U.S. Industries, Inc.; Santa Barbara Div.
Western Gear Corp.
Yale & Towne Mfg. Co., The,-Government Defense Products Div.

HOISTS, GROUND

Acco Equipment Div., American Chain & Cable Co., Inc.
American Aeroparts
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Baker Industrial Trucks, Div.-Dtis Elevator Co.
Barrett-Christie Co.
Beaver Precision Products Inc.
Bendix Utica Div., Bendix Aviation Corp.
Bil-Jax Inc.
E. W. Bliss Co.
Breeze Corporations, Inc.
Albert H. Cayne Equipment Corp.
Chicago Pneumatic Tool Co.
Chisholm-Moore Hoist Div., Columbus McKinnon Chain Corp.
Coffing Hoist Div., Duff-Norton Co.
Control Engrg. Co., Div. Jervis B. Webb Co.
Crane Carrier Corp.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp.-South Bend Div.
Detroit Hoist & Machine Co.
Dresser Industries, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
G. W. Galloway Co.
Gardner-Denver Co.
Hoover Electric Co.
Hufford Corp., The
Jack & Heintz, Inc.
Longren Aircraft Co., Inc.
Mc Dowell-Wellman Companies, The
Morse Instrument Co., The
Regent Jack Mfg, Co., Inc.
Robbins & Myers, Inc., Hoist & Crane Div.
Rotary Lift Co., Div.-Dover Corp.
Royal Industries, Inc.
Santa Anita Engrg. Co.
Sargent Engrg. Corp.
Silent Hoist & Crane Co.
Stainless Inc.
Talley Corp., The
Western Design, Div.-U.S. Industries, Inc.; Santa Barbara Div.
Western Gear Corp.
Wheland Co., The
Yale & Towne Mfg. Co., The,-Government Defense Products Div.

HOLDERS, CHASSIS

Anchor Metal Spinning Co., The
Challenge Machinery Co., The
Hardman Tool & Engrg., Co.
Ludwig Honold Mfg. Co.
Longren Aircraft Co., Inc.
Mercury Tool & Mfg. Corp.
Mid-West Metal Products, Inc.
Monogram Precision Industries
Piasecki Aircraft Corp.

HOLOERS, CRYSTAL

Aircom Inc. of New Jersey
Augat Brothers, Inc.
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
Javex Electronics
E. F. Johnson Co.
Microlab
Microwave Associates, Inc.
Motorola Inc., Military Electronics Div.
Portchester Instrument Corp.
Sage Labs., Inc.
Special Instruments Div., British Industries Corp.
Stover Co., Inc., The
Victor R. F. & Microwave Co.
Waldom Electronics Inc.

HOLOERS, FUSE

Accurate Electronics Corp., Dept. D
Alden Products Co.
Augat Brothers, Inc.
Garde Mfg. Co.
Jonco Corp.
Howard B. Jones Div.-Cinch Mfg. Corp.
Kulka Electric Corp.
Pilgrim Products Inc.
Raytheon Mfg. Co.
Stover Co., Inc., The
Wilks Precision Instrument Co., Inc.

HORNS, MICROWAVE

Ainslie Corp.
Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
American Machine & Foundry Co., Greenwich
Bogart Mfg. Corp.
Brooks & Perkins, Inc.
Budd Stanley Co. Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
FXR, Inc.
GAR Precision Parts, Inc.
John Gombos Co., Inc.
Walter J. Hyatt Co., The
I-T-E Circuit Breaker Co.
ITT Federal Div., International Telephone & Telegraph Corp.
J-V-M Microwave Co.
D. S. Kennedy & Co.
Lieco, Inc.
Litton Industries, Inc.
Litton Industries, Mayland Div.
W. L. Maxson Corp., The
Meridian Metalcraft, Inc.
Microwave Associates, Inc.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
N.R.K. Mfg. & Engrg. Co.
Narda Microwave Corp., The
Omega Labs., Inc.
Polarad Electronics Corp.
Radar Design Corp.
Radiatronics, Inc.
Sage Labs., Inc.
Scientific-Atlanta, Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Stainless Inc.
Suffolk Products Corp.
Telerad Mfg. Corp.
Turbo Machine Co.
Victor R. F. & Microwave Co.
Walworth Co. Electronics Div.
Washington Aluminum Co., Inc.
Waveline, Inc.
Wheeler Laboratories, Inc.

HORNS, SPEAKER PROJECTOR

Kling Metal Spinning & Stamping Co.

HOSE

a. Air
b. Assemblies, Flexible
c. Flexible, Metallic
d. Flexible, Nan Metallic
e. Hydraulic

Aeroquip Corp., Jackson Div., **a, b, d, e.**
All Specs Corp., **b thru e.**
Allied Plastics Supply Corp., **a thru e.**
American Brass Co., The, **a, b, c.**
Anaconda Metal Hose Div., The American Brass Co. **a thru e.**
Anchor Coupling Co. Inc., **a, b, d, e.**
Anchor Packing Co., The
Atlantic Metal Hose Co., Inc., **b, c.**
Avica Corp., **b, c.**
Barrett-Christie Co., **a thru e.**
***BEATON & CORBIN MFG. CO., THE, b, e.**
Borden Chemical Co., **d.**
Breeze Corporations, Inc., **c.**
Bridgeport Brass Co., **c.**
Carmac Aviation, **a thru e.**
Century Fasteners Corp., **b, c, e.**
Chemplast, Inc., **d.**
Chicago Pneumatic Tool Co., **a.**
Chiksan Co., Sub.-Food Machinery & Chemical Corp., **b.**
Cobra Metol Hose Div. D K Mfg. Co., **a, b, e.**
Components Corp., **c.**
Continental Rubber Works, **a, e.**
Herbert Cooper Co., Inc., **b, d.**
Cooper Industries, Inc., **c.**
Co-Dperative Industries, Inc., **a, b, c, e.**
D K Mfg. Co., **b, c.**
C. R. Daniels, Inc., **d.**
Dayton Rubber Co., The, **a, b, c.**
Dunbar-Kapple Inc.-Aircroft Components Div., **b thru e.**
Electric Hose & Rubber Co., **a thru e.**
Flexaust Co., The, **a, d.**
Flexible Metal Hose Mfg. Co., **b, c.**
Flexible Tubing Corp., **a, b, d.**
***FLEXONICS CORP., AERONAUTICAL DIV., a thru e.**
Gering Products, Inc., **d.**
B. F. Goodrich Aviation Products, **a, d.**
B. F. Goodrich Industrial Products Co., **a, b, d, e.**
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Gray Co., Inc., **a, e.**
Hallett Mfg., Co., **b, c.**
Hannifin Co., Div.-Parker-Honnifin Corp., **b, d, e.**
Hewitt-Robins, Inc., **a, b, d.**
Imperial Brass Mfg. Co., The, **a, b, d, e.**
Jessall Plastics, **d.**
Jodee Plastics Co., **d.**
M & Q Plastic Products, **a, b, d, e.**
Matheson Co., Inc., The, **c, d.**
Minnesota Mining & Mfg. Co., **b, d.**
J. J. Monaghan Co., Inc., **b.**
New England Tape Co., Div.-United-Corr Fastener Corp., **d.**
Orchard Industries, Inc., Actionflex Div., **a, b, d,**
Owatonna Tool Co., **e.**
Parker Fittings & Hose Div., Parker-Hannifin Corp., **b, d, e.**
Parts Engrg. Co., Inc., **b, c.**
Polymer Corp., The, **a, d, e.**
H. K. Porter Co., Inc., Thermoid Div., **a, d, e.**
Pyles Industries, Inc., **a, e.**
Raybestos-Manhattan, Inc., **a, d, e.**
Raybestos-Manhattan, Inc., Pa., **a, d, e.**
Resistoflex Corp., **a, b, d, e.**
Fred T. Roberts & Co., **a, b, d.**
Ronan & Kunzl, Inc., **c.**
Saylor Electric Products Corp., **d.**
Sparta Mfg.-Co., Div.-U.S. Ceramic Title Co., **d.**
Standard-Thomson Corp., Clifford Mfg. Co. Div.,
Stratoflex, Inc., **a, b, d, e.**
Swan Rubber Co., **a, d.**
Titeflex, Inc., **a thru e.**
United States Rubber Co., **a, d, e.**
***WEATHERHEAD CO., THE, a, b, d, e.**
Winder Aircraft Corp. of Florida, **a thru e.**
Z & W Mfg. Corp., **b.**
Zallea Brothers, **b, c.**

HOT OIPPED TINNING
See TINNING, HOT OIPPED

HUMIOITY CONTROL SYSTEMS

***AIRESEARCH MFG. CO., DIV.-THE GARRET CORP.**
Airtemp Div., Chrysler Corp.
American Instruments Co., Inc.
Associated Engineers, Inc.
Bristol Co., The
CDC Control Services, Inc.
Carrier Corp.
Ellis & Watts Products, Inc.
Epic, Inc.
Instruments Corp., The
International Radiant Corp.
Lear, Inc.
Minneapolis-Honeywell Regulatar Co., Industria Product Group
Minneapolis-Honeywell Regulator Co., Drdnanc Div.

Missimers Inc.
New England Scientific Instruments Co.
Photobell Co., Inc.
Piasecki Aircraft Corp.
Pioneer Industries Div., Almar-York Co. Inc.
Project Fabrication Corp.
Research Products Corp.
Scientific Instrument Co.
Skyline Electric & Mfg. Co.
Spraying Systems Co.
Surface Combustion Corp.
Thompson Engrg. Co., The, Missile Products Div.
United Aircraft Products, Inc.
United Electric Controls Co.
United Stotes Dynamics Corp.
Warren Components, Div. El-Tronics, Inc.
Westan Instruments, Div.-Daystrom, Inc.
Winder Aircraft Corp. of Florida
Winzen Research Inc.
Warner Electronic Devices

BRID, MICROWAVE JUNCTIONS
See JUNCTIONS, HYBRID, MICROWAVE

DRAULIC ACCUMULATORS
See ACCUMULATORS, HYDRAULIC

DRAULIC AUTOMATIC PILOTS
See AUTOMATIC PILOTS, HYDRAULIC

DRAULIC OILS, COOLANTS, FLUIDS
See FLUIDS, HYDRAULIC OILS, COOLANTS, ETC.

DRAULIC RESERVOIRS
ccessory Products Co., Div.-Textron Inc.
merican Bosch Arma Corp.
pplied Dynamics Corp.
stronautics Engrg. Co.
endix-Pacific Div., Bendix Aviation Corp.
adillac Gage Co.
olonial Aircraft Corp.
ooper Development Corp., Sub.-Marquardt Aircraft Co.
enison Engrg. Div., American Brake Shoe Co.
astern Industries Inc.
lobe Hoist Co.
reer Hydraulics, Inc.
annifin Co., Div.-Parker-Hannifin Corp.
iskel Engrg. & Supply Co.
rkey-Moore Associates
fford Corp., The
ull Corp.
tegral Corp.
ahn & Co., Inc.
aiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
ercury Tool & Mfg. Corp.
il-Dyne, Inc.
zone Metal Products Corp.
arker Aircraft Co.
. K. Porter Co., Inc.
ressed Steel Tank Co.
acine Hydraulics & Machinery Inc.
andall Engrg. Corp.
ed Lion Cabinet Co., Redco Tool Div.
rgent Engrg. Corp.
n Electric Corp., Aeronautical Div.
nited Aircraft Products, Inc.
ickers Inc., Div.-Sperry Rand
nson Mfg. Co. Inc.
atertown Div., The New York Air Brake Co.
se Aeradraulics, Inc.

RAULIC SYSTEMS & CONTROLS
lel Precision Products, Div. General Metals Corp.
lel Precision Products of California, Div.-General Metals Corp.
AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
herican Bosch Arma Corp.
herican Brake Shoe Co.
herican Brake Shoe Co., Kellogg Div.
herican Machine & Foundry Co., Government Products Group
herican Machine & Foundry Co., Greenwich
herican Measurement & Control, Inc.
plied Dynamics Corp.
dmore Products
sociated Engineers, Inc.
SSOCIATED TESTING LABS., INC.
stronautics Engrg. Co.
ENDIX AVIATION CORP., HAMILTON DIV.
ENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
ndix Utica Div., Bendix Aviation Corp.
ndix-Pacific Div., Bendix Aviation Corp.
ckhowk Mfg. Co.
W. Bliss Co.
wser, Inc., Defense Dept.
stol Co., The
dillac Gage Co.
ruthers & Fernandez, Inc.
onial Aircraft Corp.
m-Air Products, Div.-A S R Products Corp.
mmercial Shearing & Stamping Co.
mponents Corp.
nsolidated Controls Corp.
nsolidated Diesel Electric Corp.
nsolidated Diesel Electric Corp., Test Equip. Div.
nsolidated Diesel Electric Corp., Western Div.
Control Engrg. Co., Div. Jervis B. Webb Co.
Denison Engrg. Div., American Brake Shae Co.
Diversey Engrg. Co.
Dumont Aircraft Fitting Co.
Dunbar-Kapple Inc.-Aircraft Campanents Div.
Eastern Industries Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Galland-Henning Napak Div.
G. W. Gollaway Co.
General Electric Co., Apparatus Sales Div.
Globe Hoist Co.
Greer Hydraulics, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Haskel Engrg. & Supply Co.
Hufford Corp., The
Hughes Tool Co., Aircraft Div.
Hull Corp.
Walter J. Hyatt Co., The
Hydra-Power Corp.
Hydraulic Press Mfg. Co., The, Div.-Kaehring Co.
***HYDRO-AIRE CO., DIV.-CRANE CO.**
Industrial Engrg. Corp.
Interstate Engrg. Corp.
Kahn & Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
***KEARFOTT CO., INC.**
Kelsey-Hayes Co.
Kemp Aero Products
Lear, Inc.
Lear Inc., Lear-Romec Div.
Leslie Co.
M. C. Mfg. Co.
Mc Dowell-Wellman Companies, The
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
George L. Nankervis Co.
Norwood Controls Unit Detroit Controls Div.
Oil-Dyne, Inc.
Ordnance Div.-Food Machinery & Chemical Corp.
Owatonna Tool Co.
Ozone Metal Products Corp.
Parker Aircraft Co.
Pesco Products Div.-Borg-Warner Corp.
Pioneer Tool & Engrg. Co.
Pneu-Hydro Valve Corp.
H. K. Porter Co., Inc.
Racine Hydraulics & Machinery Inc.
Randall Engrg. Corp.
Red Lion Cabinet Co., Redco Tool Div.
Rivett Lathe & Grinder Inc.
Royal Industries, Inc.
Sancor Corp.
Sargent Engrg. Corp.
Sinclair-Collins Valve Co., Div.-IBEC
Sirvalco Systems Corp.
Skyvalve Inc.
Space Corp.
A. U. Stone & Co., Inc.
Sun Electric Corp., Aeronautical Div.
Tactair Valve Div.-Aircraft Products Co.
Trimount Instrument Co.
Turbo Products, Inc.
United Aircraft Products, Inc.
United Electric Controls Co.
Valcor Engrg. Corp.
Vickers Inc., Div.-Sperry Rand
Vickers Inc., Marine & Ordnance Dept., Machinery Hydraulics Div.
Vinson Mfg. Co. Inc.
Waldorf Fluid Systems. Div.-F. C. Huyck & Sons
Watertown Div., The New York Air Brake Co.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp.
Wickfield, Inc.
Wise Aerodraulics, Inc.

HYDRAULIC SYSTEMS RESERVOIRS
See RESERVOIRS, HYDRAULIC SYSTEMS

HYDRAULIC SYSTEMS RESTRICTORS
See RESTRICTORS, HYDRAULIC SYSTEMS

HYDRAULIC VALVE OPERATOR
See VALVE OPERATOR, HYDRAULIC

HYDROMETERS
American Machine & Foundry Co., Government Products Group
Barrett-Christie Co.
Fischer & Porter Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Piasecki Aircraft Corp.
Precision Thermometer & Instrument Co.
Scientific Instrument Co.
Weksler Instruments Corp.

IGNITERS, JET ENGINE
Aerojet-General Corp.
American Aeroparts
***AMERICAN POTASH & CHEMICAL CORP.**
Auburn Spark Plug Co., Inc.
B G Corp., The
Bendix Aviation Corp., Scintilla Div.
Breeze Corporations, Inc.
Champion Spark Plug Co.
Com-Air Products, Div.-A S R Products Corp.
Cooper Industries, Inc.
Electric Auto-Lite Co., The
General Laboratory Associates Inc.
Holex, Inc.
Hydrodyne Corp., Skinner Seal Div.
M. W. Kellogg Co., The
Kilgore Inc., International Flare-Signal Div.
J. E. Menaugh Co.
Plastic Age Sales, Inc.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Thiokol Chemical Corp.
United Aircraft Products, Inc.

IGNITERS, LIQUID & SOLID PROPELLANT
***MC CORMICK SELPH ASSOCIATES**
***PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.**

IGNITION ASSEMBLIES
Aerolab Development Co.
Airtran Inc., Div.-Litton Industries
American Aeroparts
***AMERICAN POTASH & CHEMICAL CORP.**
Auburn Spark Plug Co., Inc.
***BEATON & CORBIN MFG. CO., THE**
Bendix Aviation Corp., Scintilla Div.
Breeze Corporations, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Dynamic Devices, Inc.
Electric Auto-Lite Co., The
General Laboratory Associates, Inc.
Hallett Mfg., Co.
Holex, Inc.
J. E. Menaugh Co.
Modelectric Products Corp.
Rocketdyne Div.-North American Aviation, Inc.
Thermal Refractories Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
United Aircraft Products, Inc.

IGNITION ASSEMBLIES, SOLID ROCKET
Aerojet-General Corp.
Aerolab Development Co.
American Machine & Foundry Co., Greenwich
***AMERICAN POTASH & CHEMICAL CORP.**
American Rocket Co.
Astrodyne, Inc.
Auburn Spark Plug Co., Inc.
Beckman & Whitley, Inc., Missile Products Div.
Bendix Aviation Corp., Scintilla Div.
Breeze Corporations, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Diversey Engrg. Co.
Dynamic Devices, Inc.
Holex, Inc.
M. W. Kellogg Co., The
Land-Air Inc.
***MC CORMICK SELPH ASSOCIATES**
Newbrook Machine Corp.
Olin Mathieson Chemical Corp., Energy Div.
***PROPELLEX CHEMICAL DIV., CHRDMALLOY CORP.**
Red Lion Cabinet Co., Redco Tool Div.
***REDEL INC.**
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Rohm & Haas Co., Redstone Arsenal Research Div.
Thiokol Chemical Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.

IGNITION COILS
See COILS, IGNITION

IGNITION DISTRIBUTORS
See DISTRIBUTORS, IGNITION

IGNITION SYSTEMS, AIRBORNE
***AMERICAN POTASH & CHEMICAL CORP.**
Auburn Spark Plug Co., Inc.
Bendix Aviation Corp., Scintilla Div.
Breeze Corporations, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
General Laboratory Associates, Inc.
Hallett Mfg., Co.
Holex, Inc.
J. E. Menaugh Co.
Reaction Motors Div., Thiokol Chem. Corp.
United Aircraft Products, Inc.

IGNITION SYSTEMS, DISCONNECTS
See DISCONNECTS, IGNITION SYSTEMS

IGNITION SYSTEMS, ELECTRONIC
Aerolab Development Co.
Auburn Spark Plug Co., Inc.
Bendix Aviation Corp., Scintilla Div.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Edgerton, Germeshausen & Grier, Inc.
Electric Auto-Lite Co., The
General Laboratory Associates, Inc.
Hallett Mfg., Co.
Holex, Inc.
Land-Air Inc.
Modelectric Products Corp.
Renwell Corp.

IGNITION TUBE ASSEMBLIES

*AMERICAN POTASH & CHEMICAL CORP.
*BEATON & CORBIN MFG. CO., THE
Bendix Aviation Corp., Scintilla Div.
Breeze Corporations, Inc.
Detranic Industries
Dynamic Devices, Inc.
General Laboratory Associates, Inc.
Huffard Corp., The
Mercury Taal & Mfg. Corp.
National Beryllio Corp.

IMPELLERS

Aerojet-General Corp.
Astronautics Engrg. Co.
Bendix Utica Div., Bendix Aviation Corp.
Capital City Mfg. Co.
J. C. Carter Co., The
Chandler Evans Corp.
Christie Machine Works
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Electro-Mechanical Products Co.
Jarvis Corp.
Kelsey-Hayes Co.
Heinz Mueller Eng. Co. Inc.
Newbrook Machine Corp.
Parker-Hartford Corp., The
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Schellens-True Corp.
Steel Improvement & Forge., The
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Turbo Products, Inc.
Western Gear Corp.

INCLINOMETERS

Cadillac Gage Co.
Crescent Engrg. & Reseorch Co.
Donner Scientific Co.
Electro-Mechanical Products Co.
Elgin Micronics Div.-Elgin National Watch Co.
*ENGIS EQUIPMENT CO.

INDICATORS

a. Air Position
b. Airspeed
c. Angle-of-Yaw
d. Antenno Position
e. Arc Back
f. Arc-Over
g. Bank & Turn
h. Capacitor Leokoge
i. Dato Display
j. Detanotion Indicotars & Meters
k. Deviation
l. Dew Point
m. Dielectric Constant
n. Dive Angle
o. Drift
p. Engine Synchronizer
q. Film Thickness
r. Fluid Conductivity
s. Fluid Flow, Electronic
t. Frequency
u. Fuel Flaw Rote
v. Fuel Mixture
w. Ground Positian
x. Gyro
y. Humidity
z. Illumination
o1. Industrial
b1. Liquid Level, Electronics
c1. Magnetic Field
d1. Moterials Thickness
e1. Modulation
f1. Moisture, Electronic
g1. Moving Torget
h1. Null
i1. Null-Balance
j1. Oxygen
k1. PH
l1. Photographic Exposure
m1. Plan Positian
n1. Pressure
o1. Proximity
p1. Pulse Timer Riser
q1. Radiation
r1. Rodiation, Nuclear
s1. Rate-of-Climb
t1. Rate-of-Rall
u1. Rote-of-Yaw
v1. Recarding Engine
w1. Remote
x1. Servo
y1. Smoke & Cambustion, Electronic
z1. Sound Level
o1. Specific Gravity
b2. Speed
c2. Strain
d2. Telemetering
e2. Temperature
f2. Thrust
g2. Timing
h2. Torque
i2. True Air Speed
j2. Vocuum
k2. Voriable
l2. Vibration
m2. Volume
n2. Weight
o2. Wind Direction
p2. Wind Speed, Electronic

ACF Industries Inc., n-1, j-2.
AMP Inc., m.
Acramag Inc., t, b-2.
Actuatar Products Div., Geartronics Carp., o-1, b-2.
Advanced Products Co., The, g-2.
Aera Instrument Co., t, g-2.
Aero Supply Mfg. Inc., s.
Aeroflex Carp., The, Aeraflex Labs. Div., x, i-1.
Aerajet-General Corp., o-1, d-2.
Aeralite Electranics Corp., z.
Aeratec Corp., The, n-1.
Aircraft Porous Media, Inc., n-1.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., b, c, i, n-1, u-1, e-2, f-2, i-2, j-2.
Airguide Instrument Co., y, e-2.
Airpax Electranics Inc. Seminole Div., b, t, b-2, o-2, p-2.
R. C. Allen Aircraft Instr. Div., R. C. Allen Bus. Machines, Inc., g, x.
Allied Chemical Carp., Natianal Aniline Div., k-1.
Allied International Co., o, b, o, y, o-2.
Alto Scientific Co., Inc., g-2.
Amelco, Inc., t.
American Aeroparts, o, b, g, o, p, u thru x, j-1, k-1, s-1, x-1, l-2.
American Instruments Co., Inc., l, p, q, y, d-1, f-1, j-1, n-1, c-2, e-2.
American Machine & Foundry Co., Government Products Group, t, x-1, m-2, n-2.
American Machine & Foundry Co., Greenwich, i.
American Measurement & Control, Inc., s.
American Missile Products Co., Inc., d-2.
American Reseorch & Mfg. Corp., l-2.
Amthor Testing Instrument Co., Inc., d-1.
R. B. Annis Co., c-1.
Antlob Inc., d.
Anton Electronic Labs., Inc., q-1, r-1.
Applied Science Corp. of Princeton, i, d-2.
*ARNOUX CORP., d-2, e-2.
Aro Equipment Corp., b-1, j-1.
Assembly Products, Inc., e-2.
Associated Engineers, Inc., y-1.
Astronautics Engrg. Co., u.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., b-1, e-2.
Atlas Precision Products, Co., d, w-1, x-1, b-2, d-2, e-2, g-2.
Automation Dynamics Corp., i.
Automation Products, Inc., b-1, a-2.
Avien, Inc., s, u, b-1, e-2, l-2.
Avtron Mfg., Inc., e-1.
B & F Instruments, Inc., c-2, f-2, h-2.
B & H Instrument Co., Inc., t, h-1, i-1, e-2.
B & K Instruments, Inc., z-1, c-2, l-2.
Barker Sales Co., d-2, j-2.
Barton Instrument Corp., u, j-1, m-2.
Beckmon Instruments, Inc., Berkeley Div., t, g-2.
Beckman & Whitley, Inc., Missile Products Div., e-2, o-2, p-2.
Beede Electrical Instrument Co. Inc., t, h-1, i-1.
Bell & Howell Co., l-1.
Belock Instrument Corp., x, x-1, d-2.
Bendix Aviation Corp., Eclipse-Pioneer Div., x, x-1.
Bendix Aviation Corp., Friez Instrument Div., y n-1, o-2, p-2.
Bendix Aviation Corp., Montrose Div., u, n-1, w-1, x-1.
Bendix Aviation Corp., Pioneer-Central Div., b, g, s, u, b-1, s-1.
Bendix Filter Div., Bendix Aviation Corp., n-1.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., u, v-1.
Bendix-Pacific Div., Bendix Aviation Corp., d-2.
Benson-Lehner Corp., i.
Bergen Labs., Inc., h-2.
James G. Biddle Co., t.
A. Biederman, Inc., b, c, d, k, n, t, u, h-1, i-1, j-1, s-1, o-2, p-2.
Bliss Electronic Corp., h.
Blonder-Tongue Labs., Inc., l-2.
Bowmar Instrument Corp., o, g, n, w, o-2.
Bawser, Inc., Defense Dept., s, u.
Branson Instruments, Inc., q, d-1.
Briggs Associates, Inc., i.
Bristol Co., The, l, r, s, t, y, z, a-1, f-1, h-1, i-1, j-1, n-1, v-1 thru y-1, o-2 thru d-2, g-2, j-2.
Brooks Rotameter Co., u, a-2.
Brush Instruments, Div.-Clevite Corp., c, u-1, v-1, x-1, b-2 thru e-2.
Burr-Brown Research Corp.
CDC Control Services, Inc., l, n-2.
Central Electronic Mfg., Div.-Nuclear Corp. of America, j-2.
Central Scientific Co., f-1, j-2.
Centranix Inc., d, i, c-2, d-2.
Chalco Engrg. Corp., s, b-1.
Chesapeake Instrument Corp., z-1.
Chicago Aerial Industries, Inc., i, w, l-1.
Collins Engrg. Corp., b, x, s-1.
Computer Instruments Corp., n-1.
Consolidoted Controls Corp., n-1, o-1, e-2, f-2, h-2.
Consolidated Diesel Electric Corp., b, t, n-1, b-2, e-2, f-2, i-2, j-2.
Consolidated Electrodynamics Corp., i, f-1, n-1, c-2, d-2, l-2.
Control Data Corp., x.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., n-1.
Cox Instruments Div., George L. Nankervis Co., i, s, u, a-2, h-2.
Crescent Engrg. & Research Co., s, u, b-1, n-1, t-1, u-1, d-2, e-2, h-2.
Crawn Cantrols Co., Inc., g.
Curtiss-Wright Electronics Div., IMI Branch, n-1, d-2.
Curtiss-Wright Carp., Research Div., o-1.
DBM Research Carp., i, d-2, g-2.
Data Instruments Div.-Telecomputing Carp., i.
Datran Electranics, Div.-Mid-Cantinent Mfg., Inc., i-1, x-1, c-2.
Daven Co., The, m-2.
Davis Instruments, j-1.
Daystrom Pacific Div.-Daystrom, Inc., b, c, i, x, i-1, s-1, t-1, u-1, w-1, x-1, e-2, f-2, i-2.
Daystram Transicoil Div., Daystrom Inc., x-1.
Dayton Aviatian Radia & Equipment Carp., o, d, i, k, w-1.
Daytranic Carp., c-2.
Dean Products, Inc., q-1.
Decker Carp., The, n-1, a-1, j-2, l-2.
Dejur-Amsco Carp., Electronic Sales Div., l-1, z-1, e-2, g-2.
Delsen Carp., m, d-1, f-1.
Device Development Carp., c-1.
J. W. Dice Co., q, d-1.
W. C. Dillon & Co., Inc., n-2.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp., x-1.
Donner Scientific Co., o, b, c, x, h-1, i-1, s-1, t-1, u-1, i-2.
Dresser Industries, Inc., i, s, u, w-1, x-1, d-2.
Dresser Mfg. Div., Dresser Industries, Inc., u.
Drioire, Inc., y.
M. Ducommon Co., g-2.
Dymec Inc., i, t.
Eastman Kodak Co., l-1, q-1, r-1.
Edcliff Instruments, c, g, n-1, s-1, t-1, u-1, i-2.
Edgerton, Germeshausen & Grier, Inc., i, j, l-1, r-1, d-2, g-2, p-2.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., k, t, a-1, h-1, n-1, w-1, x-1, y-1, e-2.
Eldorado Electronics, g-2.
Electro Instruments, Inc., i, a-1.
Electro Precision Corp., x-1.
Electro Products Laboratories, Inc., j, t, o-1, a-1, b-2, h-2, l-2.
Electronic Communications, Inc., i, g-1, m-1, w-1, d-2.
Electronic Control Corp., b-1, y-1, e-2, h-2.
Electron-Radar Products, y-1.
*ELECTROSNAP CORP., i, z, o-1, w-1.
Electro-Tech Equipment Co., e-2, g-2, l-2.
Elgin Micronics Div.-Elgin National Watch Co., h, p-1, v-1, g-2.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., j, r-1, c-2, g-2.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., d, i, g-1, m-1, x-1.
Engelhard Industries, Inc., l, j-1, k-1.
Epic, Inc., t, y, e-2, l-2.
Era Engrg. Inc., r-1.
FXR, Inc., b-1, e-1.
Fae Instrument Corp., x-1.
Federal Mfg. & Engrg. Corp., l-1.
Federal Products Corp., d-1.
Fenwol Inc., e-2.
Fenwal Electronics, Inc., e-2.
Fischer & Porter Co., i, s thru v, o-1, b-1, j-1, n-1, o-2, e-2, j-2, m-2.
Fisher Governor Co., b-1.
Fisher Research Lab., Inc., b-1, f-1.
Fisher Scientific Co., y, j-1, k-1, n-1, a-2, e-2, j-2.
Flow Corp., p-2.
Flow Measurements Corp., s, u.
Ford Instrument Co., Div.-Sperry Rand Corp., o, w.
Freed Transformer Co. Inc., h-1.
Gardner Laboratory, Inc., q, y, d-1, f-1, e-2, o-2.
General Communication Co., o-2.
General Devices, Inc., i, t, p-2, d-2, g-2.
General Electric Co., Apparatus Sales Div., u, x, a-1, d-1, l-1, q-1, r-1, w-1, x-1, y-1, b-2, e-2, f-2, j-2.
General Electric Co., Metallurgicol Products Dept., e-1.
General Electric Co., X-Ray Dept., b-1, d-1, q-1, r-1.
General Scientific Equipment Co., y, a-2.
Gilfillan Bros. Inc., o, c, d, w, g-1, m-1, t-1, u-1, x-1, d-2.
Gilmore Industries, Inc., i, s, u, i-1, n-1, e-2, e-2, f-2, h-2, n-2.
Good Electronic Corp., e-2, e-2, p-2.
Gordon Enterprises, l-1.
Graflex Inc., h-1.
Green Rectifier Co., j-2.
Gulton Industries, Inc., n-1, e-2.
Haledy Electronics Co., s, a-1.
Hallamore Electronics Co., x-1, d-2.
Hamilton Watch Co., Hathaway Instrument Div., e-2.
Harvey-Wells Electronics Inc., i.
*A. W. HAYDON CO., THE, w-1, g-2.
Hays Corp., The, n-1.
Hazeltine Electronics Div.-Hazeltine Corp., o, i, w, g-1, m-1, w-1.
High Vacuum Equipment Corp., j-2.
E. Vernon Hill & Co., l, y.
Hoffman Labs. Div., Hoffman Electronics Corp., b, c, g, n, u, w, x, h-1, s-1, t-1, u-1, x-1, f-2, j-2, l-2.
Hogan Laboratories, Inc., i.
Hughes Tool Co., Aircraft Div.
Hull Corp., j-2.
Humphrey, Inc., c, n, x, t-1, u-1.
Walter J. Hyatt Co., The, x-1.
Hycon Mfg. Co., a, l-1.

I.D.E.A., Inc., i.
I-L-S Instrument Div., The Meriam Instrument Co., s, t, u, p-1.
ITT Labs., i, g-1, m-1, o-1.
ITT Labs.-Ft. Wayne, i, g-1.
Illinois Testing Laboratories, Inc., l, e-2.
Impact-O-Graph Corp., The, o-2.
Industrial Control Co., x-1, c-2.
Industrial Instruments Inc., h, r.
Industrial Test Equipment Co., h-1, i-1.
Industrial Timer Corp., g-2.
Ingraham Co., The, g-2.
Instruments Corp., The, l, y, d-2, e-2, o-2, p-2.
International Research & Development Corp., l-2.
Jansky & Bailey, Inc., q-1.
Jordan Co., Inc., The, x-1.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., b, x, m-1, x-1.
Kauke & Co., d-2.
Kay Electric Co., t, z-1, l-2.
***KEARFOTT CO., INC.**
Keithley Instruments, Inc., i-1.
Ketay Dept., Norden Div., United Aircraft Corp., w-1.
Kinney Mfg. Div., The New York Air Brake Co., j-2.
Kin Tel Div.-Cohu Electronics, Inc., z-1.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., b, c, p, n-1, s-1, w-1, x-1, f-2, i-2, j-2.
Lampkin Labs., Inc., M.R. Div., t, e-1.
Land-Air Inc., i, p, s, u, b-1, g-1, q-1, r-1, v-1, w-1, d-2, g-2, l-2.
Lear, Inc., a, g, i, n, x, s-1, t-1, u-1, w-1, x-1, e-2, f-2, j-2.
Lear, Inc., Grand Rapids Div., i, n, x, w-1, x-1.
Leeds & Northrup Co., h-1, i-1, k-1, e-2.
***WALLACE O. LEONARD, INC.**, b, u, n-1, x-1, i-2.
***LEWIS ENGRG. CO., THE**, e-2.
Librascope Inc., i.
Liquidometer Corp., The, b-1, i-1, o-2, e-2.
Lundy Mfg. Corp., s-1.
MB Mfg. Co., l-2.
Magnaflux Corp., q, c-1, d-1, o-1, c-2.
Magnetic Instrument Co. Inc., b-1.
Magtrol, Inc., h-2.
Marion Instrument Div., h-1.
Jas. P. Marsh Corp., n-1, e-2, j-2.
Master Specialties Co., i, t.
Matheson Co., Inc., The, k-1, n-1.
W. L. Maxson Corp., The, u, b-1, w-1.
Menlo Research Lab., k-1, q-1.
Meters Inc., h-1, i-1.
Micrometrical Mfg. Co., t, l-2.
Midwestern Instruments, Inc., i, d-2.
Miller Dial & Nameplate Co., i, z.
Minco Products, Inc., e-2.
Mine Safety Appliances Co., l, y, j-1.
Minneapolis-Honeywell Regulator Co., Aeronautical Div., a, b, x, b-1, i-1, j-1, n-1, v-1, x-1, f-2, i-2.
Minneapolis-Honeywell Regulator Co., Davies Labs. Div., d-2.
Minneapolis-Honeywell Regulator Co., Industrial Div., o-1.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, i, k, l, s, t, u, y, o-1, b-1, f-1, h-1, i-1, k-1 n-1, q-1, w-1, o-2 thru f-2, h-2, j-2, n-2, o-2, p-2.
J. J. Monaghan Co., Inc., m-2.
Moran Instrument Corp., i-1, x-1.
E. L. Moseley Co., h-1, i-1.
Motorola Inc., Military Electronics Div., d, l, w, e-1, g-1, m-1, o-1, w-1, d-2.
Mueller Brass Co., r, b-1.
MRC Equipment Corp., j-2.
George L. Nankervis Co., i, s, t, u, a-2, f-2, h-2.
National Electronics, b, t, b-1, h-1, e-2.
National Research Corp., j-2.
New England Scientific Instruments Co., t, y, b-1, f-1, n-1, b-2, d-2, e-2.
Non-Linear Systems, Inc., i, w-1.
North Atlantic Industries, Inc., i, h-1, w-1, x-1, d-2, e-2.
Northrop Corp., a, o-2, p-2.
Norwood Controls Unit Detroit Controls Div., b-1, i-1, n-1, d-2.
Nuclear Corp. of America, r-1.
Nuclear-Chicago Corp., r-1.
Nucleo Semiconductors, Inc., c-1, d-1.
Numart Corp., The, o-2.
Optimized Devices, Inc., h, h-1.
Oto-Metric Tools, Inc., o-1.
Orbitron Co., Inc., n-2.
Oxygen Equipment & Service Co., j-1.
Pacific Scientific Co., l, c-2, e-2, l-2, o-2, p-2.
Palmer Thermometers, Inc., e-2.
Ralph M. Parsons Co., The, Electronics Div., a-1, d-2.
Patwin, Div.-Patent Button Co., i.
Penn Keystone Corp., o, n, w, r-1, w-1.
Performance Measurements Co., s, u, i-1, x-1, c-2, e-2, f-2, h-2, n-2.
Peschel Electronics, Inc., h, o-1.
Philco Corp., Government & Industrial Div., o-1, d-2, g-2.
Photobell Co., Inc., y, z, b-1, f-1, o-1, y-1.
Photocon Research Products, n-1, o-1.
Photo-Crystals, Inc., y.
Photomation, Inc., y-1.
Photovolt Corp., k-1, l-1.
Potter Aeronautical Corp., s, t, u, o-2, b-2, i-2.
Power-Tronic Systems Inc., b, s, t, u, w, x, b-1, c-1, g-1, x-1, h-2, p-2.
Precision Thermometer & Instrument Co., o-2, e-2.
Process & Instruments, j-2.
Puritan Compressed Gas Corp., Aviation Div., j-1.
Pyrometer Instrument Co., Inc., e-2.
Radar Relay, Inc., i.
Radiation Instrument Development Lab., Inc., r-1.
Rahm Instruments, Div.-American Machine & Metals, Inc., s, o-1, b-1, x-1, j-2, p-2.
Rawson Electrical Instrument Co., c-1.
Raymond Engrg. Lab., Inc., g-2.
Raytheon Mfg. Co., Government Equipment Div., i, w, g-1, m-1, w-1.
Republic Mfg. Co., n-1.
Revere Corp. of America, s, u, f-2, n-2.
Richardson Scale Co., n-2.
Rinco, Inc., h-1.
Milton Roy Co., b-1, k-1.
Royco Instruments, Inc., e-2.
Arthur C. Ruge Associates, Inc., e-2.
Ryan Aeronautical Co., i.
St. John X-Ray Lab., q-1, r-1.
Sanborn Co., k, t, c-2.
Schaevitz Engrg., x-1, f-2.
Schutte & Koerting Co., o-2.
Scientific Instrument Co., y, n-1, e-2.
Scientific-Atlanta, Inc., d, z-1.
H. H. Scott, Inc., h-1, i-1, z-1, l-2.
Seiscor Mfg. Co., x-1.
Servomechanisms, Inc., a, b, c, j, b-1, i-1, n-1, x-1, b-2, d-2, e-2, h-2, i-2, m-2, n-2, o-2.
Shallcross Mfg. Co., h-1.
Shannon Luminous Materials Co., i.
Signalite Inc., z.
Simmonds Aerocessories, Inc., u, b-1, m-2, n-2.
Simpson Electric Co., h-1, e-2.
Southwestern Industrial Electronics Co., h, e-1, k-1.
Space Corp., b-1, l-2.
Specialties, Inc., o, b, c, l-1, s-1, x-1, i-2.
Specialty Engrg. & Electronics Co., q-1, r-1, o-2, p-2.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp., i, x, g-1, m-1.
Sperry Piedmont Co. - Div.-Sperry Rand Corp., n, x, g-1, m-1.
Standard Controls, Inc., n-1.
Stanley Aviation Corp., o-1, q-1, r-1.
Sterling Precision Corp., Instrument Div., w, x.
M. C. Stewart, o-2, p-2.
Strand Engrg. Co., m-1.
P. A. Sturtevant Co., h-2.
Summers Gyroscope Co., g, i, x, s-1, t-1, u-1, w-1, x-1.
Sun Electric Corp., Aeronautical Div., t, w-1, d-2, l-2, o-2, p-2.
Systems Inc., r-1.
Systron Corp., s, t, u, b-2 thru h-2.
Tapco Group, Thompson-Ramo-Wooldridge Inc., t, b-1, x-1.
Task Corp., o, b, c.
W. A. Taylor & Co., k-1.
Technique Associates, e-2.
Telechrome Mfg. Corp., d-2.
Tele-Dynamics Inc., d-2.
Telerad Mfg. Corp., t.
Temperature Engrg. Corp., j-2.
Textran Corp., s-1.
Thermal Refractories Corp., e-2.
Thermo Electric Co., Inc., e-2.
Theta Instrument Corp., d, j, x-1.
Thomas Electronics, Inc., q.
Thwing-Albert Instrument Co., q-1, e-2.
Towaco Electronics Co., t.
Transistor Electronics Corp., i, o-1, g-2.
Trans-Sonics, Inc., b-1, n-1, l-2.
Trimount Instrument Co., b-1, o-1.
Uehling Instrument Co., n-1, j-2.
Union Switch & Signal, Div.-Westinghouse Air Brake Co., i, d-2.
United Electric Controls Co., o-1, n-1, w-1, e-2, j-2.
United Electrodynamics, Inc., d-2.
U. S. Science Corp., Div.-Topp Industries, Inc., o, c, i, k-1, t-1, u-1, x-1.
United States Time Corp., x, s-1, t-1, u-1.
Universal Dynamics Corp., l, y, f-1.
Vacuum Tube Products, Div.-Hughes Aircraft Co., j-2.
Varian Associates, c-1.
Vemaline Products Co., g-2.
Victory Engrg. Corp., b-1, y-1, d-2, e-2.
Vinson Mfg. Co. Inc., b-1, h-2.
Waldorf Electronics. Div.-F. C. Huyck & Sons, b, c, d, g, i, n, a, s, u, x, g-1, m-1, s-1, t-1, u-1, w-1, x-1, b-2, f-2, i-2, o-2, p-2.
Wallace & Tiernan Inc., b, k-1, n-1, f-2, h-2, i-2, j-2.
Warren Components, Div. El-Tronics, Inc., y, f-1.
Waste King Corp., Technicol Products Div., b, c, n, x, i-2.
Waugh Engrg. Co., s, t, u.
West Instrument Corp., w-1, e-2.
Westinghouse Electric Corp., c-1, q-1, r-1, d-2, e-2.
Weston Instruments, Div.-Daystrom, Inc., t, y, z, e-1, f-1, h-1, l-1, z-1, b-2, e-2, g-2, m-2.
Westronics Inc., i, l, s, t, u, y, z, o-1, b-1, h-1 thru k-1, n-1, q-1, r-1, x-1, o-2, b-2, c-2, e-2, f-2, h-2, j-2, n-2, p-2.
Whittaker Gyro. Div.-Telecomputing Corp., g, x, t-1, u-1.
Wind Turbine Co., d.
Winzen Research Inc., d-2.
N. Wood Counter Lab., q-1, r-1.
Worner Electronic Devices, y, z, o-1, b-1, y-1.
Yellow Springs Instrument Co., The, e-2.
Z & W Mfg. Corp., c.

INDICATORS, POSITION
See POSITION INDICATORS

INDICATORS, RADIO COMPASS
See RADIO COMPASS INDICATORS

INDUCTANCE SPECIALTIES, MEASUREMENT

Dietz Design & Mfg. Co.
Dresser Industries, Inc.
Leeds & Northrup Co.
Marconi Instruments
Metronix, Inc., Sub.-Assembly Products, Inc.
New England Scientific Instruments Co.
North Hills Electric Co., Inc.
Precise Development Corp.
Sangamo Electric Co.
Southwestern Industrial Electronics Co.
H. W. Sullivan Ltd.
United Transformer Co.
Vari-L Co., Inc.
Wright Engrg. Co.

INDUCTANCES, VARIABLE

Aetna Electronics Corp.
Barker & Williamson Inc.
CGS Labs., Inc.
California Spring Co., Inc.
Cambridge Thermionic Corp.
Celco (Constantine Engrg. Labs. Co.)
Coilcraft Inc.
Computer Engrg. Associates, Inc.
Forbes & Wagner, Inc.
Freed Transformer Co. Inc.
Fugle-Miller Labs. Inc.
JFD Electronics Corp.
E. F. Johnson Co.
Motorola Inc., Military Electronics Div.
NYT Electronics, Inc.
Notional Coil Co.
North Hills Electric Co., Inc.
Stanwyck Winding Co., Inc.
H. W. Sullivan Ltd.
Superex Electronics Corp.
Telectro Industries Corp.
United Transformer Co.
Universal Toroid Coil Winding, Inc.
Vanguard Electronics Co.
Vari-L Co., Inc.

INDUCTION HEATING EQUIPMENT

Astravac Corp.
Barker & Williamson Inc.
Erdco Engrg. Corp.
General Electric Co., Apparatus Sales Div.
General Electrodynamics Corp.
C. I. Hayes, Inc.
High Vacuum Equipment Corp.
Induction Heating Corp.
Instruments Div.-Philips Electronics, Inc.
Lindberg Engrg. Co.
Marion Instrument Div.
***MOTOR GENERATOR CORP.**
Pacific Scientific Co.
Papesch & Kolstad, Inc.
Reeve Electronics, Inc.
Sherman Industrial Electronics, Div.-Engrg. Design Inc.
Telectro Industries Corp.
Tocco Div., The Ohio Crankshaft Co.
United Aircraft Products, Inc.
Young Brothers Co.

INDUCTION HEATING EQUIPMENT, 400 CYCLE

***MOTOR GENERATOR CORP.**

INDUCTORS

Aerovox Corp.
Aladdin Electronics, Div.-Aloddin Industries Inc.
Amplifier Corp. of America
Audio Development Co.
Avtron Mfg., Inc.
Barker & Williamson Inc.
Burnell & Co., Inc.
CGS Labs., Inc..
Cambridge Thermionic Corp.
Carruthers & Fernandez, Inc.
Celco (Constantine Engrg. Labs. Co.)
Coils-Electronics
Computer Engrg. Associates, Inc.
Corning Glass Works
D. & R. Ltd.
Dietz Design & Mfg. Co.
Dresser Industries, Inc.
Electro Engrg. Works
Ferranti Electric Inc.
Forbes & Wagner, Inc.
Freed Transformer Co. Inc.
Fugle-Miller Labs. Inc.
General Electric Co., Apparatus Sales Div.
Genistron, Inc.
Goslin Electric & Mfg. Co.
E. F. Johnson Co.
Keystone Products Co.
Leeds & Northrup Co.
Minitran Corp.
NYT Electronics, Inc.
Networks Electronic Corp.
North Hills Electric Co., Inc.
Redman Electronics Corp.

Signal Transformer Co.
Stanwyck Winding Co., Inc.
H. W. Sullivan Ltd.
Superex Electronics Corp.
Telectro Industries Corp.
Tocco Div., The Ohio Crankshaft Co.
Transonic, Inc.
Tri-Dex Co.
United Transformer Co.
Universal Toroid Coil Winding, Inc.
Vanguard Electronics Co.
Varo Mfg. Co., Inc.
Westbury Electronics Inc.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

INDUCTORS, COILS

A. P. W. Co.
Aetna Electronics Corp.
Aladdin Electronics, Div.-Aladdin Industries Inc.
Audio Development Co.
Barker & Williamson Inc.
Burnell & Co., Inc.
CGS Labs., Inc.
Cambridge Thermionic Corp.
Carruthers & Fernandez, Inc.
Celco (Constantine Engrg. Labs. Co.)
Central Transformer Co.
Coilcraft Inc.
Coils-Electronics
Corning Glass Works
De Witt Development Co.
Dietz Design & Mfg. Co.
Dresser Industries, Inc.
Ferranti Electric Inc.
Forbes & Wagner, Inc.
Freed Transformer Co. Inc.
Fugle-Miller Labs. Inc.
General Coil Products Corp.
General Electric Co., Apparatus Sales Div.
Genistron, Inc.
Goslin Electric & Mfg. Co.
JFD Electronics Corp.
E. F. Johnson Co.
Johnson Electronics Inc.
Keystone Products Co.
Langevin Div., The W. L. Maxson Corp.
Minitran Corp.
Motorola Inc., Military Electronics Div.
NYT Electronics, Inc.
National Coil Co.
National Electronics
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Networks Electronic Corp.
New York Coil Co.
North Hills Electric Co., Inc.
Philco Corp., Government & Industrial Div.
Railway Communications Inc.
Redman Electronics Corp.
Sangamo Electric Co.
Signal Transformer Co.
Stanwyck Winding Co., Inc.
H. W. Sullivan Ltd.
Superex Electronics Corp.
Telectro Industries Corp.
Tocco Div., The Ohio Crankshaft Co.
Torwico Electronics, Inc.
Transonic, Inc.
Tri-Dex Co.
United Transformer Co.
Universal Toroid Coil Winding, Inc.
Vanguard Electronics Co.
Vari-L Co., Inc.
Westbury Electronics Inc.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

INDUSTRIAL SLIDES
See SLIDES, INDUSTRIAL

INFRARED
- **a. Detection Systems**
- **b. Image Converters**
- **c. Systems**
- **d. Systems, Guidance**

ACF Industries Inc., a thru d.
Aerojet-General Corp., a thru d.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., c.**
American Optical Co., Instrument Div., c, d.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., d.
***AVCO MFG. CORP., CROSLEY DIV.**
Axler Associates Inc., a, c.
Baird-Atomic, Inc., a, c, d.
***BAUSCH & LOMB OPTICAL CO., a, c, d.**
Bell Aircraft Corp., Niagara Frontier Div., d.
Bulow Electric Co., a, c.
Chicago Aerial Industries, Inc., a, d.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., c.
Curtiss-Wright Corp., Research Div.
Davidson Mfg., Co., Inc.
Eastman Kodak Co., a, c, d.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., a, c.
Edmund Scientific Co., a, b.
Electronic Communications, Inc., a, c, d.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., c.
Engelhard Industries, Inc.
Ford Instrument Co., Div.-Sperry Rand Corp., a.
General Electric Co., Missile & Space Vehicle Dept.
General Electrodynamics Corp., b.
General Precision Lab. Inc., d.
Gilfillan Bros. Inc., a thru d.
Guided Missile Div.-De Havilland Aircraft of Canada, Ltd., a, c, d.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co., a thru d.
Hamilton Standard, Div.-United Aircraft Corp., a.
Hayward Scientific Glass Corp., d.
Hughes Aircraft Co., a, c, d.
Walter J. Hyatt Co., The, a, c, d.
Hycon Mfg. Co., a, c.
ITT Federal Div., International Telephone & Telegraph Corp., d.
ITT Labs., a thru d.
ITT Labs.-Ft. Wayne, a thru d.
Infrared Industries Inc., a, c, d.
***KEARFOTT CO., INC., a, d**
Lear, Inc., a thru d.
Librascope Inc., a, c, d.
Lockheed Aircraft Corp., Missiles & Space Div., a, c.
Mergenthaler Linotype Co., a, c.
Minneapolis-Honeywell Regulator Co., Aeronautical Div., a, c, d.
Minneapolis-Honeywell Regulator Co., Drdnance Div., a, c.
Monogram Precision Industries, c.
Motorola Inc., Military Electronics Div., a thru d.
Northrop Corp., a thru d.
Northrop Corp., The, Nortronics Div., a thru d.
Ohio Semiconductors, Inc.
Otis Elevator Co., Electronic Div., c.
Patterson, Moos Div. - Universal Winding Co., Inc., a, c, d.
Perkin-Elmer Corp., a, c, d.
Philco Corp., Government & Industrial Div., a, c, d.
Photobell Co., Inc., a.
Pioneer Industries Div., Almar-York Co. Inc., a.
Q. D. S. Corp., a, b.
Radiation, Inc., a thru d.
Ramo-Wooldridge Div., Thompson Ramo Wooldridge of Calif.
Raytheon Mfg. Co., Government Equipment Div., a, c, d.
Republic Aviation Corp., a, c, d.
Santa Barbara Research Center, a, c, d.
Servo Corp. of America, a, c, d.
Singer Mfg. Co., The Military Products Div., a thru d.
Skiatron Electronics & Television Corp., a, d.
H. W. Sullivan Ltd.
Systems Inc., a, c, d.
Thiokol Chemical Corp., a.
Trionics Corp., a.
U. S. Industries, Inc., a, d.
Waldorf Electronics. Div.-F. C. Huyck & Sons, c, d.
Webcor, Inc., Government Div., a thru d.
Westinghouse Electric Corp., a thru d.
Worner Electronic Devices
Zenith Optical Laboratory, c.

INFRA-RED LAMPS
See LAMPS, INFRA-RED

INITIATORS
- **a. Destructors**
- **b. Primers**
- **c. Squibs**

***McCORMICK SELPH ASSOCIATES, a, b, c.**

INJECTION SYSTEMS, FUEL

American Bosch Arma Corp.
Auburn Spark Plug Co., Inc.
B. H. Aircraft Co., Inc.
***BENDIX AVIATION CORP., HAMILTON DIV.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
California Aircraft Products
Chandler Evans Corp.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
Korda Industries
Marquardt Aircraft Co.
Reaction Motors Div., Thiokol Chem. Corp.
Simmonds Aerocessories, Inc.
United Aircraft Products, Inc.
Veet Industries

INJECTION SYSTEMS, WATER

ACF Industries Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Chandler Evans Corp.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Marquardt Aircraft Co.
United Aircraft Products, Inc.

INSPECTION EQUIPMENT
- **a. Fluorescent**
- **b. Lighting**
- **c. Magnetic**
- **d. Optical**
- **e. X-Ray**

Allen Tool Corp.
American Cystoscope Makers, Inc., d.
American Optical Co., Instrument Div., d.
American Research & Mfg. Corp., d.
Bar-Ray Products, Inc., e.
***BAUSCH & LOMB OPTICAL CO., d**
Bearing Inspection, Inc.
Bendix Aviation Corp., Friez Instrument Div., e.
Blowers Inc., a, b, d.
Bracke-Seib X-Ray Co., Inc., e.
Branson Instruments, Inc.
Buhl Optical Co., d.
Collins Microflat Co.
Curtiss-Wright Corp.-Princeton Div., e.
Davidson Mfg., Co., Inc., d.
Day-Ray Products, Inc., b.
Device Development Corp., e.
Eastman Kodak Co., d.
Edmund Scientific Co., d.
Engrg. Developments, Inc., d.
***ENGIS EQUIPMENT CO., d.**
J. W. Fecker, Inc., d.
Gardner Laboratory, Inc., d.
General Electric Co., Apparatus Sales Div., e.
General Electric Co., X-Ray Dept., a, e.
Gordon Enterprises, d.
Hayward Scientific Glass Corp., d.
High Voltage Engrg., e.
Ideal Industries, Inc., a.
Instruments Div.-Philips Electronics, Inc., e.
Jones & Lamson Machine Co., d.
Kollmorgen Optical Corp., d.
Land-Air Inc., d, e.
Magnaflux Corp., a, c.
Menlo Research Lab., a.
Newbrook Machine Corp., d, e.
D & S Research, Inc., d.
Ohio Semiconductors, Inc., c.
Opto-Metric Tools, Inc., d.
Perkin-Elmer Corp., d.
Philco Corp., Government & Industrial Div., d, e.
Picker X-Ray Corp., c, e.
Rototest Labs., Inc., e.
St. John X-Ray Lab., e.
Shannon Luminous Materials Co., a thru d.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., e.
Smith-Morris Corp., a, b, e.
Soderberg Mfg. Co., Inc., b.
Sperry Products, Inc., e.
Strat-O-Seal Mfg. Co., a.
Tinsley Labs., Inc., d.
Triplett & Barton, Inc., e.
Turco Products, Inc.
***ULTRA-VIOLET PRODUCTS, INC., a.**
Van Keuren Co., d.
Veet Industries
Wasley Products, Inc., b.
Weston Instruments, Div.-Daystrom, Inc., d, e.
Wollensak Optical Co., d.
Zoomar Inc., d.

INSPECTION LAMPS
See LAMPS, INSPECTION

INSPECTION MIRRORS
See MIRRORS, INSPECTION

INSTALLATION TOOLS FOR BLIND RIVETS & LOCKBOLTS

***TOWNSEND CO., CHERRY RIVET DIV.**

INSTRUCTION PLATES
See PLATES, INSTRUCTION

INSTRUMENT DIALS
See DIALS, INSTRUMENT

INSTRUMENT LANDING SYSTEMS
See LANDING SYSTEMS, INSTRUMENT

INSTRUMENT PANEL VIBRATORS
See VIBRATORS, INSTRUMENT PANEL

INSTRUMENTS, ELECTRICAL MEASURING
- **a. Ammeters**
- **b. Audiameters**
- **c. Bridges**
- **d. Calibrators**
- **e. Circuit Linearity**
- **f. Comparators**
- **g. Comparators Voltage**
- **h. Galvanometers**
- **i. Magnetometers**
- **j. Megahmmeters**
- **k. Microammeters**
- **l. Microfaradmeters**
- **m. Micro-Microammeters**
- **n. Milliammeters**
- **o. Millivoltmeters**
- **p. Ohmmeters**
- **q. Panel**
- **r. Ratiometers**
- **s. Recorders**
- **t. Standards**
- **u. Tracers, Signal**
- **v. Ultrasonic**
- **w. Voltmeters**
- **x. Volt-Ohm-Milliammeters**
- **y. Wattmeters**

cton Labs. Inc., c, s, t, w.
eroscience, Inc.
irborne Instruments Lab., Div.-Cutler-Hammer, Inc., c, d.
irtronics International Corp., x.
llegany Instrument Co., Inc., d, e, r.
merican Aeroparts, o, w.
merican Electronics, Inc., Taller & Cooper Div., s.
merican Machine & Foundry Co., Gavernment Products Group, w.
merican Machine & Foundry Co., Greenwich
merican Measurement & Control, Inc., d.
mplifier Corp. of America, g.
. B. Annis Co., i.
ntlab Inc., s.
ntan Electronic Lobs., Inc., m, n, o, q, w, x.
pplied Physics Carp., m.
renberg Ultrasonic Lab., Inc., v.
ssembly Products, Inc., a, k, n thru q, w, y.
ssociated Research, Inc., h, j, k, p.
tlantic Research Corp., d, v.
vien, Inc., f, g.
vo Ltd., a, p, w, x.
& F Instruments, Inc., c, d.
& H Instrument Co., Inc., h, o.
& K Instruments, Inc., d, f, j, k, m.
llantine Labs., Inc., d, a, w.
eckman Instruments, Inc., Berkeley Div., p, w.
eckman-Scientific & Process Instruments Div., m.
eede Electrical Instrument Co. Inc., a, h, k, n, a, q, w.
nsan-Lehner Corp., s.
mes G. Biddle Co., h, j, p.
Biederman, Inc., t.
iss Electranic Corp., c, f, g.
ansan Instruments, Inc., v.
istol Co., The, a, c, d, h, j, k, m thru q, s, w, y.
ush Instruments, Div.-Clevite Carp., a, e, h, j, n, q, s, t, x.
rr-Brown Research Carp., a, v, w.
rtan-Rogers Ca., Sales Div.-Hoyt Electrical Instruments, a, k, n, a, p, v, w.
lifornia Technical Industries, Div.-Textran Inc., e, f, g.
ntronix Inc., f, s.
ntury Electronics & Instruments, Inc., h, s.
esapeake Instrument Corp., c.
eveland Instrument Co., f.
llins Engrg. Carp., a, w.
nsolidated Electradynamics Carp., h, s, w.
bic Corp., a, p, r, w, y.
rtiss-Wright Corp., Electronics Div., c, j, k, m, n, o, s.
rtiss-Wright Corp., Research Div., v.
tran Electronics, Div.-Mid-Continent Mfg., Inc., r.
ven Co., The, b, w, x.
venport Mfg. Co., d, g, j, t.
jur-Amsco Corp., Electronic Sales Div., a, k, n, q, w.
vice Development Corp., i.
W. Dice Co., f, j, p.
hner Scientific Ca., c, f, g.
sser Industries, Inc., j, n, a, p, s, w, x.
tronics Ca., f, t.
omas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., r.
tor, Inc., k, m.
ectric Auta-Lite Co., The, o.
ectric Design & Mfg. Co., a, k, n, a, q, w.
ectro Instruments, Inc., c, d, f, g, j thru p, r, s, w.
ectro-Measurements Inc., c.
ectronic Applications, Inc., j, p.
ectronic Instrument Co., Inc. (EICO), u, w, x.
ectronics Div., Van Norman Industries Inc., k, n, q, w.
ectro-Tech Equipment Co., a, c, h, j, k, n thru q, t, w, x, y.
lin Micronics Div.-Elgin National Watch Co., s.
pire Products Sales Corp., u.
jelhard Industries, Inc., w.
grg. Associates, c, s, t.
c, Inc., a, c, h, j, k, m thru p, s, w, x, y.
hed Products Corp., q.
R, Inc., c, r.
feral Products Corp., f.
cher & Porter Co., q, s.
her Research Lab., Inc., a, w.
her Scientific Co., h.
w Corp., o, w.
n Fluke Mfg. Co., Inc., d, g, a, w, y.
ed Transformer Co. Inc., c, f, j.
ane Plastics, Inc., f.
neral Electric Co., Apparatus Sales Div., o, h, i, j, n, o, q, s, w, y.
M. Giannini & Co., Inc., r.
more Industries, Inc., s.
y Instrument Co.
on Industries, Inc., s.
ilton Watch Co.-Industrial Div., h.
ca Labs., Inc., y.
Hpot Div.-Beckman Instruments Inc., o, q, w.
rlett-Packard Co., k, m, n, o, r, t, w, x, y.
han Laboratories, Inc., s.
t Electrical Instrument Works, Burton Rogers Co., a, k, n, o, q, w.
Industrial Instruments Inc., a, c, j, p.
Industrial Television Inc., x.
Industrial Test Equipment Co., c, f, t.
Inertia Switch, Inc., s.
Instrument Labs., x.
Internatianal Instruments Inc., a, k, n, a, q, w, x.
Jennings Radio Mfg. Corp., w.
Jones & Lamson Machine Co., f.
Julie Research Labs., Inc., c, d, g, m, a, q, s.
Kahn & Co., Inc., b, c.
Kauke & Co., o.
Koy Electric Co., w.
Keithley Instruments, Inc., j, k, m, a, p, x.
Kin Tel Div.-Cohu Electranics, Inc., a, h, k, m thru p, r, v, w.
Knopp Inc.
Land-Air Inc., d, s.
Lavoie Labaratories Inc., f, g.
Leach Carp., s.
Leeds & Northrup Co., c, g, j, k, m, p, s, t.
Leitch-Huard Carp., x.
Mac Leod & Hanopal, Inc., j.
Magnaflux Carp., i, v.
Magnetic Instrument Co. Inc., r.
Marcani Instruments, c, l, p, w, x.
Marian Instrument Div., a, k, n, o, q, w.
Massa Div.-Cohu Electronics, Inc., h, v.
Menlo Research Lab., f.
Meters Inc., a, h, j, k, n thru q, w, x.
Metranix, Inc., Sub.-Assembly Products, Inc., c, d, f, a, w.
Micrametrical Mfg. Co., s.
Midwestern Instruments, Inc., c, h.
Milgo Electronic Corp., s.
Millitest Carp., c.
Minneapolis-Honeywell Regulatar Co., Boston Div., h, i.
Minneapalis-Honeywell Regulator Ca., Industrial Div., s.
Minneapolis-Haneywell Regulator Co., Industrial Product Group, a, c thru h, j, k, m thru p, s, t, w.
F. L. Moseley Co., a, s.
Motarola Inc., Military Electronics Div., d.
National Electronics, a, h, j, k, n thru s, w, x, y.
National Instrument Labaratories, Inc., t.
National Pneumatic Co., Inc., Haltzer-Cabot Divs., j.
Nationol Spectrographic Labs., Inc., s.
New England Etching & Plating Ca., Inc., q.
New England Scientific Instruments Co., a, c, h, j, k, l, n thru q, s, t, w, y.
Non-Linear Systems, Inc., f, g, p, r, w, x.
North Atlantic Industries, Inc., r, w.
Paul Nurches Co., a, n, q, w.
Dffner Electronics Inc., h, s.
Ohia Semiconductors, Inc., i, y.
Optimized Devices, Inc., d, f, g, p.
Pace Electrical Instruments Co., Inc., a, h, k, n, a, q, w.
Paco Electronics Co., Inc., u, x.
Phaostran Instrument & Electronic Co., a, n thru q, w, x.
Philco Carp., Government & Industrial Div.
Photran Instrument Co., h, s.
Physics Research Laboratories, Inc., a, c, d, f, h, j, k, n, p, q, t, w, x, y.
Pioneer Industries Div., Almar-York Co. Inc., v.
Plasteck, Inc., q.
Power-Tronic Systems Inc., a, c, f, s.
Precise Development Corp., a thru d, f, h, j, k, n thru q, w, x, y.
Precision Apparatus Co., Inc., j, x.
Q. V. S. Inc., a, h, k, n thru q, w.
Quan-Tech Labs., k.
Radiation, Inc., e, g, s.
Rawson Electrical Instrument Co., a, d, k, n, a, t, w, x, y.
Rese Engrg., Inc., f, g.
Research Appliance Co., s.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**, m, p, x.
Rinco, Inc., c.
Rochester Mfg. Co. Inc., a.
Royal Industries, Inc., s.
Sanborn Co., n, s, w, y.
Schaevitz Engrg., s.
Sel-Rex Corp.
Servo Corp. of America, r.
Shallcross Mfg. Co., c, h, j, k, n, o.
Simpson Electric Co., a, d, h, k, n thru q, t, w, x, y.
Slaughter Co., Inc., c, e, f, g, j, p.
Solartron Inc., w, y.
Southwestern Industrial Electronics Co., b thru q, s, w.
H. W. Sullivan Ltd., c, h, k, m, n, a, t.
Sun Electric Corp., Aeronautical Div., a, b, h, k, n, a, q, w, y.
Systron Corp., f, g, r, s, w.
Technical Apparatus Builders, a, d, g, k, n, a, w.
Technology Instrument Corp., s, w, x.
Telectro Industries Corp., s, t.
Telerad Mfg. Corp., d.
Thermo Electric Co., Inc., a, s.
Theta Instrument Corp., c.
Thiokol Chemical Corp., c.
Thwing-Albert Instrument Co., s.
Trio Laboratories, Inc., g, p, w, x.
Triplett Electrical Instrument Co., a, j, k, n thru q, w, x, y.
United Electric Controls Co., q.
Varian Associates, s.
Wacline, Inc., a, j, k, m thru q, w, x.
Waltham Electronics Corp., x.
Weinschel Engrg., d.
West Instrument Carp., n, a, s.
Westinghouse Electric Carp., a, k, n, a, p, w, x, y.
Westan Instruments, Div.-Daystram, Inc., a, d, g, h, j, k, n thru q, s, t, w, x, y.
Westronics Inc., s.
Wintronics, d, f.
Wright Engrg. Co., j.
Wye Industries, v.

INSTRUMENTS, ELECTRICAL MEASURING METERS

a. **Electronic Capacitance**
b. **Field Strength**
c. **FM Deviation**
d. **Frequency**
e. **Impedance**
f. **Modulatian**
g. **Null**
h. **Output**
i. **Panel**
j. **Phase Angle**
k. **Power Factar**
l. **Q**
m. **RF Pawer**
n. **Standing Wave Ratia**
a. **Wave**
p. **X-Ray Intensity**

Acton Labs. Inc., a, e, j, k.
Adler Electranics, Inc., c, d, e.
Aera Instrument Co., d.
Air Logistics Corp., j.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., m.
Aircam Inc. of New Jersey, n.
Airpax Electronics Inc. Seminole Div., d.
American Machine & Foundry Ca., Government Products Group, d, k.
American Machine & Foundry Co., Greenwich
Anton Electronic Labs., Inc., i, p.
Assembly Products, Inc., j.
Avtron Mfg., Inc., c, d, f.
B & H Instrument Ca., Inc., d.
Ballatine Labs., Inc., a.
Barker & Williamsan Inc., m, n.
Beckman Instruments, Inc., Berkeley Div., d, j.
Bergen Labs., Inc., g, j.
Beva Lab., Inc., p.
James G. Biddle Ca., d.
A. Biederman, Inc.
Blonder-Tongue Labs., Inc., b.
Baantan Radio Carp., l.
Briggs Assaciates, Inc., a.
Budelman Electronics Corp., c, d.
Burr-Brawn Research Corp., g.
Califarnia Technical Industries, Div.-Textron Inc., n.
Centronix Inc., b, m.
Chemold Co., i.
Chesapeake Instrument Corp., e.
Clippard Instrument Lab., Inc., a.
Colorado Reseorch Corp., j.
Davenport Mfg. Co.
Daystram Pacific Div.-Daystrom, Inc., g.
Dejur-Amsco Corp., Electronic Sales Div., h, i.
Divca-Wayne Electronics, Div.-Divco-Wayne Corp., d.
Donner Scientific Co., g.
Douglas Microwave Co., Inc., d, n, a.
Dytranics Co., j.
Eastern Specialty Co., The, j.
Electro Instruments, Inc., a.
Electro-Measurements Inc., e, g.
Electronic Applications, Inc., c.
Electronic Tube Corp., j.
Electro-Tech Equipment Co., k.
Empire Products Sales Corp., b, f, m.
Engrg. Associates, b, d.
Epic, Inc., d, e, j.
Etched Products Corp., i.
FXR, Inc., d, e, f, m, n, a.
Federal Mfg. & Engrg. Corp., d.
Fischer & Porter Co., h, i.
Freed Transformer Co. Inc., l.
General Communication Co., d, m, o.
General Electric Co., Apparatus Sales Div., d, i, j, m, p.
General Electric Co., X-Ray Dept., p.
Hagan Chemicals & Controls, Inc., g.
Hamilton Watch Co.-Industrial Div., j.
Helipot Div.-Beckman Instruments Inc., d, i.
Hewlett-Packard Co., c, d, e, g, j, m, n, o.
Hoyt Electrical Instrument Works, Burton Rogers Co., i.
Industrial Instruments Inc., e.
Industrial Television Inc., b.
Industrial Test Equipment Co., g, j, k, l.
International Instruments Inc., i.
E. F. Johnson Co., n.
Kahn & Co., Inc., d.
Kay Electric Co., d, l, o.
Kin Tel Div.-Cohu Electronics, Inc., g.
Knopp Inc.
Lampkin Labs., Inc., M. R. Div., c, d, f.
Land-Air Inc., d, j, p.
Leeds & Northrup Co., g.
Liquidometer Corp., The, a.
***LYCOMING DIV., AVCO MFG. CORP.**, d.
Manson Labs., Inc., d.
Marconi Instruments, a, c, d, l, m.
Marion Instrument Div., g, i.
Measurements Div., Mc Graw Edison Co., b, d.

Meridian Metalcraft, Inc., n.
Meters Inc., g, h, i.
Metronix, Inc., Sub.-Assembly Products, Inc., a.
Micrametrical Mfg. Co., d.
Millitest Corp., g.
Minneapolis-Honeywell Regulator Co., Boston Div., g.
Minneapolis-Honeywell Regulator Co., Davies Labs. Div., d.
Minneapolis-Honeywell Regulator Co., Industrial Div., d, g.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, a, b, d, e, g thru k, p.
Miratel, Inc., c, m.
Motorola Inc., Military Electronics Div., b, c, d, f, h, i, m.
Narda Microwave Corp., The, e.
National Electronics, d, g, i, k, m.
New England Etching & Plating Co., Inc., i.
New England Scientific Instruments Co., d, i, j.
North Atlantic Industries, Inc., g, j.
Ohio Semiconductors, Inc., b.
Pace Electrical Instruments Co., Inc., i.
Paco Electronics Co., Inc., a.
Philco Corp., Government & Industrial Div., p.
Physics Research Laboratories, Inc., g, i, k.
Picker X-Ray Corp., p.
Pioneer Tool & Engrg. Co., a, b, d thru j.
Polarad Electronics Corp., b, m, n.
Polytechnic Research & Development Co., Inc., m.
Precise Development Corp., a, e, f.
Q. V. S. Inc., i.
Radar Design Corp., a.
Radiation, Inc., b, d.
Renwell Corp., i.
Rixon Electronics Inc., n.
Royal Industries, Inc., a, d, e, f, h.
Schaevitz Engrg., b.
Scientific-Atlanta, Inc., b.
Shallcross Mfg. Co., g.
Simpson Electric Co., b, i, m.
Solartron Inc., d, g, j.
Southwestern Industrial Electronics Co., a.
Special Instruments Div., British Industries Corp., n.
Sperry Microwave Electronics Co., Div.-Sperry Rond Corp., n.
Stoddart Aircraft Radio Co., Inc., b.
Sun Dial Corp., i.
Sun Electric Corp., Aeronautical Div., g, i.
Systems Inc., c, d, f.
Systron Corp., d, j.
Technology Instrument Corp., e, j.
Telechrome Mfg. Corp., j.
Telectro Industries Corp., a, b.
Telerad Mfg. Corp., d.
Teletronics Lab. Inc., d.
Theta Instrument Corp., j.
Trio Laboratories, Inc., g, j.
Triplett Electrical Instrument Co., h, i.
Varo Mfg. Co., Inc., d.
Wacline, Inc., d, g, h, i, m.
Waltham Electronics Corp., c, d, f, n.
Waveline, Inc., m, n, a.
Weinschel Engrg., g, m.
Westinghouse Electric Corp., k, p.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp., j.
Weston Instruments, Div.-Daystrom, Inc., d, h, j, k, m.
Westronics Inc., d.
Wintronics, j.
Wright Engrg. Co., a thru e, m.

INSTRUMENTS, GRAPHIC RECORDING

Allegany Instrument Co., Inc.
Applied Science Corp. of Princeton
B & F Instruments, Inc.
B & K Instruments, Inc.
Benson-Lehner Corp.
Bristol Co., The
Brush Instruments, Div.-Clevite Corp.
Century Electronics & Instruments, Inc.
Consolidated Electrodynamics Corp.
Edgerton, Germeshausen & Grier, Inc.
Electro Instruments, Inc.
Electro-Tech Equipment Co.
Engrg. Associates
Epic, Inc.
Fischer & Porter Co.
General Electric Co., Apparatus Sales Div.
Graflex Inc.
Hallicrafters
Hogan Laboratories, Inc.
Impact-D-Graph Corp., The
Instruments Corp., The
Koy Electric Co.
Leeds & Northrup Co.
Mason-Neilan
Masso Div.-Cohu Electronics, Inc.
Mast Development Co., Inc.
Merz Engrg., Inc.
Micrometrical Mfg. Co.
Midwestern Instruments, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
F. L. Moseley Co.
Motorola Inc., Military Electronics Div.
National Electronics
New England Scientific Instruments Co.
Offner Electronics Inc.
Perkin-Elmer Corp.
Photran Instrument Co.
Power-Tronic Systems Inc.
Radiation, Inc.
Sanborn Co.
Scientific Instrument Co.
Scientific-Atlanta, Inc.
Seiscar Mfg. Co.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp.
Sperry Piedmont Co. · Div.-Sperry Rond Corp.
Sun Electric Corp., Aeronautical Div.
Technitrol Engrg. Co.
Technology Instrument Corp.
Traid Corp.
Varian Associates
Waldorf Electronics. Div.-F. C. Huyck & Sons
Weksler Instruments Corp.
West Instrument Corp.
Westinghouse Electric Corp.
Weston Instruments, Div.-Daystrom, Inc.
Westronics Inc.
Zophar Mills Inc.

INSTRUMENTS, METEOROLOGICAL
See METEOROLOGICAL INSTRUMENTS

INSTRUMENTS, PRESSURE
See PRESSURE INSTRUMENTS

INSULATING COMPOUNDS

Acme Wire Co.
Aries Laboratories, Inc.
Carl H. Biggs Co.
Borden Chemical Co.
George C. Borthig Co., Inc.
Crompton & Knowles Corp.
Dayton Rubber Co., The
Dennis Chemical Co.
***DOW CORNING CORP.**
E. I. Du Pont De Nemours & Co. Inc.
Electro Tec Corp.
Gladding, McBean & Co.
Houghton Laboratories, Inc.
Joclin Mfg. Co.
Johns-Manville
Minnesota Mining & Mfg. Co.
National Engrg. Products, Inc.
Permacel
Pilgrim Products Inc.
Polymer Corp., The
Products Research Co.
Saureisen Cements Co.
Topper Mfg. Co., Inc.
United States Plywood Corp.
Westinghouse Electric Corp.

INSULATION ENAMEL
See ENAMEL INSULATION

INSULATION PAPER
See PAPER, INSULATION

INSULATION PARTS

a. Bead
b. Ceramic
c. Insulating Sleeves
d. Rods
e. Sheets
f. Silicone Rubber
g. Stampings & Punchings

AMP Inc., c.
Accurate Electronics Corp., Dept. D, g.
Aero Gasket Corp., e, f, g.
Aerolite Electronics Corp., g.
Allied Plastics Supply Corp., c thru g.
Amaton Electronic Hardware Co. Inc., c, g.
American Lava Corp., b.
Atmo Seal Co., a.
Auburn Mfg. Co., The, c thru g.
Bacon Industries, Inc., f.
W. L. Barrett Co., The, g.
Bergen Carbide Co., b, g.
Birma Mfg. Co. Inc., b, e, g.
Birnbach Radio Co., Inc., c, f.
Bonny Mfg. Corp., c, d.
Borden Chemical Co., The, Div.-The Borden Co., Resinite Dept., c, d, e.
Bristol Co., The, a, b.
Calfibe Co., Inc., c.
Carborundum Co., Latrobe Plant, Refractories Div., a thru d.
Carborundum Co., Refractories Div., b.
Centralab, Div.-Globe-Union, a thru d.
Chemplast, Inc., c, d, e, g.
Colonial Rubber Co., e, f, g.
Columbia Products Co., d.
Comco Plastics Inc., g.
Connecticut Hard Rubber Co., The, f.
Continental Diamond Fibre Corp., c, f.
Continental Rubber Works, f.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., b.
Cornell Deep Drawing Co., Div.-Lones Industries Corp., g.
Corning Glass Works, b.
Crane Packing Co., a, c, d, e.
Delta Chemical Works, Inc., b, f.
Diamonite Products Mfg. Co., b.
Dielectric Materials Co., c, f.
Dixan Corp., d, e.
Oresser Mfg. Div., Dresser Industries, Inc., c.
Du-Co Ceramics Co., a thru d.
E. I. Du Pant De Nemaurs & Co., Inc., e, f.
Duramic Products Inc., b.
Electric Auto-Lite Co., The, b, g.
Electrical Insulation Co., Inc., d, e, g.
Electrical Refractaries Co., The, b, c.
Electronic Mechanics, Inc., b thru e.
Emerson Plastics Corp., a, c, d, e, g.
Enfab Inc., g.
Engelhord Industries, Inc., b.
Erie Resistor Corp., b.
Flexrock Co., d, e, g.
Formica Corp., d, e.
Franklin Fibre-Lamitex Corp., c, d, e, g.
General Electric Co., Insulator Dept., b.
General Gasket Inc., e, f, g.
General Plastics Corp. of New Jersey, e.
Gilman Brothers Co., The, e.
Gladding, McBean & Co., a thru e.
Goodyear Tire & Rubber Co., The, Aviation Products Div., f.
Goshen Rubber Co., Inc., f.
Hampden Mfg. Co., Inc., g.
Haveg Industries, Inc., b thru f.
Hays Mfg. Co., e, g.
Hitemp Wires Inc., c.
Homolite Corp., The, c, d.
Houghton Laboratories, Inc., d, e.
Isolantite Mfg. Corp., a thru d.
Jessall Plastics, c, d.
Jodee Plastics Co., d, g.
Johns-Manville, b thru f.
Johns-Manville Sales Corp., b thru e.
Keystone Electronics Corp., g.
Kip Electronics Corp., a thru d, g.
Kling Metal Spinning & Stomping Co., g.
Lamtex Industries, Inc., c.
Lone Star Plastics Co. Inc., f.
Thomas J. Long, Inc., d, e, g.
Louthan Mfg. Co., The, Div.-Ferro Corp., b.
Mansfield Fabricators Inc., g.
Maryland Lovo Co., a thru e.
J. E. Menough Co., c.
Metallizing Co. of Los Angeles Inc., b.
Mica Fabricating Co., b thru e, g.
Mica Insulator Div.-Minnesota Mining & Mfg., Co., f, g.
Minneapolis-Honeywell Regulator Co., Drdnance Div., b, g.
Minnesota Mining & Mfg. Co., a thru e.
Minnesota Rubber Co., f.
Mitronics Inc., b.
Monogram Precision Industries, b, c, f, g.
Motorola Inc., Military Electronics Div., b.
Narmco Mfg. Co., c.
National Beryllia Corp., a thru e.
National Ceramic Co., a.
National Vulcanized Fibre Co., c, d, e, g.
Natvar Corp., c, f.
New England Laminotes Co., Inc., e.
Norton Co., b.
Norton Co., New Products Dept., b, c, d.
Peerless Products Industries, c, g.
Penn Fibre & Specialty Co., Inc., d, e, g.
Penn-Michigan Mfg. Corp., g.
Permacel, c, e, f.
Piasecki Aircraft Corp., g.
Pilgrim Products Inc., c, d, e, g.
Plastic Age Sales, Inc., b, c.
Polymer Corp., The, a, c, d, e, g.
Raybestos-Manhattan, Inc., f.
Raytheon Mfg. Co., b.
Rogers Corp., b thru g.
Rubbercraft Corp. of Californio, f.
Russell Reinforced Plastics Corp., e.
Ryan Aeronautical Co., g.
St. Regis Paper Co., Panelyte Div., d, e, g.
Sealectric Switch & Relay Corp., g.
Silicone Insulation, Inc., c, d, e, g.
Silicones Div.-Union Carbide Corp., f.
Skinner Precision Products, c, g.
Stanley-Judd Div.-The Stanley Works, g.
Stover Co., Inc., The, g.
Stevens Products, Inc., g.
Strat-O-Seal Mfg. Co., f.
Superior Steatite & Ceramic Corp., a thru d, g.
Sylvania Electric Products Inc., Parts Div., g.
Taylor Fibre Co., d, e, g.
Thermal Refractories Corp., a, b, c.
H. I. Thompson Fiber Glass Co., c.
Topper Mfg. Co., Inc., a thru g.
Union Asbestos & Rubber Co., c, e.
United Mineral & Chemical Corp., b.
United States Rubber Co., c.
Varflex Corp., c, f.
Warren Wire Co., c, e.
Wasley Products, Inc., g.
Western Felt Works & Acadia Synthetic Products Div., e.
Western Gold & Platinum Co., a, b, c.
Westinghouse Electric Corp., e.
Wilmington Fibre Specialty Co., c, d, e, g.
Zippertubing Co., The, c.

ULATORS

a. Antenno Insulators & Spring Assemblies
b. Bead
c. Bearing
d. Con Liner
e. Ceramic
f. Cord
g. Electric
h. Fabricated
i. Feed Through
j. Feeder Spreader
k. Fused Quartz
l. Glass Banded Mica
m. High Dielectric Paper
n. HV Power Line
o. Laminated
p. Metallized Bushing
q. Mica
r. Molded
s. Plastic
t. Rods
u. Sheets
v. Shock
w. Shock & Vibration
x. Sleeve
y. Standoff
z. Strain
a1. Test Clip
b1. Thermal
c1. Thermocouple
d1. Tower
e1. Transmitting Antenna

AC ELECTRONICS DIV., GENERAL MOTORS CORP., c-1.

MP Inc., i, r, s.
ccurate Electronics Corp., Dept. D, a, h, i, m, o, r, s, y.
ero Gasket Corp., r, s.
ero Research Instrument Co. Inc., c-1.
erolite Electronics Corp., a, h, i, o, s, x, y, z.
llied Plastics Supply Corp., b, c, h, i, l, m, o, q thru x.
matom Electronic Hardware Co. Inc., i, s.
merican Aeroparts, l, s, t, w.
merican Agile Corp., r thru u.
merican Latex Products Corp., r, s.
merican Lava Corp., e, y, z.
merican Molded Products Co., r, s.
nchor Plastics Co., Inc., s, t.
ntenna Specialists Co., The, a.
nti-Corrosive Metal Products Co., Inc., r, s.
rmel Electronics, Inc., i, r, s, y.
tlantic Research Corp., s, v, w.
rmo Seal Co., i, y.
shburn Spark Plug Co., Inc., a, e, m, q, s.
G Corp., The, e.
rker Sales Co., m, n.
A. Beauchaine H Sons Inc., r, s.
ndix Filter Div., Bendix Aviation Corp., v, w.
rgen Carbide Co., e, h.
rl H. Biggs Co., f, b-1.
rma Mfg. Co., Inc., e, r, u, v, w, b-1.
rnbach Radio Co., Inc., a, e, i, j, s, x, y, z, a-1, e-1.
nny Mfg. Corp., r thru u.
rden Chemical Co., s.
am Metallurgical & Chemical Co., k, q.
lliam Brand & Co., Inc., s, x.
istol Co., The, c-1, d-1.
shings, Inc., v, w.
lfibe Co., Inc., a, s, w.
mbridge Thermionic Corp., e, i, s.
rborundum Co., Latrobe Plant, Refractories Div., b, e, g thru j, p, r, t, u, x, y, z, c-1.
rborundum Co., Refractories Div., e.
ntralab, Div.-Globe-Union, b, e, g, i, p, t, x, y.
ramaseal, Inc., i, p. y.
emold Co., r, s, u.
emplast, Inc., c, d, h, r thru u, x, e-1.
icago Gasket Co., s.
eveland Container Co., The, s, x.
lonial Rubber Co., r, u, w.
lumbia Products Co., a, s, t, x, z, e-1.
mco Plastics Inc., h, l, a, s.
mmercial Plastics & Supply Corp., s, t, u.
ntinental Diamond Fibre Corp., a, q, t, u, x.
ntinental Rubber Works, r.
rning Glass Works, e, g, i, k.
ane Packing Co., b, i, s, t, u, x, y.
M Research Corp., s, t, u.
kyton Aircraft Products, Inc., a, s.
kytan Rubber Co., The, r, s.
l Optics Co., Ltd., k.
lta Chemical Works, Inc., e, k.
nnis Chemical Co., g, s.
timonite Products Mfg. Co., e, t, u.
lectric Materials Co., s, x.
ton Corp., s.
l-Co Ceramics Co., b, e, s, y, z, c-1.
l. Du Pont De Nemours & Co. Inc., a, u.
ramic Products Inc., e.
ctric Auto-Lite Co., The, e.
ctrical Insulation Co., Inc., g, h, o, s, t, u, y.
ctrical Refractories Co., The, e.
ctronic Mechanics, Inc., i, l.
eloid Co., Inc., The, r, s, u.
erson & Cuming, Inc., s, t, u.
erson Plastics Corp., b, c, d, g, h, i, l, o, q thru , x.
ab Inc., w.
Engelhard Industries, Inc., e, c-1.
Erie Resistor Corp., e.
Fluorulon Labs., Inc., s, t, u.
Ford Radio & Mica Corp., q.
Formica Corp., h, o, s, t, u, x.
Fronklin Fibre-Lamitex Corp., h, o, s, t, u.
Frenchtown Porcelain Co., e, i, p.
Furone Plastics, Inc., o, g, h, q, r.
Garde Mfg. Co., i, r, s, y.
General American Transportation Corp., r, s.
General Cement Mfg. Co., Div.-Textron, Inc., o, r, y, z, o-1.
General Electric Co., Apparatus Sales Div., e, n, r, d-1.
General Electric Co., Insulator Dept., o, e, g, n, y, z, d-1, e-1.
General Plastics Corp. of New Jersey, o, s, u.
Gering Products, Inc., u.
Gladding, McBean & Co., o, e, g, i, p, t, u, x, y, b-1, c-1.
Glasseal Products Co., Inc., i, y.
Globar Plant, Refractories Div.-The Carborundum Co., c-1.
Goe Engrg. Co., e, i, y.
Claud S. Gordon Co., b-1, c-1.
Grant Chemical Co., Inc., s.
Haveg Industries, Inc., c, d, e, g, h, i, k, l, o, q thru u, b-1.
Hays Mfg. Co., h, o, q, r, t, y.
Heyman Mfg. Co., f, z.
Hobson Brothers, Inc., i, r.
Holex, Inc., i.
Homalite Corp., The, g, r thru u.
Houghton Laboratories, Inc., s, t, u.
Huntington Rubber Mills, w.
Hydro Molding Co., Inc., r, s.
i-T-E- Circuit Breaker Co., g.
ITT Federal Div., International Telephone & Telegraph Corp., i.
Integrated Mica Corp., l, o, q, u.
Isolantite Mfg. Corp., o, b, e, g thru j, p, r, t, y, z, l-1.
Jan Hardware Mfg. Co., Inc., n, x, y.
Janco Corp., o.
Jessall Plastics, s, t.
Joclin Mfg. Co., i, r, s, y.
Jodee Plastics Co., h, l, o, s, t, u, x.
Johns-Manville, m, t thru x, b-1.
Johns-Manville Sales Corp., g, m, r, s, b-1.
E. F. Johnson Co., o, i, j, y, z, e-1.
J. W. Johnson & Co., Inc., v, w.
Keystone Electronics Corp., h.
Kip Electronics Corp., b, e, r, s, y.
Lamtex Industries, Inc., o, p, s, u, x.
Landsverk Electrometer Co., The, r, s.
Lone Star Plastics Co. Inc., o, r, s.
Thomas J. Long, Inc., h, o, s, t, u.
Louthan Mfg. Co., The, Div.-Ferro Corp., e.
MB Mfg. Co., w.
M & Q Plastic Products, s, t.
Mansfield Fabricators Inc., h, o, s, u.
Mark Products Co., a.
Maryland Lava Co., o, b, c, e, g, i, s thru z, c-1.
*MC CORMICK SELPH ASSOCIATES, i.
J. E. Menaugh Co., x.
Mercury Tool & Mfg. Corp., h.
Metallizing Co. of Los Angeles Inc., e.
Mica Fabricating Co., k, l, o, q thru u, x.
Mica Insulator Div.-Minnesota Mining & Mfg., Co., q thru u.
Micacraft Products Inc., l.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, c-1.
Minneapolis-Honeywell Regulator Co., Ordnance Div., e, r, s.
Minnesota Mining & Mfg. Co., o, b, e, g, l, m, o, q thru u, x, b-1.
Minnesota Rubber Co., h, r.
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV., d, s, w.
Mitronics Inc., e, i, p.
Monogram Precision Industries, d, e.
Motorola Inc., Military Electronics Div., e.
Mueller Electric Co., a-1.
Mullenbach Div.-Electric Machinery Mfg. Co., g, s.
NRC Equipment Corp., b-1.
National Beryllia Corp., b, e, b-1, c-1.
National Ceramic Co., e, i, y, z.
National Tel-Tronics Corp., s, t, u, x.
National Vulcanized Fibre Co., g, h, o, s, t, u.
New England Laminates Co., Inc., o, u.
New England Tape Co., Div.-United-Carr Fastener Corp., i, s, x.
M. M. Newman, Corp., s.
Northern Plastics Corp., u.
Norton Co., e, b-1, c-1.
Norton Co., New Products Dept., e.
Pacific Scientific Co., w.
Peerless Products Industries, g, h, r, x.
Penn Fibre & Specialty Co., Inc., g, h, m, o, s, t, u.
Permax Products Div., Chisholm-Ryder Co., Inc., a.
Perry Plastics, Inc., s.
Pilgrim Products Inc., g, n, r, s, t, w.
Plastic Age Sales, Inc., o, r, s.
Polymer Corp., The, c, h, s, t, u, y.
Precision Sheet Metal, Inc., h.
Raybestos-Manhattan, Inc., Pa., s.
Raytheon Mfg. Co., e.
Rex Corp., The, Sub.-American Enka, s, x, b-1.
Robinson Technical Products, Inc., v, w.
Rogers Corp., g, h, m, o, r thru u.
Milton Ross Metals Co., The, i, o, r, s, x, y, z.
Rubbercraft Corp. of California, r, w.
Russell Reinforced Plastics Corp., o, s.
St. Regis Paper Co., Panelyte Div., o, s, t, u.
Sanford Plastics Corp., s, t, u, x.
D. A. Schultz Co., h.
Silicone Insulation, Inc., b, d, g, h, o, r thru u, x, b-1.
Sinclair Mfg. Co., h, o, s.
Skinner Precision Products, x.
Sparto Mfg. Co., Div.-U. S. Ceramic Tile Co., s, x.
Spaulding Fibre Co., Inc., m, o, s, t, u.
Spruce Pine Mica Co., Inc., g, m, q.
Stanley-Judd Div.-The Stanley Works, o, o-1.
Staver Co., Inc., The, h, o, w.
Stevens Products, Inc., h, o, r.
Strat-o-Seal Mfg. Co., i.
Superior Cable Corp., x.
Superior Steatite & Ceramic Corp., b, e, r, s, y.
Swedlow Inc., o, r, s, u.
Sylvania Electric Products Inc., Parts Div., q, r, s.
Taylor Fibre Co., o, s, t.
Technical Appliance Corp., y.
Thermal Refractories Corp., b, c, e, b-1, c-1.
Thermo Electric Co., Inc., c-1.
Thompson Engrg. Co., The, Missile Products Div., k.
Torwico Electronics, Inc., i.
Turbo Products, Inc., s.
Ucinite Co., The, Div.-United-Carr Fastener Corp., w.
Union Asbestos & Rubber Co., h, o, u, b-1.
United Mineral & Chemical Corp., e, l, q.
United States Rubber Co., w, x, b-1.
Universal Moulded Products Corp., r, s.
Valpey Crystal Corp., k.
Victor R. F. & Microwave Co., o, s.
Waterbury Companies, Inc., q, r.
West Instrument Corp., c-1.
Western Coating Co., s.
Western Felt Works & Acadia Synthetic Products Div., s, u.
Western Gold & Platinum Co., d.
Westinghouse Electric Corp., l, q.
Wilmington Fibre Specialty Co., s, t, u.
Wind Turbine Co., o, h, i, j, s, y, z, d-1, e-1.
Winder Aircraft Corp. of Florida, h.
Yardley Plastics Co., s.
Zippertubing Co., The, s, x, b-1.

INTEGRATORS, ELECTRONIC

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Allegany Instrument Co., Inc.
Analytical Instruments, Inc.
Antlab Inc.
Bendix Computer, Div.-Bendix Aviation Corp.
Briggs Associates, Inc.
Bristol Co., The
Burton-Rodgers, Inc.
Chesapeake Instrument Corp.
Colorado Research Corp.
Consolidated Diesel Electric Corp.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Di-An Controls, Inc.
Donner Scientific Co.
Dymec Inc.
Elcor, Inc.
Eldorado Electronics
Electro Instruments, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Federal Mfg. & Engrg. Corp.
Feedback Controls, Inc.
Fischer & Porter Co.
Graflex Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Helipot Div.-Beckman Instruments Inc.
I-L-S Instrument Div., The Meriam Instrument Co.
ITT Labs.
*KEARFOTT CO., INC.
Land-Air Inc.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Librascope Inc.
W. L. Maxson Corp., The
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Miratel, Inc.
Morse Instrument Co., The
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Power-Tronic Systems Inc.
Radiation, Inc.
Raymond Engrg. Lab., Inc.
Reeves Instrument Corp.
Research Appliance Co.
Scientific-Atlanta, Inc.
Sequoia Wire & Cable Co., Div.-Mondrel Industries, Inc.
Servomechanisms, Inc.
Spectrum Instruments, Inc.
Stanley Aviation Corp.
Summers Gyroscope Co.
Sun Electric Corp., Aeronautical Div.
U. S. Industries, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Varion Associotes
Waldorf Electronics. Div.-F.C. Huyck & Sons
Webcor, Inc., Government Div.
Weston Instruments, Div.-Doystrom, Inc.

INTERCOMMUNICATION SYSTEMS

Barker Sales Co.
Bendix Radio Div., Bendix Aviation Corp.
Bliss Electronic Corp.

Bionaer-Tongue Labs., Inc.
Bogen-Presto Co., Div.-Siegler Corp., The
Chalco Engrg. Corp.
Continental Mfg., Inc.
Cooper Development Corp., Sub.-Morquordt Aircraft Co.
Dayton Aviation Radio & Equipment Corp.
Du Kane Corp.
Electronic Communications, Inc.
Executone, Inc.
Federal Mfg. & Engrg. Corp.
Feiler Engrg. & Mfg. Co.
Fidelity Amplifier Co.
Flush Wall Radio Co.
General Precision Lab. Inc.
Gilfillan Bros. Inc.
ITT-Kellogg
Lane Electronics Mfg. Corp.
Litton Industries, Maryland Div.
J. M. Loge, Sound Engineers
Miratel, Inc.
Motorola Inc., Military Electronics Div.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
North Electric Co.
Perry Plastics, Inc.
Philco Corp., Government & Industriol Div.
Precise Development Corp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Specialty Engrg. & Electronics Co.
Stromberg-Carlson Div.-General Dynamics Corp.
Talk-A-Phone Co.
Telectro Industries Corp.
Television Utilities Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Webcor, Inc., Government Div.

INTERFERENCE EQUIPMENT, RF

Double E Products Co.
Hallett Mfg., Co.
Hallicrafters
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
ITT Labs.
Interference Measurement Laboratory, Inc.
Jansky & Bailey, Inc.
Litton Industries, Marylond Div.
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Topco Group, Thompson-Ramo-Wooldridge Inc.
Telectro Industries Corp.

INTERNAL POWER SUPPLY SYSTEMS, MISSILE

***BENDIX AVIATION CORP., HAMILTON DIV.**

INTERVALOMETERS

Atlas Precision Products, Co.
Bell & Howell Co.
Bendix-Pacific Div., Bendix Aviation Corp.
Brown Engrg. Co., Inc.
Bulow Electric Co.
Cedar Engrg. Div.-Control Data Corp.
Chicago Aerial Industries, Inc.
Cooper Development Corp., Sub.-Marquardt Aircroft Co.
Daystrom Pacific Div.-Daystrom, Inc.
Destron Co.
Di-An Controls, Inc.
Elgin Micronics Div.-Elgin National Watch Co.
Elgin Micronics, West Coast Div.-Elgin National Watch Co.
***A. W. HAYDON CO., THE**
Hycon Mfg. Co.
Jordan Electronics, Div.-Victoreen Instrument Co.
Revere Corp. of America
Telectro Industries Corp.
Tempo Instrument Inc.
Textron Corp.
Traid Corp.
Trio Laboratories, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Webcor, Inc., Government Div.
Western Design, Div.-U.S. Industries, Inc.; Sonta Barbaro Div.

INVERTERS

a. DC-AC
b. Measurement
c. Power Supply
d. Rectifier

ACF Industries Inc., a.
Accurate Instrument Co., a.
Aerojet-General Corp., a thru d.
Aerolab Development Co., a thru d.
Airborne Accessories Corp., a.
Alto Scientific Co., Inc., a.
Amelco, Inc., c.
American Electronics, Inc., a, c.
American Missile Products Co., Inc., a, c.
American Research & Mfg. Corp., a, c.
***ARNOUX CORP.**, a, c, d.
Bendix Aviation Corp., Red Bonk Div., a thru d.
Bendix Aviation Corp., York Div., a, c.
Bogue Electric Mfg., Co., a, c, d.
Bristol Co., The, a, b.
Brown Engrg. Co., Inc., a, b, c.
Brunswick Instruments, a.
Carruthers & Fernandez, Inc., a, c, d.
Chalco Engrg. Corp., a, c, d.
Chrysler Corp., Defense Operations Div.
Consolidated Avionics Corp., a thru d.
Consolidated Diesel Electric Corp., a, c.
Continental Electric Co., Inc., a.
Cornell-Dubilier Electric Corp., a, c.
Cubic Corp., d.
Curtiss-Wright Corp., Research Div.
Dalmotor Div., Yuba Consolidated Industries, Inc., a, c, d.
Daven Co., The, a, c, d.
Davenport Mfg. Co., a, c.
Dresser Industries, Inc., a, c, d.
Eicor Div.-Scranton, b.
Electronic Research Associates, Inc., a, c.
Electro Products Laboratories, Inc., a, c.
Engineered Magnetics, Div.-Gulton Industries, Inc., a, b, c.
Fairfield Engrg. Corp.
Ferrotran Electronics Co., Inc., a, c.
Freed Transformer Co. Inc., a, c.
General Electric Co., Apparatus Sales Div., a, c, d.
Gerator Corp., a, c.
Geotronic Labs. Inc., a.
Green Rectifier Co., c, d.
Guided Missile Div.-De Havilland Aircraft of Canada, Ltd., a, c.
Gulton Industries, Inc., a.
Hallamore Electronics Co., a.
Hertner Electric Co., The, a, c.
Hoover Electric Co., a.
Industrial Test Equipment Co., c.
International Research Associates, a.
Jack & Heintz, Inc., a, c, d.
Jordan Electronics, Div.-Victoreen Instrument Co., a.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., a, c.
La Roe Instruments, Inc., a, c.
Leach Corp., a, c.
Lear, Inc., a, c.
Leland Airborne Products, Div.-American Machine & Foundry Co., a, c, d.
Litton Industries, Marylond Div., a.
Magnetic Controls Co., a, c.
W. L. Maxson Corp., The
Minneapolis-Honeywell Regulator Co., Industrial Product Group, a.
Minneapolis-Honeywell Regulator Co., Drdnance Div., a, c, d.
Motorola Inc., Military Electronics Div., a.
Heinz Mueller Eng. Co. Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., a, c.
Networks Electronic Corp., a, c.
Dhio Semiconductors, Inc., a.
D. W. Dnan & Sons Inc., a, c.
Pacific Magnetic Corp., a, c, d.
Perkin Engrg. Corp., a thru d.
Perry Plastics, Inc., c.
Pesco Products Div.-Borg-Warner Corp., a.
Power Supplies Inc., a, c, d.
Power Sources, Inc., a, c, d.
Redmond Co., Inc., a.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**, a.
Rixon Electronics Inc., a.
Royal Industries, Inc., a.
Sangomo Electric Co., a, c.
Sequoia Wire & Cable Co., Div.-Mandrel Industries, Inc., a, c, d.
Servomechanisms, Inc., a.
Sorensen & Co., Inc., a, c.
Spectrol Electronics Corp., a, c.
Talley Corp., The, a, c, d.
Tapco Group, Thompson-Ramo-Wooldridge Inc., a.
Technical Apparatus Builders, a thru d.
Technology Instrument Corp., a.
Terado Co., a, c.
Torwico Electronics, Inc., a.
Trans Electronics, Inc., a, c.
Transonic, Inc., a, c, d.
United Control Corp., a, d.
U. S. Science Corp., Div.-Topp Industries, Inc., c.
Varo Mfg. Co., Inc., a, c.
Western Design, Div.-U.S. Industries, Inc.; Santa Barbora Div., a.
Western Gear Corp., a, c, d.
Westinghouse Electric Corp., a, c, d.
Wincharger Corp., Sub.-Zenith Rodio Corp., a, c.

ION TRAPS

Philco Co., Government & Industrial Div.

IRONS, SOLDERING

See SOLDERING IRONS

ISOLATORS, MICROWAVE

Airtron Inc., Div.-Litton Industries
Canoga Div., Underwood Corp.
DBM Reseorch Corp.
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
ITT Labs.
J-V-M Microwave Co.
***KEARFOTT CO., INC., MICROWAVE DIV.**
Litton Industries, Inc.
Lockheed Aircraft Corp., Missiles & Spoce Div.
Microwave Associates, Inc.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
N.R.K. Mfg. & Engrg. Co.
Philco Corp., Government & Industrial Div.
Polytechnic Research & Development Co., Inc.
Radar Design Corp.
Sage Lobs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Sylvania Electric Products Inc., Special Tube Operations
Tomor Electronics, Inc.
Victor R. F. & Microwave Co.

JACK PANEL ASSEMBLIES

Accurate Electronics Corp., Dept. D
Aerodex, Inc.
Aerolite Electronics Corp.
Aerovox Corp.
Audio Development Co.
Automatic Electric Sales Corp.
Barker Sales Co.
Bernco Engrg. Corp.
Bud Radio Inc.
Carmody Corp.
Coaxial Connector Co. Inc.
Coils-Electronics
Croname Inc.
Donner Scientific Co.
Electrical Insulation Co., Inc.
Electrocraft, Inc.
Electromath Corp.
Electro-Mechanical Products Co.
***ETS-HOKIN & GALVAN**
First Electronics Corp., The
Fletcher Mfg. Co., Inc., The
Foto-Video Labs., Inc.
Good Electronic Corp.
Harco Lobs., Inc.
Paul Hardeman, Inc.
ITT-Kellogg
Jan Hardware Mfg. Co., Inc.
Jodee Plastics Co.
Keystone Electronics Corp.
Mid-West Metal Products, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Di
Minneapolis-Honeywell Regulator Co., Industriol Product Group
Modelectric Products Corp.
Mullenbach Div.-Electric Machinery Mfg. Co.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
North Electric Co.
Paraplegics Mfg. Co., Inc.
Ravenno Metal Products, Div.-Standard Screw Co.
Reinhold Engrg. & Plastics Co.
Milton Ross Metals Co., The
Skyline Electric & Mfg. Co.
Standard Electric Time Co., The
Stromberg-Carlson Div.-General Dynamics Corp.
Switchcraft, Inc.
Telectro Industries Corp.
United Aircraft Products, Inc.
Waltham Horological Corp.

JACKS

Accurate Electronics Corp., Dept. D
Aerovox Corp.
Alden Products Co.
Amatom Electronic Hardware Co. Inc.
Audio Development Co.
Automatic Electric Sales Corp.
Barker Sales Co.
Cambridge Thermionic Corp.
Coaxial Connector Co. Inc.
Colson Corp., The
Crown Controls Co., Inc.
Dockendorff & Co. Inc.
Electrocraft, Inc.
General Cement Mfg. Co., Div.-Textron, Inc.
Globe Hoist Co.
Harco Labs., Inc.
Holland Hitch Co.
Hoover Electric Co.
Horkey-Moore Associates
Hufford Corp., The
Indusl. Prod.-Danbury Knudsen Div. Amphenal-Bar Electronics Corp.
ITT-Kellogg
Javex Electronics
E. F. Johnson Co.
Howard B. Jones Div.-Cinch Mfg. Corp.
Keystone Electronics Corp.
Walter Kidde & Co., Inc., Aviation Div.
Lear, Inc.
P. R. Mallory & Co. Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Nationol Pneumotic Co., Inc., Holtzer-Cabot Divs
National Tel-Tronics Corp.
North Electric Co.
Paul Nurches Co.
Raytheon Mfg. Co.
Regent Jack Mfg, Co., Inc.
Milton Ross Metals Co., The
Rotary Lift Co., Div.-Dover Corp.
Sancor Corp.
Specialty Engrg. & Electronics Co.
Standord Electric Time Co., The
Stromberg-Carlson Div.-General Dynamics Corp.
Superex Electronics Corp.
Switchcraft, Inc.
Templeton, Kenly & Co.
Ucinite Co., The, Div.-United-Carr Fastener Corp
U. S. Industries, Inc.
Vard Inc.

W-S Fittings Works, Farge & Fittings Div., H. K. Porter Co. Inc.
Waltham Horological Corp.

T ENGINE DIAPHRAGMS
See DIAPHRAGMS, JET ENGINE

T ENGINE IGNITERS
See IGNITERS, JET ENGINE

T ENGINE NOZZLE DIAPHRAGMS
See DIAPHRAGMS, JET ENGINE NOZZLE

T ENGINE TAILPIPES
See TAILPIPES, JET ENGINE

T ENGINES

AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
General Electric Co., Apparatus Sales Div.
A. W. Kellogg Co., The
Marquardt Aircraft Co.
Smith-Marris Corp.
Solar Aircraft Co.
Westinghouse Electric Corp.

WELS
Federal Screw Products Inc.
Hamilton Watch Co.-Industrial Div.
Hugo P. Keller, Jr.
Hartan Co., New Products Dept.
Sphinx-American Co.
Swiss Jewel Co.
United Mineral & Chemical Corp.
Valpey Crystal Corp.
Waltham Precision Instrument Co.

WELS, GLASS
Richard H. Bird & Co., Inc.
Vialight Corp.
General Electric Co., Apparatus Sales Div.
Grimes Mfg. Co.
Sphinx-American Co.
Valpey Crystal Corp.

INT ASSEMBLIES
Aero Supply Mfg. Inc.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Garmac Aviation
Shiksan Co., Sub.-Food Machinery & Chemical Corp.
Sunbar-Kapple Inc.-Aircraft Components Div.
FLEXONICS CORP., AERONAUTICAL DIV.
Garman Div., Aeroquip Corp.
J. R. K. Mfg. & Engrg. Co.
National Utilities Corp.
Piasecki Aircraft Corp.
Smith-Morris Corp.
Solar Aircraft Co.
Ulman Devices Corp.
Variety Aircraft Corp.

INTS
a. Ball
b. Swivel
c. Torsian
d. Universal

Accessory Products Co., Div.-Textron Inc., a thru d.
Allegany Instrument Co., Inc., a.
American Aeroparts, a thru d.
Apex Machine & Tool Co., The, d.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., a, d.
Barco Mfg. Co., a, b.
Shiksan Co., Sub.-Food Machinery & Chemical Corp., b.
Bom-Air Products, Div.-A S R Products Corp., b.
Bomponents Corp., a, b.
Consolidated Diesel Electric Corp.
Corbin Products Div., a.
Curtis Universal Joint Co., Inc., d.
Curtiss-Wright Corp.-South Bend Div., a.
Diversey Engrg. Co., a, b.
Eckendorff & Co. Inc., c.
Fairmont Aircraft Fitting Co., b.
Sunbar-Kapple Inc.-Aircraft Components Div., a thru c.
Gissex Mfg. Co., Inc., b.
Govejoy Flexible Coupling Co., d.
Hox Clock Mfg. Co., Inc., d.
Garman Div., Aeroquip Corp., d.
Hational Utilities Corp., b.
HPW-Jordan, a, b.
IC Design Corp., Sub.-Benrus Watch Co., Inc., a thru d.
Jarts Engrg. Co., Inc., d.
Kerless Machine Co., b.
Lann-Michigan Mfg. Corp., a.
Lockwell-Standard Corp., d.
Lohr Aircraft Corp., a.
Man Aeronautical Co., a, d.
Magent Engrg. Corp., c.
Mallol Corp., b.
Mitler Corp., d.
Mar Aircraft Co., a.
Northwest Products Co., a, b, c.
Ulman Devices Corp., a.
United Supply Co., a, b.
Vard Inc., a, b, c.
Waste King Corp., Technical Products Div., a, b, c.

JUMPERS, BONDING
AMP Inc.
Aerolite Electronics Corp.
Best Aircraft Corp.
Birnbach Radio Co., Inc.
Century Fasteners Corp.
Entron, Inc.
First Electranics Corp., The
Hallett Mfg., Co.
Janco Corp.
Madelectric Products Corp.
New England Electrical Works, Inc.

JUNCTION BOXES & PANELS
A & P Metal Products Mfg. Corp.
Abalan Precision Mfg. Corp.
Accurate Electranics Corp., Dept. D
Adept Industries Inc.
Aerodex, Inc.
Aerolite Electronics Corp.
Alpitec, Inc.
Anchor Metal Spinning Co., The
Associated Engineers, Inc.
Brooks & Perkins, Inc.
Bud Radio Inc.
Coble Electric Products Inc.
Chrysler Corp., Defense Operations Div.
Coaxial Connector Co. Inc.
Coils-Electronics
Colonial Aircraft Corp.
Consolidated Productions, Inc.
Daven Co., The
Dayton Aviation Radio & Equipment Corp.
Electro-Mechanical Products Co.
Federal Mfg. & Engrg. Corp.
Firestone Tire & Rubber Co., The, Guided Missile Div.
Fletcher Mfg. Co., Inc., The
General Electric Co., Apparatus Sales Div.
Grimes Mfg. Co.
Hardman Tool & Engrg. Co.
Ludwig Hanold Mfg. Co.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
Motorola Inc., Military Electronics Div.
Mullenbach Div.-Electric Machinery Mfg. Co.
Paraplegics Mfg. Co., Inc.
Piasecki Aircraft Corp.
C. F. Roark Welding & Engrg. Co., Inc.
Skyline Electric & Mfg. Co.
Specialty Engrg. & Electronics Co.
Suffolk Products Corp.
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
Variety Aircraft Corp.

JUNCTIONS, HYBRID, MICROWAVE
Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
Alford Mfg. Co.
Antenna & Radome Research Associates
W. A. Beauchaine & Sons Inc.
Bendix Aviation Corp., York Div.
Coaxial Connector Co. Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Demornay-Bonardi
Douglas Microwave Co., Inc.
John Gombos Co., Inc.
I-T-E Circuit Breaker Co.
Indusl. Prod.-Danbury Knudsen Div. Amphenol-Borg Electronics Corp.
J-V-M Microwave Co.
Litton Industries, Inc.
Meridian Metalcraft, Inc.
Microwave Associates, Inc.
Monogram Precision Industries
N. R. K. Mfg. & Engrg. Co.
Narda Microwave Corp., The
Omega Labs., Inc.
Philco Corp., Government & Industrial Div.
Portchester Instrument Corp.
Radar Design Corp.
Sage Labs., Inc.
Special Instruments Div., British Industries Corp.
Telerod Mfg. Corp.
Wheeler Laboratories, Inc.

KEYERS
Applied Science Corp. of Princeton
Barker Sales Co.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Dayton Aviation Radio & Equipment Corp.
Foto-Video Labs., Inc.
General Devices, Inc.
General Precision Lab. Inc.
Grimes Mfg. Co.
Jordan Electronics, Div.-Victoreen Instrument Co.
Kauke & Co.
Litton Industries, Maryland Div.
Minneapolis-Honeywell Regulator Co., Ordnance Div.
Motorola Inc., Military Electronics Div.
Munston Mfg. & Service, Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Nuclear Products-Erco Div.-ACF Industries, Inc.
Radar Relay, Inc.
Radiatian, Inc.
Seeburg Carp., The
Sulfolk Products Corp.
Telechrome Mfg. Corp.
Telectro Industries Corp.
Tawaco Electranics
United Cantral Carp.
Webcor, Inc., Government Div.
Winder Aircraft Corp. of Florida

KEYERS & COUPLERS
Barker Sales Co.
Bendix Aviation Corp., York Div.
Dayton Aviatiap Radio & Equipment Carp.
Nationol Pneumatic Co., Inc., Holtzer-Cabot Divs.
Radiation, Inc.
Telectro Industries Corp.

KEYS & CODING EQUIPMENT
Barker Sales Co.
CGS Labs., Inc.
Daytan Aviation Radio & Equipment Corp.
General Devices, Inc.
E. F. Johnsan Co.
Kauke & Co.
Matarala Inc., Military Electronics Div.
Natianal Pneumatic Co., Inc., Haltzer-Cabat Divs.
Narth Electric Co.
Soroban Engrg., Inc.
Stramberg-Carlsan Div.-General Dynamics Corp.
Telectro Industries Corp.
Vitro Labs.
Western Design, Div.-U. S. Industries, Inc.; Santa Barbara Div.
Winzen Research Inc.

KILOVOLTMETERS
Associated Research, Inc.
Beede Electrical Instrument Co. Inc.
Bristol Co., The
Davenport Mfg. Co.
Del Electranics Corp.
Electro Instruments, Inc.
Electra-Tech Equipment Co.
Ferranti Electric Inc.
General Electric Co., Apparatus Sales Div.
Jennings Radio Mfg. Corp.
Keithley Instruments, Inc.
Meters Inc.
Minneapolis-Honeywell Regulatar Co., Industrial Product Group
National Electronics
New England Scientific Instruments Co.
Rawson Electrical Instrument Co.
Shallcross Mfg. Co.
Sun Electric Corp., Aeronautical Div.
Wacline, Inc.
Weston Instruments, Div.-Daystrom, Inc.

KITS
a. Geiger Counter
b. Modification
c. Partable Lighting
d. Test Equipment

Aerojet-General Corp., d.
Anton Electronic Labs., Inc., a.
Associated Research, Inc., d.
Atlas Precision Products, Co., d.
A. Biederman, Inc., d.
Borden Chemical Co.
Burton-Rogers, Inc., d.
Centronix Inc., d.
Consolidated Diesel Electric Corp., Western Div., d.
Continental Technical Service, Inc., d.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., c.
Cornelius Co., The, Aero Div., b, d.
Curtiss-Wright Corp., Research Div., d.
Double E Products Co., b, c, d.
Douglas Microwave Co., Inc., d.
Eastern Specialty Co., The, d.
Electro Products Laboratories, Inc., d.
Electronic Instrument Co., Inc. (EICO), d.
FXR, Inc., d.
Federal Mfg. & Engrg. Corp., b.
First Electronics Corp., The, b, d.
Foto-Video Labs., Inc., d.
Gardner Laboratory, Inc., d.
Good Electronic Corp., b.
Gordon Enterprises, c, d.
Green Recitfier Co., d.
Harco Labs., Inc., d.
E. Vernon Hill & Co., d.
Hufford Corp., The, d.
Hycon Mfg. Co., d.
Kahn & Co., Inc., d.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., d.
Koehler Aircraft Products Co., b.
Land-Air Inc., a.
Lear, Inc., d.
Lear, Inc., Grand Rapids Div., d.
W. L. Maxson Corp., The, b.
Merz Engrg., Inc., d.
Nuclear-Chicago Corp., a.
Paco Electronics Co., Inc., d.
Parker-Hartford Corp., The, b.
Peschel Electronics, Inc., d.
Pioneer Industries Div., Almar-York Co. Inc., d.

Precise Development Corp., a, d.
Ravenna Metal Products, Div.-Standard Screw Co., d.
Republic Aviation Corp., b.
Republic Mfg. Co., d.
Ryan Aeronautical Co., d.
Seco Mfg. Co., d.
Sel-Rex Corp., d.
Sequoia Wire & Cable Co.-Div.-Mandrel Industries, Inc., d.
Speciol Projects Lab., Food Machinery & Chemical Corp., d.
Specialty Engrg. & Electronics Co., a thru d.
Squiers Gage Co., d.
Stanley Aviation Corp., d.
State Testing Lab. Inc., d.
Sterling Precision Corp., Instrument Div., d.
Sun Electric Corp., Aeronautical Div., d.
Superex Electronics Corp., b.
Tolley Corp., The, b, d.
Telectro Industries Corp., d.
United Aircraft Products, Inc., b, d.
United Mfg. Co., Div., The W. L. Maxson Corp., d.
Variety Aircraft Corp., d.

KLYSTRON TUBE CHECKERS
See CHECKERS, KLYSTRON TUBE

LACQUERS

Ambroid Co. Inc.
Arco Co., The
Bios Labs., Inc.
Cooper Industries, Inc.
Dennis Chemical Co.
Emerson & Cuming, Inc.
Fidelity Chemical Products Corp.
Grant Chemical Co., Inc.
Krylon, Inc.
Maas & Woldstein Co.
Morblette Corp., The
Micro-Circuits Co.
Midland Industrial Finishes Co.
Organic Products Co.
Polymer Corp., The
Thomas Electronics, Inc.
Trio Chemical Works, Inc.
United States Plywood Corp.
Voroc Co., The
Waldom Electronics Inc.

LADDERS, FUELING

Ainslie Corp.
Alad Aluminum Ladder Corp.
American Aeroparts
Bollymore Co.
Barrett-Christie Co.
Bil-Jax Inc.
Coloniol Aircroft Corp.
Cromer Mfg. & Engrg., Inc.
Ludwig Honold Mfg. Co.
Mercury Tool & Mfg. Corp.
Dpelika Welding, Machine & Supply Inc.
Schaffer Air Industries, Inc.
Skyline Products, Inc.
Thiokol Chemical Corp.
Western Arc Welding, Inc.

LAMINATED SHIMS
See SHIMS, LAMINATED

LAMINATES

Air Logistics Corp.
Allied Plastics Supply Corp.
American Printed Circuits Co., Inc.
American Silver Co.
Carl H. Biggs Co.
Bridgeport Brass Co.
Chemold Co.
Continental Diamond Fibre Corp.
Cordo Chemical Corp.
Crystal-X Corp.
Curtiss-Wright Corp., Research Div.
E. I. Du Pont De Nemours & Co. Inc.
Durolith Corp.
Electrical Insulation Co., Inc.
Emerson Plastics Corp.
Formica Corp.
Franklin Fibre-Lamitex Corp.
General Plastics Corp. of New Jersey
Goodyear Aircraft Corp.
Hardman Tool & Engrg., Co.
Haskelite Mfg. Corp.
Haveg Industries, Inc.
International Resistance Co.
Joclin Mfg. Co.
Jodee Plastics Co.
Johns-Manville
Lamtex Industries, Inc.
Lone Star Plastics Co. Inc.
Thomas J. Long, Inc.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
Narmco Mfg. Co.
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
Northern Plastics Corp.
Panel Engrg. Corp.
Penn Fibre & Specialty Co., Inc.
Plastic Age Sales, Inc.
Raybestos-Manhattan, Inc.
Raybestos-Manhatton, Inc., Pa.
Reinhold Engrg. & Plastics Co.
Republic Aviation Corp.
Rogers Corp.
Milton Ross Metals Co., The
Russell Reinforced Plastics Corp.
St. Regis Paper Co., Panelyte Div.
Sierracin Corp., The
Silicone Insulation, Inc.
Spoulding Fibre Co., Inc.
Standard Metals Corp.
Stevens Products, Inc.
Swedlow Inc.
Taylor Fibre Co.
United States Chemicol Milling Corp.
United States Plywood Corp.
United States Rubber Co.
Universal Moulded Products Corp.
Virginia Plok Co.
Western Tool & Mfg. Co., The
Westinghouse Electric Corp.
Zippertubing Co., The

LAMINATIONS, TRANSFORMER

Allegheny Ludlum Steel Corp.
American Printed Circuits Co., Inc.
G-L Electronics Co., Inc.
Johns-Manville
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Westinghouse Electric Corp., Metals Plant

LAMINATORS, PLASTIC HIGH PRESSURE

Adept Industries Inc.
Allied Plastics Supply Corp.
American Aerophysics Corp.
American Printed Circuits Co., Inc.
Chemold Co.
Collins Engrg. Corp.
Continental Diamond Fibre Corp.
Doyton Aircraft Products, Inc.
Durolith Corp.
Electricol Insulation Co., Inc.
Emeloid Co., Inc., The
Engineered Plastics, Inc.
Forley & Loetscher Mfg. Co., Plastics Div.
Formiqa Corp.
Franklin Fibre-Lamitex Corp.
Hardman Tool & Engrg. Co.
Haveg Industries, Inc.
Homolite Corp., The
Hull Corp.
Joclin Mfg. Co.
Kerrco Products
Lamtex Industries, Inc.
Lone Star Plastics Co. Inc.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Monrovia Aviation Corp.
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
Panel Engrg. Corp.
Perry Plastics, Inc.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Raybestos-Manhatton, Inc.
Raybestos-Manhattan, Inc., Po.
Republic Aviation Corp.
Rogers Corp.
Milton Ross Metals Co., The
St. Regis Paper Co., Panelyte Div.
Sierracin Corp., The
Spaulding Fibre Co., Inc.
Swedlow Inc.
Taylor Fibre Co.
H. I. Thompson Fiber Glass Co.
United States Chemical Milling Corp.
Universal Moulded Products Corp.
Virginia Electronics Co., Inc.
Virginio Plak Co.

LAMPS, INFRA-RED

Chicago Miniature Lamp Works
Collins Engrg. Corp.
Eagle Electric Mfg. Co. Inc.
Edmund Scientific Co.
Engelhord Industries, Inc.
Fisher Scientific Co.
Kemlite Laboratories, Inc.
Miskello Infra-Red Co., The
Monogram Precision Industries
Radiant Lamp Corp.
Westinghouse Electric Corp.

LAMPS, INSPECTION

A. D. W. Corp.
Blowers Inc.
Chicago Miniature Lamp Works
Collins Engrg. Corp.
Eagle Electric Mfg. Co. Inc.
Ericson Mfg. Co., The
Gordon Enterprises
Mico Instrument Co.
Radiant Lamp Corp.
Shannon Luminous Materials Co.
Strat-D-Seal Mfg. Co.

LAMPS, PROJECTION

Gordon Enterprises
Jones & Lamson Machine Co.
Radiant Lamp Corp.
Sequoia Wire & Cable Co., Div.-Mandrel Industries, Inc.
Westinghouse Electric Corp.

LAMPS, ULTRA-VIOLET

*ULTRA-VIOLET PRODUCTS, INC.

LANDING AIDS, ELECTRONIC

Belock Instrument Corp.
Bendix Radio Div., Bendix Aviation Corp.
DBM Research Corp.
Dayton Aviation Radio & Equipment Corp.
Electronic Communications, Inc.
Gilfillan Bros. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Kemlite Laboratories, Inc.
Land-Air Inc.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Litton Industries, Maryland Div.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Motorola Inc., Military Electronics Div.
Northrop Corp., The, Nortronics Div.
Philco Corp., Government & Industrial Div.
Raytheon Mfg. Co., Government Equipment Div.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Thiokol Chemical Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Virginio Electronics Co., Inc.
Westinghouse Electric Corp.

LANDING GEAR ASSEMBLIES

*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bruce Engrg. Co.
Coloniol Aircraft Corp.
Cromer Mfg. & Engrg., Inc.
Electrol Inc.
Holland Hitch Co.
Hydro-Power Corp.
Interstate Engrg. Corp.
Kaiser Aircroft & Electronics, Div.-Kaiser Industries Corp.
Kanorr Corp.
Longren Aircraft Co., Inc.
Mercury Tool & Mfg. Corp.
Nebel Machine Tool Corp.
Newbrook Machine Corp.
Phillips Aviation Co.-Morples Geors
Piosecki Aircraft Corp.
Sargent Engrg. Corp.
Talley Corp., The
United Mfg. Co., The
U. S. Industries, Inc.
Vord Inc.
Western Geor Corp.
Wise Aerodraulics, Inc.

LANDING GEAR RETRACTORS
See RETRACTORS, LANDING GEAR

LANDING GEAR SHOCK ABSORBERS
See SHOCK ABSORBERS, LANDING GEAR

LANDING SYSTEMS, AIRBORNE
See AIRBORNE LANDING SYSTEMS

LANDING SYSTEMS, GROUND
See GROUND LANDING SYSTEMS

LANDING SYSTEMS, INSTRUMENT

Americon Aeroparts
*AVCO MFG. CORP., CROSLEY DIV.
Belock Instrument Corp.
Centronix Inc.
Dayton Aviation Radio & Equipment Corp.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Labs.
ITT-Kellogg
Korda Industries
Land-Air Inc.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Litton Industries, Maryland Div.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Motorola Inc., Military Electronics Div.
Raytheon Mfg. Co., Government Equipment Div.
Telectro Industries Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Westinghouse Electric Corp.

LATCHES

Adams Rite Mfg. Co.
Americon Aeroparts
Anchor Metol Spinning Co., The
Bud Radio Inc.
Burklyn Co.
Camloc Fostener Corp.
Capital City Mfg. Co.
Components Corp.
Dimco-Gray Co.
Hughes Tool Co., Aircraft Div.
Kaiser Aircroft & Electronics, Div.-Kaiser Industries Corp.
Monogram Precision Industries
National Lock Co.
Reinhold Engrg. & Plastics Co.

Richards-Wilcox Mfg. Co.
Scavill Mfg. Co.
Simmonds Aeracessories, Inc.
Stanley-Judd Div.-The Stanley Works
United States Chemical Milling Corp.
United Supply Co.

TCHES, BALL
See BALL LATCHES

THES, BENCH

American Aeraparts
Barrett-Christie Co.
Clausing Div.-Atlas Press Co.
Hardinge Brothers, Inc.
Carl Hirschmann Co., Inc.
R. K. Lebland Machine Taal Co.
Louis Levin & Son, Inc.
Red Lion Cabinet Co., Redca Taal Div.
Rivett Lathe & Grinder Inc.
Joseph T. Ryerson & San, Inc.
Stark Taal Co.
Transmares Carp.

UNCHERS, AIRBORNE ROCKET

ACF Industries Inc.
Accessary Products Co., Div.-Textran Inc.
Acco Equipment Div., American Chain & Cable Co., Inc.
Aerojet-General Corp.
Aeronca Mfg. Corp.
Aircraft Armaments, Inc.
American Machine & Faundry Co., Government Products Group
American Machine & Faundry Co., Greenwich
Associated Engineers, Inc.
Atlantic Research Corp.
Basic Taal Industries, Inc.
Breeze Carporations, Inc.
Bridgeport Brass Co.
Coloniol Aircraft Corp.
Cooper Development Carp., Sub.-Marquordt Aircraft Co.
Diversey Engrg. Co.
Dresser Industries, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Dresser-Ideca Co., Div.-Dresser Industries, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avianics Div.
FWD Carp.
General Electric Co., Missile & Space Vehicle Dept.
Goodyear Aircraft Corp.
Hardman Taal & Engrg. Co.
Hoover Electric Co.
Harkey-Maare Associates
Industrial Taals Mfg. Carp., Sub.-Pendleton Taal Industries, Inc.
Intercantinentol Mfg. Co., Inc.
Interstate Engrg. Corp.
Jack & Heintz, Inc.
Kaiser Aircraft & Electranics, Div.-Kaiser Industries Corp.
Kelsey-Hayes Co.
Land-Air Inc.
Lockheed Aircraft Corp.
Marquardt Aircraft Co.
Martin Co., The, Nartranics Div.
Mc Donnell-Douglas Corp.
Narmco Industries, Inc.
Northrop Corp.
Pacific Coast Engrg. Co.
Philips & Davies Inc.
Pioneer Taal & Engrg. Co.
Ryan Aeronautical Co.
Sargent Engrg. Corp.
Space Corp.
Temco Aircraft Corp.
Thiokol Chemical Corp.
Trailmobile Inc.
Twin Coach Co., Aircraft-Missiles
U. S. Industries, Inc.
Universal Metal Products Inc.
Vard Inc.
Vought Aeronautics Co., Div.-Ling-Temco-Vought Inc.
Washington Aluminum Co., Inc.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Western Gear Corp.
Whelond Co., The

UNCHERS, GROUND BASED MISSILES

ACF Industries Inc.
Accessary Products Co., Div.-Textran Inc.
Acco Equipment Div., American Chain & Cable Co., Inc.
Aerojet-General Corp.
Arrolab Develapment Co.
Aeronca Mfg. Co.
Air Lagistics Corp.
Alco Products, Inc.
Aircraft Armaments, Inc.
Arco Products, Inc.
American Car & Foundry, Div.-ACF Industries, Inc.
American Machine & Foundry Co., Government Products Group
American Machine & Faundry Co., Greenwich
Applied Design Co.
Associated Engineers, Inc.
Atlantic Research Corp.
Austin-Western, Canstr. Equip. Div.,-Baldwin-Lima-Hamilton Corp.
Baker Industrial Trucks, Div.-Dtis Elevator Co.
Basic Taal Industries, Inc.
Beaver Precision Products Inc.
E. W. Bliss Co.
Bowser, Inc., Defense Dept.
Breeze Carporations, Inc.
Brown Engrg. Co., Inc.
C. B. Christiansen Co.
Cleveland Pneumatic Industries, Inc.
Canco Engrg. Warks
Consalidated Diesel Electric Carp., Western Div.
Cooper Development Carp., Sub.-Marquordt Aircraft Co.
Cramer Mfg. & Engrg., Inc.
Curtiss-Wright Carp., Santa Barbara Div.
Diversey Engrg. Co.
Dresser Industries, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Dresser-Ideca Co., Div.-Dresser Industries, Inc.
Dynamic Devices, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avianics Div.
FWD Carp.
Fairchild Astrianics Div., Fairchild Engine & Airplane Corp.
Farrel Birmingham Co. Inc.
Fruehauf Trailer Co., Military Equipment Div.
Fulton-Irgon Corp., The
G. W. Gallaway Co.
General Electric Co., Missile & Space Vehicle Dept.
Goodyear Aircraft Corp.
Hardman Taal & Engrg. Co.
Ludwig Hanald Mfg. Co.
Hoover Electric Co.
Harkey-Maare Associates
Hussmann Aircraft Div.
ITT Labs.
Industrial Tools Mfg. Carp., Sub.-Pendleton Taal Industries, Inc.
Ingersoll Kalamazaa Div., Borg-Worner Corp.
Intercontinental Mfg. Co., Inc.
Interstate Engrg. Corp.
Jack & Heintz, Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Carp.
M. W. Kellogg Co., The
Kelsey-Hayes Co.
Kemp Aera Products
Land-Air Inc.
Longren Aircraft Co., Inc.
Marquardt Aircraft Co.
W. L. Maxsan Corp., The
Mc Dawell-Wellman Companies, The
Mechanics Universal Joint Div., Barg-Warner Corp.
***MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.**
Monagram Precision Industries
Newbrook Machine Carp.
Northrop Carp.
Narthrop Corp., The, Nartranics Div.
Dpelika Welding, Machine & Supply Inc.
Drdnance Div.-Food Machinery & Chemical Carp.
Pacific Caast Engrg. Co.
Philips & Davies Inc.
Pioneer Taal & Engrg. Ca.
Pittsburgh-Des Maines Steel Ca.
Portland Capper & Tank Warks Inc.
Project Fabrication Corp.
Ravenna Metal Products, Div.-Standard Screw Ca.
Red Lion Cabinet Co., Redca Taal Div.
Regent Jack Mfg. Ca., Inc.
Republic Aviation Carp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Royal Industries, Inc.
Sancar Corp.
Sargent Engrg. Corp.
Space Carp.
Stainless Inc.
Stearns-Roger Mfg. Ca.
Talley Carp., The
Tapco Group, Thampsan-Rama-Wooldridge Inc.
Thiokal Chemical Carp.
Trailmabile Inc.
Turba Products, Inc.
Twin Caach Ca., Aircraft-Missiles
U. S. Industries, Inc.
Van Zelm Assaciates, Inc.
Vard Inc.
Washington Aluminum Ca., Inc.
Waste King Corp., Technical Products Div.
Woyne Pump Co., The, Div.-Symington Wayne Carp.
Western Gear Carp.
Westinghause Electric Carp.
Whelond Ca., The
Wickfield, Inc.

LAUNCHING DEVICES, ROCKET
See ROCKET LAUNCHING DEVICES

LAUNCHING PLATFORMS

Acca Equipment Div., American Chain & Cable Ca., Inc.
Aerajet-General Carp.
Air Lagistics Carp.
Alco Products, Inc.
***ALUMINUM SAFETY PRODUCTS, INC.**
American Car & Faundry, Div.-ACF Industries, Inc.
American Machine & Foundry Ca., Government Products Group
American Machine & Foundry Co., Greenwich
Astranautics Engrg. Ca.
Basic Tool Industries, Inc.
Beaver Precisian Products Inc.
E. W. Bliss Co.
Chicago Bridge & Iron Ca.
Conca Engrg. Works
Cooper Develapment Carp., Sub.-Marquardt Aircraft Ca.
Crane Carrier Carp.
Cramer Mfg. & Engrg., Inc.
Dresser Industries, Inc.
Dresser-Ideco Ca., Div.-Dresser Industries, Inc.
Emersan Electric Mfg. Ca., The, Electronics & Avionics Div.
FWD Carp.
Fruehauf Trailer Co., Military Equipment Div.
G. W. Gallaway Ca.
Hordman Tool & Engrg. Ca.
Harkey-Maore Assaciates
Huffard Corp., The
ITT Labs.
Industrial Toals Mfg. Carp., Sub.-Pendleton Taal Industries, Inc.
Jack & Heintz, Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kemp Aero Products
Langren Aircraft Ca., Inc.
Managram Precisian Industries
Newbraok Machine Carp.
Narthrop Carp.
Dpelika Welding, Machine & Supply Inc.
Pacific Coast Engrg. Ca.
Pianeer Tool & Engrg. Co.
Pittsburgh-Des Maines Steel Ca.
Portland Capper & Tank Works Inc.
Praject Fabricotion Carp.
Red Lian Cabinet Ca., Redca Tool Div.
Regent Jack Mfg. Co., Inc.
Royal Industries, Inc.
Sancor Carp.
Space Corp.
Stainless Inc.
Stearns-Roger Mfg. Ca.
Thiakal Chemical Corp.
Turbo Products, Inc.
Twin Caach Ca., Aircraft-Missiles
U. S. Industries, Inc.
Van Zelm Assaciates, Inc.
Washington Aluminum Ca., Inc.
Wayne Pump Co., The, Div.-Symingtan Wayne Corp.
***R. D. WERNER CO., INC.**
Western Gear Corp.
Wheland Co., The

LEAD FOIL
See FOIL, LEAD

LEAD SHIELDS
See SHIELDS, LEAD

LEADS, TEST

Aeralite Electronics Corp.
Anchar Specialty Mfg. Co. Inc.
Birnbach Radia Ca., Inc.
Bud Radio Inc.
Cable Electric Products Inc.
Devcon Corp.
Double E Products Co.
Eastern Specialty Co., The
Electro-Tech Equipment Co.
First Electronics Carp., The
Hallett Mfg., Co.
Keystone Electronics Carp.
National Electranics
Paul Nurches Ca.
Poca Electronics Co., Inc.
Paraplegics Mfg. Ca., Inc.
Pamona Electranics Ca., Inc.
Precisian Apparatus Ca., Inc.
Stanley-Judd Div.-The Stanley Warks
Thamas Electranics, Inc.
Western Internatianal Co.
Westwood Cable Carp.

LEATHER HANDLES
See HANDLES, LEATHER

LENSES
a. Inspection
b. Motion Picture
c. Optical
d. RF
e. Zoom

American Dptical Ca., Instrument Div.,**a, c.**
Atlantic Research Carp., **c.**
Seman Bache & Co., **a, b, c.**
***BAUSCH & LOMB OPTICAL CO., a, b, c.**
Bell & Howell Ca., **a thru e.**
Braaks & Perkins, Inc., **d.**
Buhl Dptical Co., **a, b, c.**
Burke & James Inc., **a, b, c.**
Camera Mart Inc., The, **b, c, e.**
Cameraflex Corp., **b, c.**
DBM Research Corp., **d.**
Davidsan Mfg., Ca., Inc., **c.**
Dell Dptics Ca., Ltd., **a, b, c, e.**
Diamond Antenna & Micrawave Corp., **d.**
Eastman Kadak Ca., **a, b, c.**
Edmund Scientific Co.
***ELECTROSNAP CORP., c.**
Elgeet Dptical Ca., Inc., **b, c.**
Emersan & Cuming, Inc., **d.**
J. W. Fecker, Inc., **a thru d.**

Gaertner Scientific Corp., The, c.
General Scientific Equipment Co., a.
Gordon Enterprises, a thru e.
Hayward Scientific Glass Corp., a, b, c.
Jones & Lamsan Machine Co., c.
Kollmorgen Optical Corp., b, c.
Kollsman Instrument Carp., Sub.-Standard Coil Products Co. Inc., c.
Lancaster Glass Carp., c.
McMillan Industrial Corp., d.
Meridian Metalcraft, Inc., d.
Monogram Precision Industries, c.
Northrop Corp., c, d, e.
Northrop Corp., The, Nortronics Div., c, d.
D & S Research, Inc., c.
Pacific Optical Corp., a thru e.
Pacific Universal Products Corp., c.
Perkin-Elmer Corp., a, c, e.
Republic Lens Co. Inc., a, c, d.
Seiscor Mfg. Co., c.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., d.
Sterling Glass Corp., a.
Sterling-Howard Corp., b, c, e.
Traid Corp., b, c, e.
Universal Unlimited, Inc., c.
Valpey Crystal Corp., c.
Wollensak Optical Co., a thru e.
Zenith Optical Laboratory, c.
Zoomar Inc., c, e.

LENSES, PRISMS, MIRRORS

American Cystoscope Makers, Inc.
American Instrument Co., Inc.
American Optical Co., Instrument Div.
Atlantic Research Corp.
Semon Bache & Co.
***BAUSCH & LOMB OPTICAL CO.**
Bell & Howell Co.
Buhl Optical Co.
Burke & James Inc.
Camera Mart Inc., The
Chicago Aerial Industries, Inc.
Corning Glass Works
Dovidson Mfg. Co., Inc.
Eastman Kodak Co.
Edmund Scientific Co.
***ELECTROSNAP CORP.**
***ENGIS EQUIPMENT CO.**
J. W. Fecker, Inc.
Fish-Schurman Corp.
Gaertner Scientific Corp., The
Gordon Enterprises
Hayward Scientific Glass Corp.
Kollmorgen Optical Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Kopp Glass, Inc.
Lancaster Glass Corp.
Liberty Mirror Div., Libbey-Owens-Ford Glass Co.
Minneapolis-Honeywell Regulator Co., Ordnance Div.
Monogram Precision Industries
National Spectrographic Labs., Inc.
Northrop Corp.
Northrop Corp., The, Nortronics Div.
D & S Research, Inc.
Pacific Optical Corp.
Pacific Universal Products Corp.
Perkin-Elmer Corp.
Republic Lens Co. Inc.
Seiscor Mfg. Co.
Singer Mfg. Co., The, Military Products Div.
Sterling Glass Corp.
Traid Corp.
Valpey Crystal Corp.
Wollensak Optical Co.
Zenith Optical Laboratory
Zoomar Inc.

LEVERS

***BALCRANK, INC., MACHINE TOOL DIV.**

LIGHT SUPPLIES

Burke & James Inc.
Cooper Industries, Inc.
Edgerton, Germeshausen & Grier, Inc.
Grimes Mfg. Co.
Soderberg Mfg. Co., Inc.
Technical Apparatus Builders

LIGHTING, COLD CATHODE

Acme Electric Corp.
American Printed Circuits Co., Inc.
Crouse-Hinds Co.
Kemlite Laboratories, Inc.
Julian A. McDermott Corp.

LIGHTING CONTROL CONSOLES

See CONSOLES, LIGHTING CONTROL

LIGHTING EQUIPMENT, EMERGENCY

Anchor Metal Spinning Co., The
Consolidated Diesel Electric Corp.
Consolidated Diesel Electric Corp., Western Div.
Cooper Development Corp., Sub.-Morquardt Aircraft Co.
Exide Industrial Div.-The Electric Storage Battery Co.
General Scientific Equipment Co.
Grimes Mfg. Co.
Internationol Fermont Machinery Co., Inc.
Kemlite Laboratories, Inc.
Julian A. McDermott Corp.
***MOTOR GENERATOR CORP.**
D. W. Dnan & Sons Inc.
Soderberg Mfg. Co., Inc.
Terodo Co.
Wallace & Tiernan Inc.
Wincharger Corp., Sub.-Zenith Rodio Corp.
Winpower Mfg. Co.

LIGHTING EQUIPMENT, PRESET PANELS

American Printed Circuits Co., Inc.
Anchor Metal Spinning Co., The
***ELECTROSNAP CORP.**
Kilgen Aircraft Div.
Korry Mfg. Co.
Mullenbach Div.-Electric Machinery Mfg. Co.
Panel Engrg. Corp.
Radar Relay, Inc.
Soderberg Mfg. Co., Inc.
Sun Dial Corp.

LIGHTING EQUIPMENT, TOWER

Crouse-Hinds Co.
General Electric Co., Apporatus Sales Div.
Hughey & Phillips, Inc.
Kemlite Laboratories, Inc.
Julian A. McDermott Corp.
Soderberg Mfg. Co., Inc.
Specialty Engrg. & Electronics Co.
Westinghouse Electric Corp.
Wind Turbine Co.

LIGHTNING ARRESTERS

Airtron Inc., Div.-Litton Industries
American Missile Products Co., Inc.
Dale Products, Inc.
Doyton Aircraft Products, Inc.
Garde Mfg. Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Insulator Dept.
Westinghouse Electric Corp.

LIGHTS

a. Arc
b. Black
c. Dial, Panel & Pilot
d. Flood
e. Fluorescent
f. Glow
g. Incandescent
h. Indicator
i. Jewel Pilot
j. Miniature
k. Neon Test
l. Photoelectric Source
m. Signal
n. Spot
o. Stroboscopic Source

A. D. W. Corp., e, g.
Aerolab Development Co., a.
Aerolite Electronics Corp., c, h thru k, m.
Alden Products Co., c, h, i.
American Machine & Foundry Co., Greenwich, c, h, j.
American Printed Circuits Co., Inc., c, f, h thru k, m.
Amglo Corp., f, m, a.
Anchor Metal Spinning Co., The, d, m, n.
Associated Engrg. & Mfg. Corp., g.
Bell & Howell Co., l.
Carl H. Biggs Co., e.
Brunswick Instruments, k.
Burke & James Inc., a.
Carling Electric, Inc., c.
Chicago Miniature Lamp Works, b, c, f, g, h, j thru m, a.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., a, d, n.
Crouse-Hinds Co., d, m, n.
Davenport Mfg. Co., a.
Day-Ray Products, Inc., e.
Dialight Corp., c, f thru k, m.
Dryomatic Corp., m.
Eagle Electric Mfg. Co. Inc., c, g, k.
Eder Instrument Co., Inc., i.
Edgerton, Germeshausen & Grier, Inc., a.
Eldema Corp., c, f thru k.
***ELECTROSNAP CORP.**, c, g, h, j.
Electronic Control Corp., l.
Etched Products Corp., c.
Ferranti Electric Inc., f, a.
General Electric Co., Apparatus Sales Div., c, d, e, i, l.
Gordon Enterprises, a, d, f, m, n.
Graflex Inc., a.
Green Rectifier Co., h, i.
Grimes Mfg. Co., c, d, e, g thru j, m, n.
Herzog Miniature Lamp Works, Inc., c, g, h, j, l, m.
Hudson Lamp Co., f, g, j.
Kemlite Laboratories, Inc., b, a.
Korry Mfg. Co., c, e, h, i, j, m.
Leecraft Mfg. Co., Inc., c, g, h, j, k, m.
Luminous Resins Inc., b.
Magnaflux Corp., b.
Marco Industries Co., c, f, h, i, j.
Master Specialties Co., h.
Menlo Research Lab., e.
Miller Diol & Nameplate Co., c, e, f, g.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., a.
National Pneumatic Co., Inc., Holtzer-Cabat Divs., c.
Oxford Components, Inc., c, f, g, h, j, k.
Penn Keystone Carp., h.
Photobell Co., Inc., k.
Photomotion, Inc., l.
Plasteck, Inc., c, g, j.
Pyle-National Co., The, d.
Q. O. S. Carp., b.
Radar Relay, Inc., g.
Schauer Mfg. Carp., k.
Shannon Luminous Materials Co., b.
Signalite Inc., f.
Sloan Co., The, h, j.
Soderberg Mfg. Co., Inc., b thru h, m, n.
Sperry Piedmont Co.-Div.-Sperry Rand Corp., n.
Ucinite Co., The, Div.-United-Carr Fastener Corp., c, h, i, j.
***ULTRA-VIOLET PRODUCTS, INC.**, b.
Westinghouse Electric Corp., d, e, g, h, j.
Westinghouse Electric Corp., Lamp Div., a thru o.

LINERS

a. Can
b. Combustion Chamber
c. Combustion Chamber, Gas
d. Turbine Engine
e. Metal
f. Racket Engine

A & P Metal Products Mfg. Corp., e.
Aerojet-General Corp., f.
Aerolab Development Co., f.
Aeronca Mfg. Corp., b thru e.
Allied Plastics Supply Corp., a.
American Aluminum Co., a, e.
American Rocket Co., f.
Anchor metal Spinning Co., The, e.
Atlantic Reseorch Corp., f.
B. H. Aircraft Co., Inc., e.
Bemis Brothers Bag Co., a.
Benson Mfg., Co., The, b, e.
J. Bishop & Co., Platinum Works, f.
Borden Chemical Co., a.
Bridgeport Brass Co., a, e.
Brooks & Perkins, Inc., e.
Colfibe Co., Inc., b.
Corborundum Co., Refroctories Civ., b.
Christie Machine Works, b, d, f.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., b, c, e, f.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., a, e.
Crystal-X Corp., a.
Curtiss-Wright Corp., Research Div., b, c, f.
Curtiss-Wright Corp., Wright Aeronautical Div., a thru f.
Diversey Engrg. Co., e, f.
Double E Products Co., a.
Dresser Mfg. Div., Dresser Industries, Inc., b thru
Dunbar-Kapple Inc.-Aircraft Components Div., e.
Dynamic Devices, Inc., f.
Dyna-Therm Chemical Corp., a thru f.
Emerson Plastics Corp., a.
Farwell Metal Fabricating, e.
Finn Aeronautical Div., T. R. Finn & Co., Inc., b, f.
***FLEXONICS CORP., AERONAUTICAL DIV.**
General American Transportation Corp., a.
Haveg Industries, Inc., a, b, c, f.
Hewitt-Robins, Inc., b.
Houston Fearless Corp.
Hupp Aviation Co., a thru d, f.
***JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.**, b, d.
Joclin Mfg. Co., f.
Johns-Manville
Kaiser Metal Products, Inc.-Fleetwings Div., d.
Konarr Corp., f.
C. B. Kaupp & Sons, Inc., b, d.
M. W. Kellogg Co., The, b, e, f.
Kling Metal Spinning & Stomping Co., e.
***LAVELLE AIRCRAFT CORP.**, b, d, e.
Mercury Tool & Mfg. Corp., e.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**, a, e.
Monogram Precision Industries, a, c.
National Beryllia Corp., b, c, f.
Norton Co., b.
Penn-Michigan Mfg. Corp., b, c.
Plastic-Age Soles, Inc., b.
Portland Copper & Tank Works Inc., b thru f.
Precision Sheet Metal, Inc., a, e.
Pressed Steel Tank Co., b, c, e, f.
Reaction Motors Div., Thiokol Chem. Corp., b, f.
Reinhold Engrg. & Plastics Co., b, c, f.
Rimak, Inc., e.
C. F. Roork Welding & Engrg. Co., Inc., b, c, d, f.
Ryan Aeronautical Co., a thru e.
Smith-Morris Corp., a thru e.
Solar Aircraft Co., b, e, f.
Stackpole Carbon Co., f.
Stainless Inc., e.
Stainless Steel Products, Inc., b thru e.
Standord-Thomson Corp., Clifford Mfg., Co. Div., a, c, e, f.
Swedlow Inc., b, f.
Thermal Refroctories Corp., b.
H. I. Thompson Fiber Glass Co., b, f.
Topper Mfg. Co., Inc., b, f.
C. W. Torngren Co., Inc., a.

Turbo Products, Inc., d.
Twigg Industries, a thru e.
United States Rubber Co., f.
Westinghouse Electric Carp., d.
Zaung Development Div., Hercules Powder Ca., b, c.

LIES, SLOTTED

Aircom Inc.
Airmcom Inc. of New Jersey
Alford Mfg. Ca.
California Technical Industries, Div.-Textran Inc.
Coaxial Connector Co. Inc.
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwove Co., Inc.
Engrg. Associates
EXR, Inc.
Gabriel Ca., The, Gobriel Electronics Div.
Hallicrafters
Hewlett-Packard Co.
ITT Labs.
Meridian Metalcraft, Inc.
Narda Microwave Carp., The
Omega Labs., Inc.
Polytechnic Research & Development Co., Inc.
Rohm & Haas Ca., Redstone Arsenal Research Div.
Sage Labs., Inc.
Selectro Industries Corp.
Selerad Mfg. Corp.
Silks Precision Instrument Co., Inc.
Tight Engrg. Ca.

LKS, ANTENNA

Anslie Carp.
Artron Inc., Div.-Litton Industries
Automation Dynomics Corp.
Diamond Antenna & Microwave Corp.
Gabriel Co., The, Gabriel Electronics Div.
Hallicrafters
Inco Corp.
Jark Products Co.
Radiatronics, Inc.
Stanley-Judd Div.-The Stanley Works
Tiokal Chemical Corp.

LIQUID BINDERS
See BINDERS, LIQUID

LIQUID FUELED MISSILE BOOSTERS
See BOOSTERS, MISSILE, LIQUID FUELED

LIQUID FUELS

Arojet-General Corp.
ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.
Allied Chemical Corp., Nitrogen Div.
AMERICAN POTASH & CHEMICAL CORP.
Anhlond Dil & Refining Co.
Allery Chemical Co.
Bad Machinery & Chemical Corp.
Liquidometer Corp., The
Matheson Co., Inc., The
Min Mathieson Chemical Corp., Energy Div.
Monsalt Chemicols Corp.
Rohm & Haas Co., Redstone Arsenol Research Div.
Shell Chemicol Corp., Industriol Chemicols Div.
Special Projects Lab., Food Machinery & Chemical Corp.
Tomount Instrument Co.

LIQUID LEVEL MEASURING DEVICES

Arojet-Generol Corp.
Arascience, Inc.
Ay Equipment Corp.
Contic Instrument Corp., Sub.-Americon Electronics, Inc.
Automation Products, Inc.
Aven, Inc.
Bendix Aviation Corp., Pioneer-Centrol Div.
Blue Electric Mfg., Co.
Elton Auto Gage Co., The
Ewser, Inc., Defense Dept.
Gleze Corporotions, Inc.
Gistal Co., The
Hoaks Rotometer Co.
Choflow Corp.
Diametrics Corp.
Diamic Controls Corp.
Electric Auto-Lite Co., The
Fisher & Porter Co.
Fisher Governor Co.
Fisher Research Lob., Inc.
General Electric Co., Apporotus Soles Div.
General Electric Co., X-Ray Dept.
Hedy Electronics Co.
Hughes Tool Co., Aircraft Div.
Lid-Air Inc.
MALLACE O. LEONARD, INC.
Liquidometer Corp., The
Minetrol, Inc.
Mon-Neilon
Minneapolis-Honeywell Regulotor Co., Aeronoutical Div.
Minneapolis-Honeywell Regulator Co., Industriol Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Monol Electronics
Niere Corp. of America
Riol Industries, Inc.
Simonds Aerocessories, Inc.
Space Carp.
Sterns-Roger Mfg. Co.
Trans-Sonics, Inc.
Trimount Instrument Co.
United Aircraft Products, Inc.
Victary Engrg. Corp.
Wallace & Tiernan Inc.

LIQUID NITROGEN

Air Reduction Sales Co., Div.-Air Reductian Ca., Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Hafman Labs., Inc.
Linde Co., Div.-Union Carbide Carp.
Liquidometer Corp., The
Sterns-Roger Mfg. Co.
Trionics Carp.

LIQUID OXYGEN

Air Reductian Sales Co., Div.-Air Reductian Co., Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Linde Ca., Div.-Union Carbide Corp.
Liquidometer Corp., The
Sterns-Roger Mfg. Ca.

LIQUID OXYGEN VAPORIZERS
See VAPORIZERS, LIQUID OXYGEN

LIQUID PROPELLANTS, ROCKET
See PROPELLANTS, LIQUID, ROCKET

LOCATORS
a. Cable & Line Fault
b. Metal Flaw
c. Non-Metal Flaw
d. Open-Short

Associated Research, Inc., a.
Barker Sales Co., a.
James G. Biddle Co., a.
Bransan Instruments, Inc., b, c.
Cansalidated Diesel Electric Corp., a, d.
Curtiss-Wright Carp., Research Div., b, c.
Davenport Mfg. Co., a.
J. W. Dice Co., b.
Dit-Mco, Inc., Electronics Div., a, c.
Fisher Research Lab., Inc., a.
Leeds & Northrup Co., a.
Magnaflux Corp., b, c.
Menlo Research Lab., b.
Peschel Electronics, Inc., a, d.
Shallcross Mfg. Co., a.
Sorensen & Co., Inc., a.
Tobe Deutschmann Carp., a.

LOCK BOLTS
See BOLTS, LOCK

LOCKNUTS

Abbott Screw & Mfg. Co.
All Specs Corp.
Barrett-Christie Co.
Best Aircraft Corp.
Calinoy-Div.-Illinois Tool Works
Capitol City Mfg. Co.
Century Fosteners Corp.
Cooper Industries, Inc.
Corbin Products Div.
R. C. Dudek & Co.
Eaton Mfg. Co., Reliance Div.
Elastic Stop Nut Corp. of America
Eljoy Corp.
Federal Screw Products Inc.
Hi-Shear Rivet Tool Co.
Koynor Mfg. Co., Inc.
Lamson & Sessions Co., The
Notionol Screw & Mfg. Co., The
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Rotton Mfg. Co., The
Republic Steel Corp.
SKF Industries, Inc.
Stondard Locknut & Lockwasher Inc.
Stondard Pressed Steel Co.
***TOWNSEND CO., CHERRY RIVET DIV.**
United Supply Co.
Waltham Precision Instrument Co.
Waterbury Pressed Metal Co., The

LOCKS
a. Dial
b. General
c. Hydraulic
d. Shaft

Adams Rite Mfg. Co., b.
Adel Precision Products of California, Div.-Generol Metals Corp., c.
Amatom Electronic Hordwore Co. Inc., a, d.
Birnboch Radio Co., Inc., a, d.
Bud Radio Inc., a.
Cambridge Thermionic Corp., a.
Goe Engrg. Co., d.
Hoskel Engrg. & Supply Co., c.
E. F. Johnson Co., a.
Kemp Aero Products, c.
Keystone Electronics Corp., a, d.
Litton Industries, U.S. Engrg. Co., Div., a.
Notionol Lock Co., a, b.
Dmego Electronic Corp., d.
PIC Design Corp., Sub.-Benrus Watch Co., Inc., a, d.
Rinco, Inc., a, d.
Ronson Hydraulic Units Carp., c.
Waldam Electronics Inc., a, d.
Yale & Towne Mfg. Co., The,-Government Defense Products Div., a, b.

LORAN SYSTEMS

Bendix Radio Div., Bendix Aviation Corp.
General Cammunicatian Ca.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Labs.
Jansky & Bailey, Inc.
W. L. Maxson Carp., The
Philco Carp., Government & Industrial Div.
Piasecki Aircraft Corp.
Polarad Electranics Carp.
Telectra Industries Corp.

LOW TEMPERATURE DISCHARGE EQUIPMENT
See DISCHARGE EQUIPMENT, LOW TEMPERATURE

LUBRICANTS

Achesan Colloids Co., Div.-Achesan Industries, Inc.
All Specs Carp.
Alpha Molykate Corp., The
***AMERICAN POTASH & CHEMICAL CORP.**
Anderson Dil & Chemical Co., Inc.
Armite Labs.
George Basch Co., The
Caig Labs.
Curtiss-Wright Corp., Research Div.
Delta Chemicol Warks, Inc.
***DOW CORNING CORP.**
Ed-Berl Products, Inc.
Esso Standard Dil Ca.
Everlube Carp.
Grafa Collaids Carp.
Hamilton Watch Ca.-Industriol Div.
E. F. Houghtan & Co.
Kano Labs.
Kelite Corp.
Lockrey Co., The
Minnesota Mining & Mfg. Ca.
New York & New Jersey Lubricant Co.
Protective Caatings, Inc.
Quietrale Co.
Silicones Div.-Union Carbide Corp.
G. W. Smith & Sons, Inc.
Special Projects Lab., Faad Machinery & Chemical Corp.
Topper Mfg. Ca., Inc.

LUBRICATING DEVICES

***BALCRANK INC., MACHINE TOOL DIV.**
Curtiss-Wright Carp., Research Div.
Gardner-Denver Co.
Gits Brothers Mfg. Co.
Gray Co., Inc.
Honnifin Co., Div.-Parker-Hannifin Corp.
Hills-Mc Canno Co.
United Aircraft Products, Inc.
Wesrep Corp.

LUG SWAGGERS, TERMINAL
See TERMINAL LUG SWAGGERS

LUGS

AMP Inc.
Accurate Electronics Corp., Dept. D
Aloc, Inc.
Amatom Electronic Hordwore Co. Inc.
Americon Aeroports
Best Aircroft Corp.
Birnboch Radio Co., Inc.
Cambridge Thermionic Corp.
Century Fosteners Corp.
Dolmore Corp.
Dante Electric Mfg. Co.
Emmco Plastic Fobricotors - Div.-E. M. McCorthy Mochine Co.
Federal Screw Products Inc.
Goe Engrg. Co.
Hobson Brothers, Inc.
Keystone Electronics Corp.
Kulka Electric Corp.
Molco Mfg. Co.
Mercury Tool & Mfg. Corp.
Sealectric Switch & Reloy Corp.
Sinclair Mfg. Co.
Stanley-Judd Div.-The Stanley Works
Thompson-Bremer & Co.
Waldom Electronics Inc.
Zierick Mfg. Corp.

LUGS, CABLE-ELECTRIC

AMP Inc.
Americon Aeroports
Best Aircraft Corp.
Birnbach Radio Co., Inc.
Burndy Corp., Dmoton Div.
Century Fosteners Corp.
Dante Electric Mfg. Co.
Electric Auto-Lite Co., The
Emmco Plastic Fobricotors - Div.-E. M. McCarthy Machine Co.
Hallett Mfg., Co.
Keystone Electronics Corp.
C. Sjoberg & Son
Stanley-Judd Div.-The Stanley Works

Waldom Electronics Inc.
Zierick Mfg. Corp.

MACH LIMIT SWITCHES

Aerotec Corp., The
Bendix Aviation Corp., Pioneer-Central Div.
Cole Electric Co.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Control Engrg. Co., Div. Jervis B. Webb Co.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Crystal-X Corp.
Curtiss-Wright Electronics Div., IMI Branch
Cutler-Hammer Inc.
Donner Scientific Co.
***ELECTROSNAP CORP.**
G. M. Giannini & Co., Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
***WALLACE O. LEONARD, INC.**
Marquordt Aircraft Co.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Sealectric Switch & Relay Corp.
Servomechanisms, Inc.
Specialties, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Waste King Corp., Technical Products Div.

MACHINE PARTS, HIGH PRECISION

***LAVEZZI MACHINE WORKS**

MACHINE PRODUCTS SCREW
See **SCREW, MACHINE PRODUCTS**

MACHINES

a. Abrasive Cutting
b. Air Conditioning
c. Balancing
d. Bending
e. Blueprint
f. Capacitor Manufacturing
g. Cleaning
h. Coil Winding
i. Counting
j. Crystal Manufacturing & Finishing
k. Cutting
l. Diecasting
m. Electric Soldering
n. Electron Tube
o. Electronic Balancing
p. Electronic Transcribing
q. Engroving & Profiling
r. Forming
s. Glass Working
t. Hermetic Sealing
u. Impregnating
v. Lamination Stacking
w. Marking
x. Metal Forming
y. Modular & Automatic Assembly
z. Photocopy & Whiteprint
a1. Plastic Press
b1. Riveting
c1. Shock Testing
d1. Soldering
e1. Tube Manufacturing
f1. Vibration Fatigue Testing
g1. Weighing
h1. Wire Stripping

ACF Industries Inc., x, b-1.
A&P Metal Products Mfg. Corp., x.
Acromark Co., The, q, a-1.
Adept Industries Inc., w.
Aircraft Tools, Inc., b-1.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., b.**
All American Tool & Mfg. Co., f-1.
Allen Tool Corp.
Allied Research Products, Inc., g.
Alloys Unlimited Inc., d-1.
American Electronics, Inc., Taller & Cooper Div., g-1.
American Instrument Co., Inc., a.
American Machine & Foundry Co., Government Products Group, h, i, y, g-1.
American Machine & Foundry Co., Greenwich, h, u.
American Optical Co., Instrument Div., s.
R. B. Annis Co., c, o.
Artos Engrg. Co., k, w, h-1.
Associated American Winding Co., Inc., f, h.
Associated Engrg. & Mfg. Corp., n, s, t, e-1.
Associated Engineers, Inc., y.
***ASSOCIATED TESTING LABS., INC., c-1, f-1.**
Astravac Corp., j, m, v, d-1.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., x.
Leon J. Barrett Co., The, f, g, u.
Barrett-Christie Co., a, c.
Bendix Aviation Corp., Pioneer-Central Div., g.
E. W. Bliss Co., x, a-1.
Branson Ultrasonic Corp., g.
Bristol Co., The, y.
Brown Engrg. Co., Inc., v, y, b-1.
CDC Control Services, Inc., g-1.
Cedar Engr. Div.-Control Data Corp., h.
Chambersburg Engrg. Co., r, x.
Chicago Pneumatic Tool Co., b-1.
Cincinnati Cleaning & Finishing Machinery, g.
Cincinnati Milling Machine Co., The, x.
Cincinnati Shaper Co., The, r, x.
Cleveland Automatic Machine Co., l.
Clover Industries, Inc., x.
Cobehn, Inc., g.
Columbia Research & Development Corp., v.
Consolidated Electrodynamics Corp., c-1.
Consolidated Electrodynamics Corp., Rochester Div., c-1.
Continental Technical Service, Inc., h, v.
Control Data Corp., h.
Cosa Corp., c, q, x, f-1.
Covel Mfg. Co., a.
Dean & Benson Research, Inc., c, a.
Decker Corp., The, c, a.
Delsen Corp., g-1.
Denison Engrg. Div., American Brake Shoe Co., a-1, c-1, f-1.
W. C. Dillon & Co., Inc., g-1.
Diversey Engrg. Co., x.
Dynametrics Corp., c, g-1.
Eastman Kodak Co., z.
Eisler Engrg. Co., Inc., a, h, k, m, r, s, t, d-1, e-1.
Electro Technical Products Div. Sun Chemical Corp., u.
***ENGIS EQUIPMENT CO.**, q.
Falstrom Co., x, y.
Farrel Birmingham Co. Inc., k, a-1.
Federal Tool Engrg. Co., x, h-1.
Felker Mfg. Co., a.
Ferrotherm Co., The, d-1.
Finnell System, Inc., g.
Fish-Schurman Corp., s.
Foredom Electric Co., Inc., a, w, b-1.
Forsberg Mfg., Co., The, l, x, b-1.
Gardner-Denver Co., b-1.
General Electro-Mechanical Corp., b-1.
Duncon M. Gillies Co. Inc., w.
Globe Electrical Mfg. Co., q, a-1.
Gordon Enterprises, e, z.
George Gorton Machine Co., q, w.
Grant Chemical Co., Inc., g.
Green Instrument Co., q.
Gremco, Inc., b.
Grotnes Machine Work, Inc., r, x.
Gulton Industries, Inc., h.
Hannifin Co., Div.-Parker-Hannifin Corp., x, b-1, e-1.
Hayward Scientific Glass Corp., s.
High Speed Hammer Co., Inc., The, w, b-1, h-1.
High Vacuum Equipment Corp., j, n, u.
Carl Hirschmann Co., Inc., h, j, q, x, c-1, f-1.
Hi-Shear Rivet Tool Co., b-1.
Hobbs Mfg. Co., k.
P. R. Hoffman Co., j, k.
Hufford Corp., The, d, r, x, a-1, c-1.
Hull Corp., f, u, a-1.
Hussmann Aircraft Div., b.
Hydraulic Press Mfg. Co., The, Div.-Koehring Co., l, r, x, a-1.
Ideal Industries, Inc., h-1.
Impact-D-Graph Corp., The, c-1.
Induction Heating Corp., t, d-1.
Industrial Winding Machinery Corp., h.
Intercontinental Mfg. Co., Inc., x.
International Research & Development Corp., c.
Invincible Vacuum Cleaner Mfg. Co., g.
Kanorr Corp., q.
Kinney Mfg. Div., The New York Air Brake Co., n, t, u, e-1.
L. A. B. Corp., c-1, f-1.
Lapointe Machine Tool Co., The, x.
Lemert Engrg. Co., Inc., b-1.
Litton Engrg. Labs., s.
Lodge & Shipley Co., The, x, z.
MB Mfg. Co., f-1.
Marlo Coil Co., b.
Jas. H. Matthews & Co., w.
Mc Dowell-Wellman Companies, The, x, b-1.
Merz Engrg., Inc., w.
Mico Instrument Co., q.
Miller Dial & Nameplate Co., x, z.
Minnesota Mining & Mfg. Co., z.
Monode Inc., w.
Monogram Precision Industries, x, e-1.
Montgomery Engrg. Co., x, b-1.
Robert E. Morris Co., The, j.
NRC Equipment Corp., j, u.
National Ultrasonic Corp., g.
Nebel Machine Tool Corp., h, x.
Newbrook Machine Corp., m, r, x, d-1, e-1, f-1.
Noble & Westbrook Mfg. Co., The, w.
Norton Co., a, j.
Norton Co., New Products Dept., a, k.
Nuclear Products-Erco Div.-ACF Industries, Inc., x, b-1.
Oliver Corp., The, r, x.
Oliver Corp., The-A.B. Farquhar Div., a-1.
O'Neil-Irwin Mfg. Co., d, r, x, a-1.
Onsrud Machine Works, Inc., q.
Pacific Scientific Co., f-1.
Paragon-Revolute Corp., e, z.
Peck & Harvey Mfg. Corp., z.
Peerless Photo Products Inc., z.
Philips & Davies Inc., d.
Photobell Co., Inc., i.
Pines Engrg. Co. Inc., d.
Pioneer Tool & Engrg. Co., c, d, h.
H. K. Porter Co., Inc., d, k, x.
Potter Aeronautical Corp., i.
H. P. Preis Engraving Machine Co. q, w.
Pryor Marking Products, w.
Ransohoff, Co., g.
Raytheon Mfg. Co., b.
Red Point Corp., u.
Reeve Electronics, Inc., m, t, d-1.
Robot Industries Inc., i.
Roll Formed Products Co., x.
Roovers-Latsch Corp., w.
Rotex Punch Co., Inc., d, x.
Joseph T. Ryerson & Son, Inc., d, k, r, x.
Schaevitz Engrg., c-1.
Sealectric Switch & Relay Corp., v, h-1.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., y.
Spectra-Strip Wire & Cable Corp., w.
Squiers Gage Co., c, x.
State Testing Lab. Inc., c-1, f-1.
Stratos, Div.-Fairchild Engine & Airplane Corp., b.
W. Whitney Stueck, Inc., d, k, r, x.
Surface Combustion Corp., b.
Thiokol Chemical Corp., g-1.
Thomas Electronics, Inc., n, e-1.
Thomas Instrument Co., h-1.
Tinsley Labs., Inc., s.
Torrington Co., The, x.
Trane Co., The, b.
Transmares Corp., x, a-1
United Shoe Machinery Corp., Ordnance Dept., y.
U. S. Industries, Inc., x, y, a-1.
Universal Mfg. Co., Inc., h.
Vapor Blast Mfg. Co., a, g.
Veet Industries, a-1.
Verson Allsteel Press Co., r, x.
Vilter Mfg. Co., The, b.
Wales Strippit Inc., Unit of Houdaille Industries, Inc., x.
Weighing & Control Components, Inc., g-1.
Westinghouse Electric Corp., b.
Westlake Plastics Co., a-1.
Wheelabrator Corp., g.
Woolf Aircraft Products, Inc., x.
York Corp., b.
Zippertubing Co., The, e-1.

MACHINING, METAL
See **METAL MACHINING**

MACHMETERS

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
American Electronics, Inc., Taller & Cooper Div.
Bendix Aviation Corp., Pioneer-Central Div.
A. Biederman, Inc.
Consolidated Diesel Electric Corp.
Daystrom Pacific Div.-Daystrom, Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
***WALLACE O. LEONARD, INC.**
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Servomechanisns, Inc.
Specialties, Inc.
Waldorf Electronics. Div.-F.C. Huyck & Sons
Wallace & Tiernan Inc.

MAGNETIC ANALYSIS EQUIPMENT

R. B. Annis Co.
Di-An Controls, Inc.
J. W. Dice Co.
Harvey-Wells Electronics Inc.
Magnaflux Corp.
Rese Engrg., Inc.

MAGNETIC CLUTCHES
See **CLUTCHES, MAGNETIC**

MAGNETIC MODULATORS
See **MODULATORS, MAGNETIC**

MAGNETIC STRIPE FILM
See **FILM, MAGNETIC STRIPE**

MAGNETIC TAPE DUPLICATORS
See **DUPLICATORS, MAGNETIC TAPE**

MAGNETIZERS & DEMAGNETIZERS

R. B. Annis Co.
Cinema Engrg.
Crucible Steel Co. of America
Electronic Brazing Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Metallurgical Products Dept.
Green Rectifier Co.
Indiana Steel Products Co., The
Kinevox Div.-Electromation Co.
Librascope Inc.
Magnaflux Corp.
Montgomery Engrg., Co.
Palo Alto Engrg. Co.
Qutronic Transformer Corp.
Raytheon Mfg. Co.
Technicol Apparatus Builders

MAGNETOMETERS

R. B. Annis Co.
Device Development Corp.
General Electric Co., Apparatus Sales Div.
Magnaflux Corp.
Minneapolis-Honeywell Regulator Co., Boston Div.
Ohio Semiconductors, Inc.
Varian Associates

MAGNETOS & PARTS

American Bosch Arma Corp.
Bendix Aviation Corp., Scintilla Div.

General Electric Co., Metallurgical Products Dept.
. E. Menaugh Co.

GNETS

erovox Corp.
rnold Engrg. Co., The
arker Sales Co.
rucible Steel Co. of America
dmund Scientific Co.
riez Mfg. Co.
erroxcube Corp. of America
amilton Watch Co.-Industrial Div.
diana Steel Products Co., The
. E. Menaugh Co.
ational Moldite Co.
ebel Machine Tool Corp.
tackpole Carbon Co.
llman Devices Corp.
estinghouse Electric Corp., Metals Plant

GNETS, ELECTRO

llied Control Co., Inc.
arruthers & Fernandez, Inc.
oils-Electronics
rucible Steel Co. of America
evice Development Corp.
erroxcube Corp. of America
arvey-Wells Electronics Inc.
oover Electric Co.
. J. Houlihan Co.
eetronics, Inc.
odelectric Products Corp.
ickering & Co., Inc.
alley Corp., The
arian Associates

GNETS, FOCUSING

hristie Machine Works
rucible Steel Co. of America
erroxcube Corp. of America
olo Alto Engrg. Co.
arian Associates

GNETS, PERMANENT

erovox Corp.
rnold Engrg. Co., The
arker Sales Co.
ram Metallurgical & Chemical Co.
riez Mfg. Co.
erroxcube Corp. of America
eneral Electric Co., Metallurgical Products Dept.
amilton Watch Co.-Industrial Div.
diano Steel Products Co., The
. E. Menaugh Co.
ational Moldite Co.
ockpole Carbon Co.
llman Devices Corp.
estinghouse Electric Corp., Metals Plant

MANIFOLDS
a. Air System
b. Fuel
c. Ignition
d. Intake & Exhaust
e. Nitrogen
f. Oxygen
g. Primer

eroquip Corp., Jackson Div., b.
ircraft Mechanics, Inc., a, b, d.
merican Tube Bending Co., Inc., d.
ro Equipment Corp., e, f.
. H. Aircraft Co., Inc., a, b, d.
BEATON & CORBIN MFG. CO., THE, a, b, c, d, f.
BENDIX AVIATION CORP., HAMILTON DIV., b.
endix Aviation Corp., Scintilla Div., c.
enson Mfg., Co., The, a, d.
owser, Inc., Defense Dept., b.
eeze Corporations, Inc., c.
alifornia Aircraft Products, b.
apital City Mfg. Co., a, g.
rmac Aviation, a, b, d thru g.
olonial Aircraft Corp., a, b, d.
ooper Development Corp., Sub.-Marquardt Aircraft Co., b.
urtiss-Wright Corp., Santa Barbara Div.
urtiss-Wright Corp., Wright Aeronautical Div., a, b, d, g.
esser Mfg. Div., Dresser Industries, Inc., d.
unbar-Kapple Inc.-Aircraft Components Div., a, b, d.
FLEXONICS CORP., AERONAUTICAL DIV., a.
W. Galloway Co., a, b, e, f.
illett Mfg., Co., c.
ighland Rim Machine Works Inc., d.
ofman Labs., Inc., e. f.
udwig Honold Mfg. Co., a, d.
ouston Fearless Corp., b, e.
ternational Pump & Machine Works, e, f.
aiser Aircraft & Electronics, Div.-Kaiser Industries Corp., a, d thru g.
LAVELLE AIRCRAFT CORP., a, b.
ewis & Saunders, b, d thru g.
nde Co., Div.-Union Carbide Corp., e, f.
ntheson Co., Inc., The, e, f.
ercury Tool & Mfg. Corp., d.
onogram Precision Industries, a, b, c, d.
ygen Equipment & Service Co., e, f.
rts Engrg. Co., Inc., a, b, d, f.
enn-Michigan Mfg. Corp., d.
ritan Compressed Gas Corp., Aviation Div., f.
ed Lion Cabinet Co., Redco Tool Div., d.
Republic Mfg. Co., a.
Resistoflex Corp., b, e, f.
Precision Sheet Metal, Inc., a, d, e.
C. F. Roark Welding & Engrg. Co., Inc., a, e.
Robbins Aviation, Inc., a, e, f.
Ryan Aeronautical Co., a, d.
Sargent Engrg. Corp., a, b, e, f.
Sirvalco Systems Corp., d, e, f.
Smith-Morris Corp., a thru f.
Stainless Steel Products, Inc., a thru g.
Standard-Thomson Corp., Clifford Mfg. Co. Div., d.
Stratos, Div.-Fairchild Engine & Airplane Corp., a.
Superior Air Products Co., f.
Talley Corp., The, a.
Twin Coach Co., Aircraft-Missiles, d.
United Aircraft Products, Inc., a, b.
Veet Industries, b.
Waste King Corp., Technical Products Div., a, d, e, f.
Woolf Aircraft Products, Inc., a thru g.

MANIPULATORS, NUCLEAR

American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
American Research & Mfg. Corp.
Beaver Precision Products Inc.
Forrel Birmingham Co. Inc.
Greer Hydraulics, Inc.

MANOMETERS

Bristol Co., The
Centronix Inc.
Consolidated Electrodynamics Corp.
Dynametrics Corp.
Fisher Scientific Co.
Flow Corp.
E. Vernon Hill & Co.
Meriam Instrument Co.
Minneapolis-Honeywell Regulator Co., Industriol Product Group
Royal Industries, Inc.
Scientific Instrument Co.
Trimount Instrument Co.
Wallace & Tiernan Inc.
Western Arc Welding, Inc.

MARKERS, CODE & TAB
See CODE & TAB MARKERS

MARKING SERVICE, WIRE
See WIRE MARKING SERVICE

MASKS, APERTURE, TUBE

American Research & Mfg. Corp.
Birnbach Radio Co., Inc.
Croname Inc.
Falstrom Co.
Milton Ross Metals Co., The
Waldom Electronics Inc.

MASS RATE FLOWMETERS
See FLOWMETERS, MASS RATE

MATERIALS HANDLING EQUIPMENT

Acco Equipment Div., American Chain & Cable Co., Inc.
Aerodex, Inc.
Air Logistics Corp.
Aluminum Co. of America
***ALUMINUM SAFETY PRODUCTS, INC.**
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Associated Engineers, Inc.
Baker Industrial Trucks, Div.-Otis Elevator Co.
Barrett-Christie Co.
Basic Tool Industries, Inc.
Brooks & Perkins, Inc.
Albert H. Cayne Equipment Corp.
Chain Belt Co.
Clark Equipment Co.
Colson Corp., The
Columbia Research & Development Corp.
Conco Engrg. Works
Consolidated Diesel Electric Corp.
Continental Technical Service, Inc.
Cromer Mfg. & Engrg., Inc.
Delsen Corp.
Deluxe Metal Products Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Econoweld Corp.
Elwell-Parker Electric Co., The
FWD Corp.
Fairbanks Co., The
G. W. Galloway Co.
Globe Hoist Co.
Gyrex Corp., The
Hallicrafters
Hapman Conveyors, Inc.
Hardman Tool & Engrg., Co.
Hewitt-Robins, Inc.
Hufford Corp., The
Hyster Co.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Jeffrey Mfg. Co., The
Link-Belt Co.
Magline Inc.
Mc Dowell-Wellman Companies, The
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
National Vulcanized Fibre Co.
Nelson Labs., Inc.
Nuclear Products-Erco Div.-ACF Industries, Inc.
Oliver Corp., The-A. B. Farquhar Div.
O'Neil-Irwin Mfg. Co.
Opelika Welding, Machine & Supply Inc.
Ordnance Div.-Food Machinery & Chemical Corp.
H. K. Porter Co., Inc.
R & R Engrg. Co.
Rapids-Standard Co., Inc., The
Regent Jack Mfg. Co., Inc.
Revolvator Co.
Richardson Scale Co.
Richards-Wilcox Mfg. Co.
Robbins & Myers, Inc., Hoist & Crane Div.
Rotary Lift Co., Div.-Dover Corp.
Royal Industries, Inc.
Sage Equipment Co. Inc.
Skyline Products, Inc.
Special Projects Lab., Food Mochinery & Chemical Corp.
Thoyer Scale Corp.
Trailmobile Inc.
Unit Crane & Shovel Corp.
United States Chemical Milling Corp.
Van Zelm Associates, Inc.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
***R. D. WERNER CO., INC.**
Albert Wesling & Sons Inc.

MATRIXES COMPUTER

Aeronutronic Systems, Inc., Sub.-Ford Motor Co.
American Felt Co.
Control Data Corp.
Di-An Controls, Inc.
Erie Resistor Corp.
Ferroxcube Corp. of America
Librascope Inc.
Motorola Inc., Military Electronics Div.
Radiation, Inc.
Thoyer Scale Corp.

MEASUREMENT INDUCTANCE SPECIALTIES
See INDUCTANCE SPECIALTIES, MEASUREMENT

MEASUREMENT SERVOS
See SERVOS, MEASUREMENT

MEASURING CELLS, FORCE
See FORCE MEASURING CELLS

MEASURING DEVICES, LIQUID LEVEL
See LIQUID LEVEL MEASURING DEVICES

MEASURING EQUIPMENT, DISTANCE
See DISTANCE MEASURING EQUIPMENT

MEASURING EQUIPMENT, PRESSURE

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Bristol Co., The
Brush Instruments, Div.-Clevite Corp.
Colvin Labs., Inc.
Consolidated Diesel Electric Corp.
Consolidated Electrodynamics Corp.
Continental Technical Service, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Curtiss-Wright Electronics Div., IMI Branch
Decker Corp., The
Dynametrics Corp.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Endevco Corp.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
E. Vernon Hill & Co.
Intercontinental Dynamics Corp.
Interstate Engrg. Corp.
Kin Tel Div.-Cohu Electronics, Inc.
Midwestern Instruments, Inc.
Minneapolis-Honeywell Regulator Co., Industriol Product Group
Photron Instrument Co.
Radiation, Inc.
Rahm Instruments, Div.-American Machine & Metals, Inc.
Rosemount Engrg. Co.
Sanborn Co.
Schaevitz Engrg.
Scientific Instrument Co.
Specialties, Inc.
Steel City Testing Machines, Inc.
Sun Electric Corp., Aeronautical Div.
Systron Corp.
Technology Instrument Corp.
Telechrome Mfg. Corp.
Thayer Scale Corp.
Trans-Sonics, Inc.
United Electric Controls Co.
U. S. Science Corp., Div.-Topp Industries, Inc.
Winzen Research Inc.

MEASURING EQUIPMENT, TEMPERATURE
See TEMPERATURE MEASURING EQUIPMENT

MEASURING EQUIPMENT, VIBRATION

American Research & Mfg. Corp.
Applied Science Corp. of Princeton

B & K Instruments, Inc.
Brush Instruments, Div.-Clevite Corp.
Chrysler Corp., Defense Dperations Div.
Consolidated Electrodynamics Corp.
Decker Corp., The
Electro Products Laboratories, Inc.
Endevco Corp.
Epic, Inc.
Gaertner Scientific Corp., The
Insco Co., Div.-Barry Controls Inc.
Kahn & Co., Inc.
Kay Electric Co.
Land-Air Inc.
MB Mfg. Co.
Midwestern Instruments, Inc.
Minneapolis-Honeywell Regulator Co.-Dovies Labs. Div.
Pacific Scientific Co.
Photron Instrument Co.
Radiation, Inc.
Schaevitz Engrg.
H. H. Scott, Inc.
Southwestern Industrial Electronics Co.
Space Corp.
Sun Electric Corp., Aeronautical Div.
Systron Corp.
Technology Instrument Corp.
Tel-Instrument Electronics Corp.
United Electrodynamics, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.

MEASURING EQUIPMENT, VSWR

Alford Mfg. Co.
Barker Sales Co.
Barker & Williamson Inc.
California Technical Industries, Div.-Textron Inc.
Cubic Corp.
Demornay-Bonardi
Engrg. Associates
FXR, Inc.
Hewlett-Packard Co.
Kay Electric Co.
Polarad Electronics Corp.
Radar Design Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Telectro Industries Corp.
Webcor, Inc., Government Div.

MEASURING INSTRUMENTS, THRUST
See THRUST MEASURING INSTRUMENTS

MECHANICAL CABLE ASSEMBLIES
See CABLE ASSEMBLIES, MECHANICAL

MECHANICAL OR HAND TOOLS
See TOOLS, HAND OR MECHANICAL

MECHANICAL RECEIVER TUNING DEVICES
See TUNING DEVICES, RECEIVER MECHANICAL

MECHANICAL & VACUUM ENGINE CONTROLS
See ENGINE CONTROLS, MECHANICAL & VACUUM

MECHANISM UNITS, RETRACTING
See RETRACTING, MECHANISM UNITS

MEGAPHONES, ELECTRONIC

Davenport Mfg. Co.
Gordon Enterprises
Motorola Inc., Military Electronics Div.

MEGOHMETERS, VACUUM TUBE

Associated Research, Inc.
Brush Instruments, Div.-Clevite Corp.
Dresser Industries, Inc.
Electro-Tech Equipment Co.
Freed Transformer Co. Inc.
Greibach Instruments Corp.
Industrial Instruments Inc.
Keithley Instruments, Inc.
Leeds & Northrup Co.
MacLeod & Hanopol, Inc.
Paco Electronics Co., Inc.
Precise Development Corp.
Precision Apparatus Co., Inc.
Slaughter Co., Inc.
Telectro Industries Corp.
Weston Instruments, Div.-Daystrom, Inc.

MEMORY
a. Crystal
b. Drums
c. Multi-Core Magnetics
d. Systems
e. Tape Loop
f. Tubes

ACF Industries Inc., **b.**
Aeronutronic Systems, Inc., Sub.-Ford Motor Co., **b, c, d.**
Airtronics International Corp., **b.**
American Missile Products Co., Inc., **b.**
Anaheim Electronics Co., Inc., **e.**
Barker Sales Co., **b, d.**
Bell & Gossett Co., **c.**
Bendix Computer, Div.-Bendix Aviation, Corp., **b, c, d.**
Burroughs Corp., **b, c, d.**
Centronix Inc., **d.**
Christie Machine Works, **b.**
Communications Research Co., **d.**
Computer Control Co., Inc., **d.**
Consolidated Controls Corp., **b, d.**
Control Engrg. Co., Div. Jervis B. Webb Co., **b, d.**
DBM Research Corp., **e.**
Di-An Controls, Inc., **b, c, d.**
Donner Scientific Co., **d.**
Dresser Industries, Inc., **b, d.**
Thomas A. Edison Ind. Instrument Div.-McGrow-Edison Co., **d.**
Erie Resistor Corp., **d.**
Ferranti Electric Inc., **b, d.**
Ferroxcube Corp. of America, **c.**
Forbes & Wagner, Inc., **c.**
General Electric Co., Computer Dept., **c, d.**
General Transistor Western Corp., **b, e.**
Haller, Raymond & Brown Inc. Div., Singer Mfg., Co., **d.**
Hamilton Watch Co.-Industrial Div., **b.**
Hughes Aircraft Co., **b.**
ITT Labs.-Ft. Wayne, **f.**
Instrumentaion Div.-Ampex Corp., **e.**
Instruments for Industry, Inc., **a.**
***KEARFOTT CO., INC., c.**
Kilgen Aircraft Div., **d.**
Libroscope Inc., **b, c, d.**
Mica Insulator Div.-Minnesota Mining & Mfg. Co., **f.**
Midwestern Instruments, Inc., **b, d, e.**
Milgo Electronic Corp., **c.**
Minneapolis-Honeywell Regulator Co., Davies Labs. Div., **e.**
Minneapolis-Honeywell Regulator Co., Industrial Product Group, **e.**
Minneapolis-Honeywell Regulator Co., Drdnance Div., **d.**
Minnesota Mining & Mfg. Co., **e.**
Monarch Bearing Co. Inc., **b.**
Motorola Inc., Military Electronics Div., **a, c, d.**
National Cash Register Co., The, Electronics Div., **b, d.**
Northrop Corp., **b, c, d.**
Northrop Corp., The, Nortronics Div., **b, d.**
Philco Corp., Government & Industrial Div., **c, d, e.**
Power-Tronic Systems Inc., **d.**
Precision Methods & Machines Div.-Textron Inc., **b.**
Raytheon Mfg. Co., **f.**
Servomechanisms, Inc.
Tapco Group, Thompson-Ramo-Wooldridge Inc., **b.**
Telechrome Mfg. Corp., **e.**
Telectro Industries Corp., **d, e, f.**
Vard Inc., **b.**
Vitro Labs., **c, d.**
Wong Labs., Inc., **c, d, e.**
Webcor, Inc., Government Div., **d, e.**
Winzen Research Inc., **e.**
Wright Engrg. Co., **b.**

METAL ANODES
See ANODES, METAL

METAL CHASSIS
See CHASSIS, METAL

METAL CLAD SHEETS

Aeronca Mfg. Corp.
Allegheny Ludlum Steel Corp.
Allied Plastics Supply Corp.
Alloys Unlimited Inc.
Aluminum Co. of America
American Printed Circuits Co., Inc.
American Silver Co.
J. Bishop & Co., Platinum Works
Bram Metallurgical & Chemical Co.
Bridgeport Brass Co.
Continental Diamond Fibre Corp.
Curtiss-Wright Corp., Marquette Div.
Curtiss-Wright Corp., Propeller Div.
Curtiss-Wright Corp., Research Div.
Delta Chemical Works, Inc.
E. I. Du Pont De Nemours & Co., Inc.
Engelhard Industries, Inc.
Engelhard Industries Inc., D. E. Makepeace Div.
Etched Products Corp.
Firestone Tire & Rubber Co., The, Guided Missile Div.
General Plastics Corp. of New Jersey
Gladding, McBean & Co.
Hupp Aviation Co.
Kanarr Corp.
Kelsey-Hayes Co.
Metals & Controls Corp., General Plate Div.
Met-L-Wood Corp.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
Pilgrim Products Inc.
Red Lion Cabinet Co., Redco Tool Div.
Republic Steel Corp.
Standard Metals Corp.
Taylor Fibre Co.
U. S. Steel Supply Div., United States Steel Corp.
United States Chemical Milling Corp.
United States Plywood Corp.

METAL FORMING PRESSES
See PRESSES, METAL FORMING

METAL GRILLES
See GRILLES, METAL

METAL MACHINING

Abalon Precision Mfg. Corp.
Aerodex, Inc.
Aeronca Mfg. Corp.
Aircraft Precision Products, Inc.
Allen Tool Corp.
Amatom Electronic Hardware Co. Inc.
American Non Gran Bronze Co.
Anchor Metal Spinning Co., The
Anchor Specialty Mfg. Co. Inc.
Arnolt Corp.
Astronautics Engrg Co.
B. H. Aircraft Co., Inc.
W. A. Beauchoine & Sons Inc.
Bergen Carbide Co.
Bland Burner Co., The
E. W. Bliss Co.
Bridgeport Brass Co.
Brown Engrg. Co., Inc.
Bruce Engrg. Co.
Brush Beryllium Co., The
California Aircraft Products
Capital City Mfg. Co.
Carmoc Aviation
Chicago Screw Co., The, Div.-Standard Screw Co.
C. B. Christiansen Co.
Christie Machine Works
Continental Technical Service, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Crompton & Knowles Corp.
Curtiss-Wright Corp.-Marquette Div.
Curtiss-Wright Corp.-Propeller Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dresser Industries, Inc.
Electro-Mechonical Products Co.
Electronic Parts Mfg. Co., Inc.
Elzee Metal Products Co., Inc.
Etched Products Corp.
Farrel Birmingham Co. Inc.
Farwell Metal Fabricating
Federal Machine Co. Inc.
Fletcher Mfg. Co., Inc., The
Freeman Co., The
GAR Mfg. Corp.
Gordon Enterprises
Graflex Inc.
Hardman Tool & Engrg. Co.
Highland Rim Machine Works Inc.
Hufford Corp., The
Hughes Tool Co., Aircraft Div.
Hupp Aviation Co.
Intercontinental Mfg. Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industrie Corp.
Kanarr Corp.
M. W. Kellogg Co., The
Kelsey-Hayes Co.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
E. Konigslow Stamping & Tool Co.
Ladish Co.
La Pointe Industries Inc.
***LAVEZZI MACHINE WORKS**
Lux Clock Mfg. Co., Inc.
Mercury Tool & Mfg. Corp.
Meridian Metalcraft, Inc.
Merz Engrg., Inc.
Monogram Precision Industries
National Research Corp.
Nordberg Mfg. Co.
Dnsrud Machine Works, Inc.
Pacific Coast Engrg. Co.
Papesch & Kolstad, Inc.
Parts Engrg. Co., Inc.
Philips & Davies Inc.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.
Precision Shapes, Inc.
R & R Engrg. Co.
Ravenna Metal Products, Div.-Standard Screw Co.
Red Devil Mfg. Co.
Red Lion Cabinet Co., Redco Tool Div.
Edw. Renneburg & Sonos Co.
Rimak, Inc.
C. F. Roark Welding & Engrg. Co., Inc.
Rohr Aircraft Corp.
Ryan Aeronautical Co.
Sheffield Corp., The, Sub.-Bendix Aviation Corp.
Sinclair Mfg. Co.
Specialties Mfg. Co., Inc.
Stainless Steel Products, Inc.
Stanley Aviation Corp.
Taft-Peirce Mfg. Co., The
Teiner Engrg. Corp.
Texas Metal & Mfg. Co., Inc.
Arthur Tickle Engrg. Works, Inc.
Turbo Products, Inc.
United Aircraft Products, Inc.
United Mfg. Co., The
United Plating Works
Washington Machine & Tool Works, Inc.
Wayne Pump Co., The, Div.-Symington Wayne Corp
Western Iron & Foundry Co., Inc.
Wheland Co., The
Wilks Precision Instrument Co., Inc.

METAL TO METAL ADHESIVES
See ADHESIVES, METAL TO METAL

TAL NEEDLES
ee NEEDLES, METAL

TAL OR PLASTIC PLATES
ee PLATES, METAL OR PLASTIC

TAL TREATING

erodex, Inc.
eronca Mfg. Corp.
matom Electronic Hardward Co. Inc.
. W. Bliss Co.
rooks & Perkins, Inc.
rown Engrg. Co., Inc.
alifornia Aircraft Products
hicago Screw Co., The, Div.-Standard Screw Co.
rompton & Knowles Corp.
urtiss-Wright Corp.-Wright Aeronoutical Div.
iversey Engrg. Co.
resser Industries, Inc.
errotherm Co., The
raflex Inc.
igh Vacuum Equipment Corp.
tercontinentol Mfg. Co., Inc.
elite Corp.
. W. Kellogg Co., The
olcast Industries-Div. Thompson Ramo Wooldridge Inc.
ux Clock Mfg. Co., Inc.
etalectro Lab.
akite Products, Inc.
iosecki Aircroft Corp.
rtland Copper & Tank Works Inc.
nsohoff, Co.
d Lion Cabinet Co., Redco Tool Div.
imak, Inc.
ohr Aircraft Corp.
yon Aeronautical Co.
ectronic Plating Co., Inc., Div.-Spectranome
Ploting Co., Inc.
ainless Steel Products, Inc.
anley Aviation Corp.
einer Engrg. Corp.
nited Plating Works
. S. Industries, Inc.
VALL COLMONOY CORP., STAINLESS
PROCESSING DIV.
ye Industries

MTALLIC BUSHINGS
ee BUSHINGS, METALLIC

MTALLIC EXTRUSIONS
ee EXTRUSIONS, METALLIC

MTALLIC FITTINGS
ee FITTINGS, METALLIC

MTALLIC GASKETS
ee GASKETS, METALLIC

MTALLIC MOUNTINGS
ee MOUNTINGS, METALLIC

MTALLIC PAINT
ee PAINT, METALLIC

MTALLIC SLEEVES
ee SLEEVES, METALLIC

METEOROLOGICAL EQUIPMENT, ELECTRONIC

erofab Development Co.
herican Machine & Foundry Co., Government Products Group
tomation Dynamics Corp.
J Electronics, Borg-Warner Corp.
eckman & Whitley, Inc., Missile Products Div.
ndix Aviation Corp., Friez Instrument Div.
oper Development Corp., Sub.-Marquardt Aircraft Co.
atex Corp.
errotron Electronics Co., Inc.
a Pointe Industries Inc.
otorola Inc., Military Electronics Div.
adiotion, Inc.
C. Stewart
pco Group, Thompson-Ramo-Wooldridge Inc.
ele-Dynamics Inc.
ctory Engrg. Corp.

METEOROLOGICAL INSTRUMENTS

erolob Development Co.
rguide Instrument Co.
J Electronics, Borg-Warner Corp.
eckman & Whitley, Inc., Missile Products Div.
ndix Aviation Corp., Friez Instrument Div.
oper Development Corp., Sub.-Morquardt Aircraft Co.
struments Corp., The
nneapolis-Honeywell Regulator Co., Industrial Product Group
otorola Inc., Military Electronics Div.
ientific Instrument Co.
C. Stewart
pco Group, Thompson-Ramo-Wooldridge Inc.
ele-Dynamics Inc.
ited Electrodynamics, Inc.
llace & Tiernan Inc.

METER SHUNTS
e SHUNTS, METER

METERS
- a. Accelerotion
- b. Ammeter
- c. Ammeter RF
- d. Attenuotion
- e. Audio
- f. Coble Testing
- g. Copocltonce
- h. Conductonce
- i. Counting Rote
- j. Counting Rate, Nuclear
- k. D Arsonvol
- l. Decibel
- m. Deflection
- n. Deviotion
- o. Distortion & Noise
- p. Dosimeter
- q. Dosimeter, Nuclear
- r. Elapsed Time
- s. Electrometer
- t. Electronic Micrometer
- u. Events-Per-Unit-Time
- v. Exposure for Film
- w. Field Strength
- x. Flow
- y. Flutter
- z. Flux
- o1. FM Deviotion
- b1. Footcondle
- c1. Frequency
- d1. Galvonameter
- e1. Goniometer
- f1. Grid Dip
- g1. Impedance
- h1. Industriol
- i1. Infrared
- j1. Intermodulotion
- k1. Kilovolt
- l1. Kilowott
- m1. Light
- n1. Megohm
- o1. Microfarod
- p1. Microvolt
- q1. Microwove
- r1. Milliompere
- s1. Millivalt
- t1. Modulotion
- u1. Moisture, Electranic
- v1. Multimeter
- w1. Multiplier
- x1. Noise, Electricol Measurement
- y1. Ohm
- z1. Output, Electricol Measurement
- o2. Output, RF
- b2. Panel
- c2. PH Meters, Recarders & Comporotors
- d2. Phase
- e2. Photoelectric Reflection
- f2. Power Output
- g2. Pressure
- h2. Pyrameter
- i2. Q
- j2. Rodiotion, Nuclear
- k2. Rote
- l2. Rotio
- m2. Recarding
- n2. RF Power
- o2. Snap Around
- p2. Sound Level
- q2. Spectrol
- r2. Stonding Wove Rodio
- s2. Tachometer
- t2. Tension
- u2. Thermocouple
- v2. Thermometer
- w2. Thrust
- x2. Time
- y2. Torque
- z2. Ultra-Violet
- a3. Vacuum Tube Volt
- b3. Vibroting Reed
- c3. Vibration
- d3. Viscosity, Electronic
- e3. Volt-Ohm, Electronic
- f3. Wott
- g3. Watt-Hour
- h3. Wove
- i3. Wow & Flutter
- j3. X-Roy Intensity

Acromog Inc., c-1.
Acton Lobs. Inc., g, g-1, d-2, a-3.
Actuator Products Div., Geortronics Corp., u, h-1, b-2, k-1, s-2.
Advonced Products Co., The, r, x-2.
Ad-Yu Electronics Lob., Inc., c-1, d-2.
Aero Instrument Co., r, c-1, x-2, b-3.
Aerojet-Generol Corp., i-1.
Aircom Inc., e-1, q-1, r-2.
Aircom Inc. of New Jersey, c-1, q-1, r-2.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., w-2.
Airguide Instrument Co., v-2.
Airpox Electronics Inc., Seminole Div., i, c-1, h-1, s-2, i-3.
Allied Reseorch Products, Inc., b.
Amelco, Inc., c-1.
Ameroc Inc., h-3.
American Aeroports, o, b, c, r, x.
American Mochine & Foundry Co., Government Products Group, o, c-1, f-2, f-3.
Americon Mochine & Foundry Co., Greenwich
American Measurement & Control, Inc., x.
American Missile Products Co., Inc., g.
Amplifier Corp. of America, n, y, i-3.
Amthor Testing Instrument Co., Inc., m-2, s-2.
Analytical Meosurements, Inc., c-2.
Antenna & Radome Research Associates, d.
Anton Electronic Labs., Inc., b, i, j, k, r, r-1, v-1, b-2, j-2, a-3, j-3.
Assembly Products, Inc., b, c, k, h-1, m-1, p-1, r-1, s-1, y-1, b-2, h-2, u-2, a-3, e-3, f-3.
Associated Research, Inc., f, k-1, n-1, v-1, y-1, e-3.
Astronautics Engrg. Co., x.
Audio Instrument Co., Inc., j-1.
Automation Products, Inc., d-3.
Avien, Inc., x.
Avo Ltd., b, v-1, e-3.
Avtron Mfg., Inc., a-1, c-1, t-1.
Axler Associates Inc., i-1, z-2.
B & F Instruments, Inc., t-2, w-2, y-2.
B & H Instrument Co., Inc., c-1, s-1, h-2, s-2, u-2.
B & K Instruments, Inc., e, l, n-1, p-2, c-3.
Baird-Atomic Inc., j, u, j-2, q-2.
Ballantine Labs., Inc., g, v-1, a-3.
Barker & Williamson Inc., o, c-1, f-1, a-2, n-2, r-2.
Beckman Instruments, Inc., Berkeley Div., r, u, c-1, y-1, s-2, x-2, e-3.
Beckmon-Scientific & Process Instruments Div., c-2.
Beckman & Whitley, Inc., Missile Products Div., u-2.
Beede Electrical Instrument Co. Inc., b, c, k, l, r, d-1, k-1, r-1, s-1, b-2, h-2, p-2, s-2, x-2.
Bendix Aviation Corp., Pioneer-Central Div., x.
Bendix Aviation Corp., York Div., e-3.
Bergen Labs., Inc., r, v-1.
Beva Lab., Inc., f, i, r, u, j-3.
James G. Biddle Co., d-1, n-1, y-1, s-2, b-3.
A. Biederman, Inc., b-2, s-2.
Boonton Radio Corp., i-2.
Bowser, Inc., Defense Dept., x, h-1.
Briggs Associates, Inc., h-3.
Bristol Co., The, b, i, k, n, r, s, u, x, c-1, d-1, h-1, k-1, l-1, n-1, p-1, r-1, s-1, u-1, y-1, b-2, c-2, f-2, g-2, h-2, m-2, s-2, u-2, v-2, x-2, d-3.
Brooks Rotameter Co., x.
Brunswick Instruments, n-2.
Brush Instruments, Div.-Clevite Corp., o, k thru n, u, d-1, g-1, h-1, p-1, s-1, t-1, u-1, y-1, a-2, m-2, p-2, s-2 thru x-2.
Budd Stanley Co. Inc., c-1, q-1.
Budelman Electronics Corp., a-1, x-1.
Californio Technical Industries, Div.-Textron Inc., f, q-1, r-2.
Cambridge Instrument Co., Inc., k, p, z, c-2.
Centronix Inc., i.
Chemalloy Electronics Corp., q-1.
Chesapeake Instrument Corp., g-1.
Collins Engrg. Corp., b.
Columbia Electric Mfg. Co., b.
Com-Air Products, Div.-A S R Products Corp., x.
Conax Corp., u-2.
Consolidated Controls Corp., g-2, w-2, y-2.
Consolidated Diesel Electric Corp., g-2, v-2.
Consolidated Electrodynamics Corp., d, u-1, g-2, c-3.
Convair-Instruments, Div.,-General Dynamics Corp., s-1.
Cornell-Dubilier Electric Corp., g.
Cramer Controls Corp., r, x-2.
Cubic Corp., k-1, n-1, p-1, y-1, l-2, f-3.
Curtiss-Wright Corp., Research Div., j.
DBM Research Corp., u.
D. & R. Ltd., i-3.
Doven Co., The, e, l, o, c-1, x-1, f-2, p-2, a-3, e-3.
Davenport Mfg. Co., f, k-1, n-1, x-1, p-2.
Daystrom Pacific Div.-Daystrom, Inc., o, s-1, g-2, h-2, w-2.
Dejur-Amsco Corp., Electronic Sales Div., b, k, l, r, v, k-1, m-1, r-1, s-1, v-1, z-1, b-2, p-2.
Del Electronics Corp., k-1, w-1.
Demornay-Bonordi, c-1, q-1.
Device Development Corp., z.
Diamond Antenna & Microwave Corp., c-1, q-1, h-3.
J. W. Dice Co., t, n-1, y-1.
W. C. Dillon & Co., Inc., t-2, v-2.
Dimco-Gray Co., x-2.
Divco-Wayne Electronics Div., Divco-Wayne Corp., c-1.
Donner Scientific Co., o, o, y, w-1, i-3.
Douglas Microwave Co., Inc., c-1, q-1, n-2.
Dresser Industries, Inc., n-1, r-1, v-1, y-1, a-3, e-3.
M. Ducommun Co., x-2.
Duront Mfg. Co., h-1.
Dynomics Instrumentation Co., Div.-Alberhill Corp., p-1, s-1.
Dytronics Co., d-2.
Eastern Specialty Co., The, d-2.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., k, c-1, g-1, g-2, l-2, v-2.
Eldorado Electronics, r, e-2, j-2, x-2.
Electric Auto-Lite Co., The,b.
Electric Design & Mfg. Co., b, k, k-1, r-1, s-1, b-2.
Electro Instruments, Inc., b, g, k-1, n-1, a-1, p-1, r-1, s-1, y-1, l-2, u-2, e-3.
Electro Precision Corp., u.
Electro Products Laboratories, Inc., s-2.
Electronic Applications, Inc., g, n, o, s, y, a-1, c-1, j-1, y-1, i-3.
Electronic Engrg. Co. of Californio, u, x-2.
Electronic Instrument Co., Inc. (EICO), a-3, e-3.
Electronics of Clearfield, Inc.,n-2, a-3, f-3.
Electro-Tech Equipment Co., b, k, r, b-1, c-1, d-1, k-1, thru n-1, r-1, s-1, u-1, v-1, w-1, y-1, b-2, h-2, m-2, a-2, p-2, s-2, u-2, v-2, x-2, a-3, b-3, e-3, f-3.
Elgin Micronics Div.-Elgin Nationol Watch Co., o, r, x-2.

Empire Products Sales Corp., d, a, w, t-1, x-1.
Engrg. Associates, c-1, j-2, r-2.
Epic, Inc., b, f, g, r, s, c-1, d-1, g-1, n-1, a-1, p-1, r-1, s-1, h-2, s-2, u-2, b-3, e-3.
Erdco Engrg. Corp., f.
Erie Resistor Corp., i, r, u, x, c-1.
Etched Products Corp., b-2.
FXR Inc., d, p, q-1, t-1, x-1, l-2, r-2, h-3.
Federal Mfg. & Engrg. Corp., c-1.
Federal Products Corp., t.
Ferranti Electric Inc., k-1, d-3, g-3.
Fischer & Porter Co., i, u, x, c-1, h-1, g-2, k-2, l-2, m-2.
Fisher Research Lab., Inc., q, s-1, u-1, x-1, j-2, a-3, c-3.
Fisher Scientific Co., c-2, h-2, v-2.
Flow Corp., x, p-1, s-1, f-2.
Flow Measurements Corp., x.
John Fluke Mfg. Co., Inc., a-3.
Freed Transformer Co. Inc., i-2.
Gardner Laboratory, Inc., c-2, e-2, h-2, v-2.
General Communication Co., h-3.
General Electric Co., Apparatus Sales Div., b, k, r, v, x, c-1, d-1, h-1, k-1, l-1, m-1, r-1, s-1, z-1, a-2, f-2, h-2, j-2, m-2, n-2 a-2, s-2, u-2 thru x-2, f-3, g-3, j-3.
General Electric Co., X-Ray Dept., e-1, j-3.
Gordon Enterprises, r, v, b-1, m-1, x-2.
Greibach Instruments Corp., b, k, d-1, n-1, r-1, s-1, v-1, y-1, b-2, u-2, e-3.
Guided Missile Div.-DeHavilland Aircraft of Canada, Ltd., n.
Hagan Chemicals & Controls, Inc., x, g-2.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co., i-1.
Hallikainen Instruments, d-3, e-3.
Hamilton Watch Co.-Industrial Div., r, x-2.
Hammel-Dahl Div.-General Controls Co., x.
*A. W. HAYDON CO., THE, r, x-2.
Hays Corp., The, g-2.
Helipot Div.-Beckman Instruments Inc., b, c-1, b-2.
Hewlett-Packard Co., b, c, d, h, l, m, n, r, u, a-1, g-1, h-1, p-1 thru t-1 x-1, a-2, n-2, r-2, s-2, a-3, j-3.
John W. Hobbs Corp., Div.-Stewart-Warner Corp., r.
Hoyt Electrical Instrument Works, Burton Rogers Co., b, k, l, r-1, s-1, a-2.
Humphrey, Inc., a.
Hycon Mfg. Co., v, x-1, e-2.
I-L-S Instrument Div., The Meriam Instrument Co., r, u, x, s-2.
Ideal Precision Meter Co., Inc., b, e, k, l, r-1, s-1, a-2.
Illinois Testing Laboratories, Inc., h-2, u-2, v-2.
Impact-D-Graph Corp., The, a.
Industrial Control Co., r-1, s-1.
Industrial Instruments Inc., f, n-1.
Industrial Test Equipment Co., d-2, i-2, a-3.
Industrial Timer Corp., x-2.
Industrial Winding Machinery Corp., t-2.
Inertia Switch, Inc., u.
Instrument Labs., z-1, a-3, e-3.
Instruments Corp., The, s-2.
International Instruments Inc., b, k, l, r-1, s-1, b-2.
International Register Co., x-2.
International Research & Development Corp., c-3.
Jennings Radio Mfg. Corp., k-1.
Kahn & Co., Inc., g, c-1, s-2.
Kauke & Co., s-1.
Kay Electric Co., e, f, l, a, y, c-1, p-1, x-1, a-2, i-2, n-2, p-2, a-3, c-3, i-3.
*KEARFOTT CO., INC.
Keithley Instruments, Inc., s, k-1, n-1, p-1, s-1, v-1, a-3, e-3.
Kin Tel Div.-Cohu Electronics, Inc., d-1, p-1, r-1, s-1, x-1, p-2.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., s-2, w-2.
Korda Industries, x.
Harold Kruger Instruments, c-2.
Lampkin Labs., Inc., M. R. Div., n, a-1, c-1, t-1.
Land-Air Inc., i, j, p, q, u, x, c-1, k-2, q-2, e-3.
Londis & Gyr Inc., g-3.
Londsverk Electometer Co., The, j-2.
Lavoie Laboratories Inc., c-1.
Leeds & Northrup Co., f, g, h, b-1, d-1, g-1, n-1, p-1, r-1, s-1, y-1, c-2, h-2, m-2, u-2, v-2.
*WALLACE O. LEONARD, INC., a.
*LEWIS ENGRG. CO., THE, h-2, u-2, v-2.
Librascope Inc., x.
Ling Electronics, Inc., c-3.
M B Mfg. Co., c-3.
MacLeod & Hanopol, Inc., g.
Magnetic Instrument Co. Inc., g, p, q, w-1, j-1, k-2, l-2, u-2.
Magtrol, Inc., y-2.
Marconi Instruments, g, n, a, a-1, j-1, n-1, a-1, u-1, x-1, y-1, z-1, a-2, f-2, h-2, n-2, q-2, a-3, e-3, f-3, h-3.
Morion Instrument Div., b, k, l, r, r-1, s-1, b-2.
Moson-Neilan, x, m-2.
Motheson Co., Inc., The, g-2.
W. L. Moxson Corp., The, x.
Measurements Div., McGrow Edison Co., f-1, j-1.
Menlo Research Lab., p, q, c-2, j-2.
Meridian Metalcroft, Inc., q-1.
Meters Inc. , b, k, l, d-1, k-1, n-1, r-1, s-1, v-1, y-1, b-2, h-2, s-2, v-2.
Metronix, Inc., Sub.-Assembly Products, Inc., g, s-1, z-2, d-3.
Mica Insulator Div.-Minnesota Mining & Mfg., Co., j-3.
Mica Instrument Co., h-3.
Microwove Associates, Inc., c-1, q-1.
Midwestern Instruments, Inc., y.
Millitest Corp., y-2.
Minco Products, Inc., v-2.
Minneapolis-Honeywell Regulator Co., Boston Div., d-1, p-1.
Minneapolis-Honeywell Regulator Co., Davies Labs. Div., y.
Minneapolis-Honeywell Regulator Co., Industrial Div., k, x, c-1, d-1, h-1, h-2, p-1, r-1, s-1, u-1, c-2, f-2, g-2, h-2, m-2, s-2, u-2, v-2, w-2, y-2.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, b, f, g, h, k thru n, s, t, x, y, b-1, c-1, d-1, g-1, h-1, k-1, l-1, n-1, a-1, p-1, r-1, s-1, u-1, v-1, w-1, y-1, z-1, b-2, c-2, d-2, f-2, g-2, h-2, j-2, m-2, s-2, u-2, v-2, y-2, f-3, i-3, j-3.
Monogram Precision Industries, q-1.
Motorola Inc., Military Electronics Div., a-1, j-1, t-1, n-2.
George L. Nankervis Co., x, h-1, y-2.
Narda Microwave Corp., The, g-1, q-1, l-2, r-2.
National Electronics, b, c, k, l, b-1, c-1, d-1, h-1, k-1 thru n-1, p-1, r-1, s-1, v-1, y-1, b-2, f-2, m-2, s-2, v-2, b-3, f-3, g-3.
National Instrument Laboratories, Inc., x.
National Spectrographic Labs., Inc., p-2.
New England Scientific Instruments Co., b, k, c-1, d-1, k-1, l-1, n-1, a-1, r-1, s-1, u-1, d-2, m-2, s-2, u-2, v-2, f-3, g-3.
Non-Linear Systems, Inc., s-1, v-1, y-1, e-3.
North Atlantic Industries, Inc., d-2, a-3.
North Hills Electric Co., Inc., i-2.
Northeastern Engrg. Inc., c-1.
Nuclear Corp. of America, j-2.
Nuclear-Chicago Corp., j, q, s, j-2, b-3.
Paul Nurches Co., r-1, b-2.
Ohio Semiconductors, Inc., z, f-2, f-3.
Pace Electrical Instruments Co., Inc., b, k, l, d-1, h-1, r-1, s-1, b-2.
Pacific Scientific Co., a, t-2, u-2, v-2, c-3.
Paco Electronics Co., Inc., v-1, a-3, e-3.
Palmer Thermometers, Inc., v-2.
Potterson, Moos Div.-Universal Winding Co., Inc., i-1.
Perkin-Elmer Corp., i-1.
Peschel Electronics, Inc., f, h-1, k-1.
Phaostron Instrument & Electronic Co., b, k, k-1, r-1, s-1, v-1, b-2.
Philco Corp., Government & Industrial Div.
Phillips Aviotion Co.-Marples Gears, x.
Photobell Co., Inc., i, e-2.
Photocon Research Products, l.
Photovolt Corp., c-2, e-2.
Photron Instrument Co., u, d-1, m-2.
Physics Research Laboratories, Inc, b, d-1, l-1, n-1, r-1, s-1, v-1, y-1, a-2, f-3.
Picker X-Ray Corp., j-2, j-3.
Pioneer Tool & Engrg. Co., e thru h, l thru a, w, g-1, n-1 thru t-1, x-1, z-1, a-2, c-2, u-2, e-3.
Polarad Electronics Corp., w, q-1, l-2, n-2, r-2.
Polytechnic Research & Development Co., Inc., c-1, r-2.
Portchester Instrument Corp., c-1, q-1.
Potter Aeronautical Corp., i, u, x, k-2, l-2, s-2.
Power-Tronic Systems Inc., a, m, n, w, x, z, a-1, c-1, f-2, y-2, f-3.
Precise Development Corp., b thru e, g, l, s, d-1, f-1, g-1, k-1, l-1, a-1 thru t-1, v-1, w-1, y-1, z-1, a-2, m-2, n-2, a-3, f-3, g-3.
Precision Apparatus Co., Inc., v-1, a-3, e-3.
Pyrometer Instrument Co., Inc., h-2, u-2, v-2.
Q. V. S. Inc., b, c, k, l d-1, k-1, r-1, b-2, u-2.
Quan-Tech Labs., a, h-3.
Radar Design Corp., q-1, h-3.
Radiation Instrument Development Lab., Inc., i, j, q, j-2.
Rawson Electrical Instrument Co., b, k, z, k-1, r-1, s-1, v-1, u-2, f-3.
Revere Corp. of America, x.
Rixon Electronics Inc., x-1.
Rochester Mfg. Co. Inc., b.
Milton Roy Co., s, c-2.
Arthur C. Ruge Associates, Inc., v-2.
Sage Labs., Inc., h-3.
Sanborn Co., n, c-1, g-2, f-3.
Sangomo Electric Co., g-3.
Santa Barbara Research Center, i-1.
Schutte & Koerting Co., x.
Scientific Instrument Co., g-2, v-2.
Scientific-Atlanta, Inc., l, a-2.
H. H. Scott, Inc., e, l, a, p-2, c-3.
Seco Mfg. Co., a-3.
Shollcross Mfg. Co., f, k, l, d-1, k-1, n-1, y-1.
Simpson Electric Co., b, c, k, l, r, w, d-1, k-1, l-1, r-1, s-1, v-1, w-1, y-1, b-2, u-2, v-2, e-3, f-3.
Slaughter Co., Inc., f.
A. O. Smith Corp., Smith-Erie Div., x.
Snap-On-Tools Corp., s-2.
Solar Aircraft Co., c-1.
Solartron Inc., x-1, z-1, c-2, d-2.
Southwestern Industriol Electronics Co., g, h, l, a, s, d-1, g-1, h-1, k-1, n-1, p-1, s-1, t-1, y-1, c-2, s-2, u-2, a-3, e-3.
Space Corp., w-2.
Specialty Engrg. & Electronics Co., p, q, v-1, j-2.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., g-1, f-2.
Standard Controls, Inc., x, g-2.
Stoddart Aircroft Radio Co., Inc., w.
Strand Engrg. Co., q.
H. W. Sullivon Ltd., e-1, s-1, w-1.
Sun Electric Corp., Aeronoutical Div., b thru e, k, l, r, d-1, k-1, r-1, s-1, t-1, z-1, a-2, b-2, n-2, u-2.
B. K. Sweeney Mfg. Co., y-2.
Systron Corp., h, i, r, u, x, a-1, c-1, d-2, g-2, k-2, l-2, s-2, w-2, x-2, y-2.
W. A. Taylor & Co., c-2.
Technical Apparatus Builders, b, k, s, h-1, r-1, s-1, w-1.
Technology Instrument Corp., g-1, d-2, g-2, a-3, e-3.
Telectro Industries Corp., w, x-1, y-1, p-2, a-3.
Telerad Mfg. Corp., c-1, q-1.
Teletronic Lab. Inc., c-1.
Tempo Instrument Inc., x-2.
Tensitron, Inc., t-2.
Thermo Electric Co., Inc., s-1, h-2, u-2.
Theta Instrument Corp., d-2.
Thiokol Chemical Corp., z.
Thwing-Albert Instrument Co., h-2, u-2, v-2.
Torque Controls Inc., t-2, y-2.
Towaco Electronics, n.
Trons-Sonics, Inc., x, g-2, v-2.
Trio Laboratories, Inc., n-1, d-2, a-3.
Triplett Electrical Instrument Co., b, c, k, l, k-1, n-1, r-1, s-1, v-1, x-1, y-1, z-1, a-2, a-3, e-3, f-3.
Varo Mfg. Co., Inc., c-1, s-2.
Victor R. F. & Microwove Co., q-1, z-1, d-2, h-3.
Wacline, Inc., b, c, e, k, l, r, s, c-1, k-1, r-1, s-1, v-1, y-1, z-1, a-2, b-2, n-2, p-2, s-2, u-2, x-2.
Waldom Electronics Inc., c, k, l, r, s, y-1, a-2.
Wallace & Tiernon Inc., x, c-2, g-2, w-2, y-2.
Waltham Electronics Corp., a-1, t-1, e-3.
Waltham Engrg. Corp., a, r, x-2.
Waltham Precision Instrument Co., r, x-2.
Wang Labs., Inc., c-1.
Waugh Engrg. Co., x, s-2.
Waveline, Inc., c-1, q-1, r-2.
Weinschel Engrg., n-2.
Weksler Instruments Corp., g-2, v-2.
West Instrument Corp., h-1, r-1, s-1, t-2, m-2, u-2, v-2.
Westberg Mfg. Co., s-2.
Westinghouse Electric Corp., b, k-1, l-1, r-1, s-1, y-1, z-1, j-2, u-1, e-3, f-3, g-3, i-3, j-3.
Weston Instruments, Div.-Daystrom, Inc., b, c, g, i, k, l, r, t, v, z, b-1, d-1, f-1, g-1, k-1 thru n-1, p-1, r-1 thru w-1, y-1, z-1, b-2, d-2, k-2, l-2, m-2, a-2, p-2, s-2, u-2, v-2, a-3, e-3, f-3.
Westronics Inc., x, c-1, h-1, c-2, g-2, h-2, j-2 thru m-2, s-2, t-2, u-2, w-2, x-2, d-3.
Wintronics, d-2.
Wollensok Optical Co., v, b-1.
Yellow Springs Instrument Co., The, v-2.
Zoomar Inc., b-1, m-1, e-2.

MICA PLATE & SHEET

Allied Plastics Supply Corp.
Bram Metallurgical & Chemicol Co.
Continental Diomond Fibre Corp.
Ford Radio & Mica Corp.
Integrated Mica Corp.
Magnetic Shield Div. Perfection Mica Co.
Mica Fabricating Co.
Micacraft Products Inc.
Minnesota Mining & Mfg. Co.
Spruce Pine Mico Co., Inc.
Sylvania Electric Products Inc., Parts Div.
United Mineral & Chemical Corp.
Westinghouse Electric Corp.

MICROMANOMETERS

Consolidated Electrodynamics Corp.
Dynametrics Corp.
Flow Corp.
Wollace & Tiernan Inc.

MICROMETERS, ELECTRONIC

Curtiss-Wright-Corp., Electronics Div.
J. W. Dice Co.
Electro Products Laborotories, Inc.
Federal Products Corp.
Land-Air Inc.
Precise Development Corp.
Weston Instruments, Div.-Daystrom, Inc.

MICRO-OHMMETERS

Associated Research, Inc.
Avtron Mfg., Inc.
James G. Biddle Co.
Curtiss-Wright Corp., Electronics Div.
J. W. Dice Co.
Electro Instruments, Inc.
Leeds & Northrup Co.

MICROPHONE CONNECTORS
See CONNECTORS, MICROPHONE

MICROPHONE STANDS
See STANDS, MICROPHONE

MICROPHONES

Atlontic Reseorch Corp.
B & K Instruments, Inc.
Curtiss-Wright Corp., Reseorch Div.
Electronic Applicotions, Inc.
Generol Cement Mfg. Co., Div.-Textron, Inc.
General Coil Products Corp.
Internotionol Research Associotes
Ling Electronics, Inc.
Nationol Pneumotic Co., Inc., Holtzer-Cobot Divs.
Perry Plostics, Inc.
Photocon Reseorch Products
Roonwell Corp.

hure Brothers, Inc.
niversal Microphone Co.

MROSCOPES, ELECTRON

nstruments Div.-Philips Electronics, Inc.
ew England Scientific Instruments Co.
hilco Corp., Government & Industrial Div.
elechrome Mfg. Corp.

MROSCOPES, OPTICAL

merican Optical Co., Instrument Div.
AUSCH & LOMB OPTICAL CO.
uhl Optical Co.
der Instrument Co., Inc.
dmund Scientific Co.
ENGIS EQUIPMENT CO.
isher Scientific Co.
aertner Scientific Corp., The
ordon Enterprises
ieco, Inc.
ew England Scientific Instruments Co.
pto-Metric Tools, Inc.

MROWAVE ABSORBERS

CF Industries Inc.
ircom Inc.
irtron Inc., Div.-Litton Industries
hemalloy Electronics Corp.
BM Research Corp.
emornay-Bonardi
ouglas Microwave Co., Inc.
merson & Cuming, Inc.
ilmohm Corp.
. F. Goodrich Co., The
ieco, Inc.
ockheed Aircraft Corp., Missiles & Space Div.
cMillon Industrial Corp.
icrowave Associates, Inc.
onogram Precision Industries
adar Design Corp.

MROWAVE ACCESSORIES

CF Industries Inc.
ctuation Research Corp.
inslie Corp.
ircom Inc.
ircom Inc. of New Jersey
ircraft Armaments, Inc.
irtron Inc., Div.-Litton Industries
lford Mfg. Co.
llied Research & Engrg., Div.-Allied Record Mfg. Co.
merac Inc.
merican Machine & Foundry Co., Government Products Group
merican Machine & Foundry Co., Greenwich
ntenna & Radome Research Associates
tlantic Instrument Corp., Sub.-American Electronics, Inc.
A. Beauchaine & Sons Inc.
endix Aviation Corp., York Div.
gart Mfg. Corp.
udd Stanley Co. Inc.
udelman Electronics Corp.
alifornia Technical Industries, Div.-Textron Inc.
hemalloy Electronics Corp.
emornay-Bonardi
lamond Antenna & Microwove Corp.
ouglas Microwave Co., Inc.
lectronic Communications, Inc.
sin Electronics Corp.
merson & Cumings, Inc.
mpire Products Sales Corp.
ngelhard Industries, Inc.
ngrg. Associates
XR, Inc.
abriel Co., The, Gabriel Electronics Div.
eneral Communication Co.
ewlett-Packard Co.
ouston Fearless Corp.
alter J. Hyatt Co., The
T-E Circuit Breaker Co.
T Labs.
EARFOTT CO., INC., MICROWAVE DIV.
tton Industries, Inc.
ockheed Aircraft Corp., Missiles & Space Div.
ark Products Co.
eridian Metalcraft, Inc.
crolab
crowave Associates, Inc.
onogram Precision Industries
otorola Inc., Military Electronics Civ.
R. K. Mfg. & Engrg. Co.
nega Labs., Inc.
ilco Corp., Government & Industrial Div.
olytechnic Research & Development Co., Inc.
adar Design Corp.
adiatronics, Inc.
eeves Instrument Corp.
ge Labs., Inc.
nders Associates, Inc.
ecial Instruments Div., British Industries Corp.
and Engrg. Co.
pco Group, Thompson-Ramo-Wooldridge Inc.
elerad Mfg. Corp.
ermal Refractories Corp.
rbo Machine Co.
vin Coach Co., Aircraft-Missiles
ited Aircraft Products, Inc.
rian Associates
Victor R. F. & Microwave Co.
Walworth Co. Electronics Div.
Waveline, Inc.
Weinschel Engrg.

MICROWAVE ASSEMBLIES
See ASSEMBLIES, MICROWAVE

MICROWAVE COUPLERS, DIRECTIONAL
See COUPLERS, DIRECTIONAL, MICROWAVE

MICROWAVE FLANGES
See FLANGES, MICROWAVE

MICROWAVE HORNS
See HORNS, MICROWAVE

MICROWAVE ISOLATORS
See ISOLATORS, MICROWAVE

MICROWAVE PARABOLAS
See PARABOLAS, MICROWAVE

MICROWAVE PASSIVE REPEATERS
See REPEATERS, PASSIVE, MICROWAVE

MICROWAVE REPEATERS
See REPEATERS, MICROWAVE

MICROWAVE SHUTTERS
See SHUTTERS, MICROWAVE

MICROWAVE SLIDING LOADS
See SLIDING LOADS, MICROWAVE

MICROWAVE TRANSMISSION LINES
See TRANSMISSION LINES, MICROWAVE

MIOFRAME SECTIONS

American Machine & Foundry Co., Government Products Group
Benson Mfg., Co., The
Clark-Aiken Co., The
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Fletcher Mfg. Co., Inc., The
Ludwig Honold Mfg. Co.
M. W. Kellogg Co., The
Longren Aircraft Co., Inc.
Mercury Tool & Mfg. Corp.
Monogram Precision Industries
Piasecki Aircraft Corp.
Royal Industries, Inc.
Solor Aircraft Co.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Turbo Products, Inc.

MIOFRAME SECTIONS, AXIAL FLOW

Dresser Mfg. Div., Dresser Industries, Inc.
Fletcher Mfg. Co., Inc., The
Monogram Precision Industries
Piosecki Aircraft Corp.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Turbo Products, Inc.

MILITARY TEST UNITS, ACCELERATION
See TEST UNITS, ACCELERATION, MILITARY

MILLIOHMMETERS

Associated Research, Inc.
James G. Biddle Co.
Bristol Co., The
Buhl Optical Co.
Curtiss-Wright Corp., Electronics Div.
Electro Instruments, Inc.
Greiboch Instruments Corp.
Keithley Instruments, Inc.
National Electronics
New England Scientific Instruments Co.
Shallcross Mfg. Co.
Weston Instruments, Div.-Daystrom, Inc.

MIRRORS, INSPECTION

Semon Bach & Co.
***BAUSCH & LOMB OPTICAL CO.**
Blowers Inc.
Buhl Optical Co.
Corbin Products Div.
Dell Optics Co., Ltd.
Eder Instrument Co., Inc.
***ELECTROSNAP CORP.**
***ENGIS EQUIPMENT CO.**
J. W. Fecker, Inc.
Liberty Mirror Div., Libbey-Owens-Ford Glass Co.
O & S Research, Inc.
Pacific Universal Products Corp.
Republic Lens Co. Inc.
Singer Mfg. Co., The, Military Products Div.
Sterling Glass Corp.
Tinsley Labs., Inc.
Ullman Devices Corp.

MIRRORS, PRISMS, LENSES
See LENSES, PRISMS, MIRRORS

MIRRORS, SPECIAL PURPOSE

America Optical Co., Instrument Div.
Atlantic Research Corp.
Semon Bache & Co.
***BAUSCH & LOMB OPTICAL CO.**
Blowers Inc.
Corning Glass Works
Davidson Mfg., Co., Inc.
Dell Optics Co., Ltd.
***ELECTROSNAP CORP.**
J. W. Fecker, Inc.
Gaertner Scientific Corp., The
Gordon Enterprises
Green Rectifier Co.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co.
Kollmorgen Optical Corp.
Liberty Mirror Div., Libbey-Owens-Ford Glass Co.
Northrop Corp., The Nortronics Div.
D & S Research, Inc.
Optical Coating Lab., Inc.
Pacific Universal Products Corp.
Red Lion Cabinet Co., Redco Tool Div.
Republic Aviotion Corp.
Republic Lens Co. Inc.
Singer Mfg. Co., The, Military Products Div.
Sterling Glass Corp.
Ullman Devices Corp.
Valpey Crystal Corp.
Van Keuren Co.
Wollensak Optical Co.
Zenith Optical Laboratory

MISSILE BOOSTERS

Aerolab Development Co.
Alco Products, Inc.
American Machine & Foundry Co., Government Products Group
Astrodyne, Inc.
Atlantic Research Corp.
Auto Specialties Mfg. Co., Inc.
E. W. Bliss Co.
Bridgeport Brass Co.
California Aircraft Products
Chrysler Corp., Defense Operations Div.
Cooper Development Corp., Sub-Marquardt Aircraft Co.
Curtiss-Wright Corp.-Wright Aeronauticol Div.
Diversey Engrg. Co.
Dresser Mfg. Div., Oresser Industries, Inc.
Dynamic Devices, Inc.
Electric Heater Co., The
Ferris-Mfg. Co., The
Fulton-Irgon Corp., The
General Electric Co., Apparatus Sales Div.
Hahn & Clay
Hercules Powder Co.
Hicks Corp., The
Hufford Corp., The
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kaiser Metal Products, Inc.-Fleetwings Div.
M. W. Kellogg Co., The
Lockheed Aircraft Corp., Missiles & Space Div.
Newbrook Machine Corp.
Norris-Thermador Corp.
Oerlikon Tool & Arms Corp. of America
Portland Copper & Tank Works Inc.
Pressed Steel Tank Co.
Reaction Motors Div., Thiokol Chem. Corp.
Red Lion Cabinet Co., Redco Tool Div.
Republic Aviation Corp.
***RHEEM MFG. CO., OEFENSE & TECHNICAL PRODUCTS OIV.**
Rohm & Haas Co., Redstone Arsenal Research Div.
Solar Aircroft Co.
Thiokol Chemical Corp.
Twin Cooch Co., Aircraft-Missiles
United States Chemical Milling Corp.
Universal Moulded Products Corp.
Veet Industries
Waste King Corp., Technical Products Div.
Woyne Pump Co., The, Div.-Symington Wayne Corp.
Wheland Co., The

MISSILE CONTROL GOVERNORS
See GOVERNORS, MISSILE CONTROL

MISSILE FIRE STANOS
See FIRE STANDS, MISSILE

MISSILE FRAMES

ACF Industries Inc.
Aerojet-General Corp.
Aerolab Development Co.
Aeronca Mfg. Corp.
American Car & Foundry, Div.-ACF Industries, Inc.
American Machine & Foundry Co., Government Products Group
Basco Metal Products, Inc.
Basic Tool Industries, Inc.
Benson Mfg., Co., The
E. W. Bliss Co.
Brooks & Perkins, Inc.
Chrysler Corp., Defense Operation Div.
Clark-Aiken Co., The
Colonial Aircraft Corp.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp., Santa Barbara Div.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Electric Heater Co., The
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Farwell Metal Fabricating
Ferris-Mfg., The
Fletcher Mfg. Co., Inc., The
General Electric Co., Missile & Space Vehicle Dept.

Gaadyeor Aircraft Corp.
Ludwig Hanold Mfg. Co.
Horkey-Moore Associates
Hufford Corp., The
Hughes Aircraft Co.
Intercontinental Mfg. Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kaiser Metal Products, Inc.-Fleetwings Div.
M. W. Kellogg Co., The
Kentucky Metal Products Co.
Ladish Co.
***LAVELLE AIRCRAFT CORP.**
Lockheed Aircraft Corp., Missiles & Space Div.
Longren Aircraft Co., Inc.
Martin Co., The, Denver Div.
Mercury Tool & Mfg. Corp.
Minneapolis-Honeywell Regulator Co., Drdnance Div.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
Monrovia Aviation Corp.
Narmco Mfg. Co.
Northrop Corp., The, Nortronics Div.
Opelika Welding, Machine & Supply Inc.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.
Precision Shapes, Inc.
Precision Sheet Metal, Inc.
Red Lion Cabinet Co., Redco Tool Div.
Republic Aviation Corp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Rohr Aircraft Corp.
Royal Industries, Inc.
Ryan Aeronautical Co.
Santa Anita Engrg. Co.
Sequoia Wire & Cable Co., Div.-Mandrel Industries, Inc.
Stanley Aviation Corp.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Turbo Products, Inc.
Twigg Industries
U. S. Industries, Inc.
Universal Moulded Products Corp.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Welded Construction Inc.
Wheland Co., The

MISSILE SYSTEMS, AUTOMATIC CHECK-OUT EQUIPMENT

***BENDIX PRDDUCTS DIV., BENDIX AVIATION CORP.**

MISSILES, GROUND CHECK-DUT EQUIPMENT

***AC ELECTRDNICS DIV., GENERAL MOTORS CORP.**
ACF Industries Inc.
Accessory Products Co., Div.-Textron Inc.
Acco Equipment Div., American Chain & Cable Co. Inc.
Acromag Inc.
Adler Electronics, Inc.
Aeronca Mfg. Corp.
Aircraft Armaments, Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Alto Scientific Co., Inc.
Amelco, Inc.
American Bosch Arma Corp.
American Electronics, Inc.
American Machine & Foundry Co., Government Products Group
Arnolt Corp.
Associated Engineers, Inc.
Atlas Precision Products, Co.
Avien, Inc.
Avtron Mfg., Inc.
Bosic Tool Industries, Inc.
Beckman-Systems Div.
Bell Aircraft Corp., Niagara Frontier Div.
Belock Instrument Corp.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix Aviation Corp., York Div.
Bendix Products Div.,-Missiles, Bendix Aviation Corp.
Bendix Rodio Div., Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Benson Mfg., Co., The
Bernco Engrg. Corp.
Bogue Electric Mfg. Co.
Brown Engrg. Co., Inc.
Burton-Rodgers, Inc.
California Technical Industries, Div.-Textron Inc.
Chalco Engrg. Corp.
Chicago Aerial Industries, Inc.
Chrysler Corp., Defense Dperations Div.
Collins Radio Co.
Colonial Aircraft Corp.
Components Corp.
Consolidated Diesel Electric Corp.
Control Engrg. Co., Div. Jervis B. Webb Co.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Craig Systems, Inc.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Electronics Div., IMI Bronch
Curtiss-Wright Corp., Santa Barbara Div.
Dolmotor Div., Yuba Consolidated Industries, Inc.
Dato-Control Systems, Inc.
Datran Electronics, Div.-Mid-Continent Mfg. Co., Inc.
Dynametrics Corp.
Electro Instruments, Inc.

***ELECTRDSNAP CDRP.**
Electro-Mechanical Products Co.
Electronic Communications, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avianics Div.
Emerson Radio & Phanagraph Corp.
Fairchild Astrionics Div., Foirchild Engine & Airplane Corp.
Firestone Tire & Rubber Co., The, Guided Missile Div.
Ford Instrument Co., Div.-Sperry Rand Corp.
G. W. Galloway Co.
Generol Communication Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Computer Dept.
General Electric Co., Missile & Spoce Vehicle Dept.
Gilfillon Bros. Inc.
Goodyear Aircraft Corp.
Gordon Enterprises
Greer Hydraulics, Inc.
Gremco, Inc.
Guided Missile Div.-DeHavilland Aircraft of Canodo, Ltd.
Hallicrofters
Hamilton Standard, Div.-United Aircraft Corp.
***A. W. HAYDON CO., THE**
Hozeltine Electronics Div.-Hozeltine Corp.
Heiland Div.-Minneapolis-Honeywell
Hufford Corp., The
Hughes Aircraft Co.
Walter J. Hyatt Co., The
Hycon Mfg. Co.
ITT Federol Div., International Telephone & Telegraph Corp.
Industrial Engrg. Corp.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Intercontinental Dynamics Corp.
Jack & Heintz, Inc.
Jeta, Inc.
Kahn & Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
***KEARFOTT CO., INC.**
Kollmorgen Dptical Corp.
Leach Corp.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Marquardt Aircraft Co.
Martin Co., The, Denver Div.
Master Specialties Co.
W. L. Maxson Corp., The
Milgo Electronic Corp.
Minneapolis-Honeywell Regulotor Co.-Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Minneapolis-Honeywell Regulator Co., Drdnonce Div.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
George L. Nankervis Co.
Northrop Corp., The, Nortronics Div.
Nuclear Products-Erco Div.-ACF Industries, Inc.
On Mork Couplings, Inc.
Dptimized Devices, Inc.
Otis Elevator Co., Electronic Div.
***PACKARD-BELL ELECTRONICS CORP.**
Ralph M. Parsons Co., The, Electronics Div.
Perkin-Elmer Corp.
Philco Corp., Government & Industrial Div.
Polorad Electronics Corp.
Radiation, Inc.
Ramo-Wooldridge Div., Thompson-Ramo-Wooldridge of Calif.
Raytheon Mfg. Co., Government Equipment Div.
Republic Aviation Corp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Royal Industries, Inc.
Rucker Co., The
Sargent Engrg. Corp.
Schaffer Air Industries, Inc.
Seeburg Corp., The
Sequoia Wire & Cable Co.-Div.-Mandrel Industries, Inc.
Servo Corp. of America
Servomechanisms, Inc.
Singer Mfg. Co., The, Military Products Div.
Skiatron Electronics & Television Corp.
Space Corp.
Specialties, Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Stanley Aviation Corp.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
Systron Corp.
Talley Corp., The
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Tele-Dynamics Inc.
Theta Instrument Corp.
Thiokol Chemical Corp.
United Aircroft Products, Inc.
United Control Corp.
United Electrodynamics, Inc.
United Mfg. Co., Div., The W. L. Maxson Corp.
U. S. Industries, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Varo Mfg. Co., Inc.
Vickers Inc., Div.-Sperry Rand
Vickers Inc., Marine & Drdnance Dept., Machinery Hydraulics Div.
Victor Adding Machine Co.
Virginia Electronics Co., Inc.
Vitro Labs.
Waldorf Electronics. Div.-F. C. Huyck & Sons
Woste King Corp., Technical Products Div.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Webcor, Inc., Government Div.
Welded Construction Inc.
Western Design, Div.-U. S. Industries, Inc.; Santa Barbara Div.
Western Geor Corp.
Wintronics

MISSILES, GRDUND HANDLING EQUIPMENT
See **GROUND HANDLING EQUIPMENT, MISSILES**

MISSILES GUIDANCE EQUIPMENT
See **GUIDANCE EQUIPMENT, MISSILES**

MOBILE COMPRESSOR ASSEMBLIES
See **COMPRESSOR ASSEMBLIES, MOBILE**

MODULATORS, MAGNETIC
Americon Research & Mfg. Corp.
Bradley Semiconductor Corp.
Emerson Radio & Phonograph Corp.
General Magnetics, Inc.
Guided Missile Div.-DeHavillond Aircraft of Canada, Ltd.
ITT Federal Div., International Telephone & Telegraph Corp.
Lear, Inc.
Levinthol Electronic Products, Inc.
Monogrom Precision Industries
Networks Electronic Corp.
Pioneer Tool & Engrg. Co.
RS Electronics Corp.
Southwestern Industrial Electronics Co.
Sperry Microwove Electronics Co., Div.-Sperry Rand Corp.
Talley Corp., The
Telechrome Mfg. Corp.
Torwico Electronics, Inc.
Transonic, Inc.
Webcor, Inc., Government Div.
Westbury Electronics Inc.
Weston Instruments, Div.-Daystrom, Inc.

MODULATORS, PHASE
Bradley Semiconductor Corp.
Centronix Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Crosby Laborotories, Inc.
Geotronic Labs., Inc.
ITT Federal Div., International Telephone & Telegraph Corp.
***KEARFOTT CO., INC., MICROWAVE DIV.**
Lear, Inc., Grond Rapids Div.
W. L. Moxson Corp., The
Mirotel, Inc.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
Pioneer Tool & Engrg. Co.
Telechrome Mfg. Corp.
Victor R. F. & Microwave Co.

MDDULATORS, PULSE
AMP Inc.
Alto Scientific Co., Inc.
Amerac Inc.
FXR, Inc.
Federal Mfg. & Engrg. Corp.
Hewlett-Packard Co.
ITT Federal Div., International Telephone & Telegraph Corp.
***KEARFOTT CO., INC., MICROWAVE DIV.**
Levinthal Electronic Products, Inc.
Magnetic Research Corp.
Manson Labs., Inc.
Marconi Instruments
W. L. Maxson Corp., The
Mirotel, Inc.
Monogram Precision Industries
Motorola Inc., Military Electronics Div.
Dmega Labs., Inc.
RS Electronics Corp.
Systems Inc.
Talley Corp., The
Telechrome Mfg. Corp.
Vorion Associates
Weinschel Engrg.

MOLDED PLASTIC GRILLES
See **GRILLES, MOLDED PLASTIC**

MOLDERS, PLASTIC
Accurate Electronics Corp., Dept. D
Airtronics International Corp.
American Aerophysics Corp.
American Molded Products Co.
Associated Engrg. Corp.
Brook Molding Corp.
Chemold Co.
Chemplast, Inc.
Chicago Molded Products Corp.
Collectron Corp.
Curtiss-Wright Corp.-Utica Div.
Dimco-Gray Co.

Emerson Plastics Corp.
First Electronics Carp., The
Fletcher Mfg. Co., Inc., The
Flexrack Co.
Form-It Products, Inc.
Garde Mfg. Co.
Hardman Taal & Engrg., Co.
Haveg Industries, Inc.
Hydro Malding Co., Inc.
Laclin Mfg. Co.
Kerrco Products
H. Koch & Sons
M & Q Plastic Products
Minnesota Mining & Mfg. Co.
Malding Carp. of America
. M. Ney Co., The
Perry Plastics, Inc.
Plastic Age Sales, Inc.
Milton Ross Metals Co., The
Russell Reinforced Plastics Carp.
St. Regis Paper Co., Panelyte Div.
Sylvania Electric Products Inc., Parts Div.
Universal Moulded Products Carp.

MOLYBDENUM SHEETS
See SHEETS, MOLYBDENUM

MONITORING EQUIPMENT, TRANSMISSION
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Bendix Radio Div., Bendix Aviation Corp.
Centronix Inc.
Consolidated Electrodynamics Corp.
Comes Cunningham Son & Co., Inc.
Douglas Microwave Co., Inc.
Electronic Communications, Inc.
Hammarlund Mfg., Co., Inc.
Helipot Div.-Beckmon Instruments Inc.
ITT Labs.
ITT-Kellogg
Lauke & Co.
Minneapolis-Honeywell Regulator Co., Dovies Labs. Div.
Minneapolis-Honeywell Regulator Co., Industriol Product Group, d, e, g.
Miratel, Inc., c, h, k.
Motorola Inc., Military Electronics Div., a, d, f, g, h, k.
National Pneumatic Co., Inc., Haltzer-Cabot Divs., a.
Philco Corp., Government & Industrial Div., a, d, f, g, h.
Portchester Instrument Corp.
Radar Design Corp., h.
Royal Industries, Inc., b.
Scam Instrument Carp., The, i.
Scientific-Atlanta, Inc., h.
Setchell-Carlson Inc., e.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., d, h.
Systron Corp., d, g.
Television Utilities Corp., k.
Theta Instrument Corp., g.
Tarwica Electronics, Inc., d.
Towaca Electronics Co., d.
U. S. Science Corp., Div.-Tapp Industries, Inc., b, g, h.
Varian Associates, a, d, g, h, k.
Waltham Electronics Corp., a, f.
Waterman Products Co., Inc., d, f, k.
Webcor, Inc., Government Div., d.
Wintronics, g, j.

MONOPROPELLANTS
Aerojet-General Corp.
Air Products, Inc.
Allied Chemical Carp., Nitrogen Div.
American Rocket Co.
Atlantic Research Corp.
Becco Chemicol Div.-Food Machinery & Chemicol Corp.
Dynamic Devices, Inc.
Fulton-Irgon Corp., The
Dlin Mathieson Chemical Corp., Energy Div.
Pennsolt Chemicals Corp.
Rohm & Haas Co., Redstone Arsenol Research Div.
Shell Chemical Corp., Industriol Chemicols Div.
Special Projects Lob., Food Mochinery & Chemical Corp.
Thiokol Chemicol Corp.
Topper Mfg. Co., Inc.

MOTION PICTURE PROCESSING EQUIPMENT
See PROCESSING EQUIPMENT, MOTION PICTURE

MOTOR BRUSHES
See BRUSHES, MOTOR

MOTOR & GENERATOR BLOWERS
See BLOWERS, MOTOR & GENERATOR

MOTOR & GENERATOR CLUTCHES
See CLUTCHES, MOTOR & GENERATOR

MOTOR GENERATOR SETS, AC-DC
*MOTOR GENERATOR CORP.

MOTOR & GENERATOR STATORS
See STATORS, MOTOR & GENERATOR

MOTORS
a. Clack
b. Contral
c. Electric
d. Fluid
e. Fractianal HP
f. Hydraulic
g. Hysteresis
h. Instrument
i. Miniature
j. Servo
k. Timing-Regulated, Constant Speed
l. Turntable
m. Universal

ACF Industries Inc., f.
Adel Precision Products of Califarnio, Div.-Generol Metols Corp., d, e, f.
Advanced Products Co., The, a, e, g, h, i, k.
Airborne Accessories Corp., c, e, j.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., b, c, e, g thru k.
Air-Marine Motors, Int., c, e, g, h.
Alco Valve Co., c, e, f.
R. C. Allen Aircraft Instr. Div., R. C. Allen Bus. Machines, Inc., c, g, h, i.
American Aeroports, c, d, f, j.
American Bosch Armo Corp., b thru f, j.
American Broke Shoe Co., f.
American Broke Shoe Co., Kellogg Div., f.
American Electronics, Inc., b, c, e, g thru k.
American Electronics, Incorporated, j.
American Electronics, Inc.-Instrument Div., j.
American Machine & Foundry Co., Government Products Group, d, f.
Americon Meosurement & Control, Inc., i, j.
American Rocket Co.
Amglo Corp., b, k.
Ashlond Electric Products, Inc., c, e, g.
Atlontic Instrument Corp., Sub.-Americon Electronics, Inc., h.
Borber-Colmon Co., b, c, e, i, j, l.
Bendix Aviotion Corp., Eclipse-Pioneer Div., b, h, i, j.
*BENDIX AVIATION CORP., HAMILTON DIV., d, f, l, j.
Bendix Aviation Corp., Mantrose Div., e.
Bendix Aviotion Corp., Red Bank Div., e.
Bendix-Pocific Div., Bendix Aviotian Corp., c, e, f, j.
Bodine Electric Co., a, b, c, e, g, h, i, k, m.
Bogue Electric Mfg. Co., j.
Borg Equipment Div., Amphenol-Borg Electronics Carp., e, h.
Bristal Motars Div.-Vocaline Co., of America, Inc., k.
Braak Motar Carp., c.
CELCD (Constantine Engrg. Labs. Co.), e, g, i, j, m.
Cedar Engrg. Div.-Control Data Corp., a, b, c, e, g thru j.
Chicago Pneumatic Taal Co., b, e.
Clifton Precisian Products Co., Inc., h, j.
Commercial Shearing & Stamping Co., f.
Continental Electric Co., Inc., c.
Cantrol Data Corp., c, e, g, i, j.
Cornelius Co., The, Aero Div., c thru f.
Cramer Controls Corp., a, b, i.
Dalmotor Div., Yuba Consolidated Industries, Inc., b, c, e, g thru j, m.
Daystram Transicoil Div., Daystrom Inc., j.
Delco-Remy Div., General Motars Corp., c.
Diehl Mfg. Co.,c, e, h, i, j.
Dresser Mfg. Div., Dresser Industries, Inc.
Dumont Aircraft Fitting Co., j.
Eastern Industries Inc., F.
Thomas A. Edisan Inc. Instrument Div.-McGraw-Edison Co., c, h thru k.
Eicar Div.-Scranton, c, e, g, m.
Electric Auto-Lite Co., The, c, e.
Electric Mochinery Mfg. Co., c.
Electric Motors & Specialties, Inc., c, e.
Electric Products Co., The, c.
Electronic Applicotions, Inc., e, g.
Electronic Communicotions, Inc., b, c, e, j.
Elgin Micronics Div.-Elgin Notionol Watch Co., a, g, i, k.
El Roy Motor Co., Inc., e, i, j, l.
Ford Instrument Co., Div.-Sperry Rand Corp., h, i.
G-M Labs. Inc., e, h, i, j.
Generol Electric Co., Apporotus Sales Div., b thru g, j, m.
Globe Industries, Inc., b, c, e, g thru k, m.
Groflex Inc., i, j, k.
Greenleaf Mfg. Div., The, Mondrel Ind. Inc., h, j.
Grimes Mfg. Co., e.
Guided Missile Div.-DeHavillond Aircroft of Conoda, Ltd., c.
Homilton Standord, Div.-United Aircraft Corp., f.
Hamilton Wotch Co., a, k.
Hamilton Wotch Co.-Industriol Div., a, i.
Honnifin Co., Div.-Porker-Honnifin Corp., d.
Honsen Mfg. Co. Inc., a, b, c, h, i, k.
Hoskel Engrg. & Supply Co., f.
*A. W. HAYDON CO., THE, a, b, c, g, h, i, k.
Hoydon Div.-General Time Corp., a, b, c, g, h, i, k.
Helipot Div.-Beckmon Instruments Inc., j.
Hertner Electric Co., The, b, c, e, g thru k.
E. Vernon Hill & Co., i.
Holtzer-Cobot Div., Notionol Pneumatic Co., Inc., b, c, e, g thru k.
Hoover Electric Co., b, c, e, g thru k, m.
Hughes Tool Co., Aircraft Div., a.
Hupp Aviotion Co., f.
Hydroulic Press Mfg. Co., The, Div.-Koehring Co., f.
Induction Motors Corp., b, c, e, g thru l.
Ingroham Co., The, a, g.
Instrument Motors, a, b, d, f thru i, l.
Internationol Register Co., a, c, h, i, k.
Jock & Heintz, Inc., c, e.
*KEARFOTT CO., INC., b, c, e thru j.
Kelsey-Hayes Co., c, d, e.
Ketay Dept., Norden Div., United Aircraft Corp., j.
Korda Industries, d, f.
Lamb Electric Co., The, Div.-Americon Mochine & Metols, Inc., b, c, e, g, i, j, l, m.
Land-Air Inc., b, i.
Leor, Inc., b thru j.
Lear, Inc., Grond Rapids Div., b, c, e, h, i, j.
Leor Inc., Leor-Romec Div., c thru f, j.
Lelond Airborne Products, Div.-Americon Mochine & Foundry Co., c, j.
Lundy Mfg. Corp., b, c, e, g, h, i.
Luther Mfg. Co., b, e, g thru j.
Lux Clock Mfg. Co., Inc., a.
Minneapolis-Honeywell Regulotor Co., Aeronautical Div., e, g, j.
Minneapolis-Honeywell Regulotor Co., Industrial Div., h, j.
Minneapolis-Honeywell Regulotor Co., Industrial Product Group, h, j.
Minneapolis-Honeywell Regulotor Co., Ordnance Div., g.
Motor Applionce Corp., c, e.
Motordyne Inc., b, c, e, g thru m.
Motoreseorch Co.
Heinz Mueller Eng. Co. Inc., c, e.
National Pneumotic Co., Inc., Holtzer-Cobot Divs., b, c, e, g thru k.
Dil-Dyne, Inc., d, f.
P. S. P. Engrg. Co., Div.-Induction Motors Corp., j.
Packard Electric Div.-Generol Motors Corp., c, e.
Porogon Electric Co., a, b, k.
Pesco Products Div.-Borg-Worner Corp., c, e, f.
Pioneer Tool & Engrg. Co., j.
Power Supplies Inc., j.
Rocine Hydroulics & Mochinery Inc., f.
Raymond Engrg. Lob., Inc., k.
Redmond Co., Inc., c, e, l.
Sofety Electricol Equipment Corp., b, c.

MOLYBDENUM SHEETS
See SHEETS, MOLYBDENUM

MONITORING EQUIPMENT, TRANSMISSION
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Bendix Radio Div., Bendix Aviation Corp.
Centronix Inc.
Consolidated Electrodynamics Corp.
Comes Cunningham Son & Co., Inc.
Douglas Microwave Co., Inc.
Electronic Communications, Inc.
Hammarlund Mfg., Co., Inc.
Helipot Div.-Beckmon Instruments Inc.
ITT Labs.
ITT-Kellogg
Lauke & Co.
Minneapolis-Honeywell Regulotor Co., Dovies Labs. Div., a, c, e, k.
Minneapolis-Honeywell Regulotor Co., Industriol Product Group, d, e, g.

MOTORS
a. AM & FM Transmitter
b. Antenna Phase
c. Audio
d. Frequency
e. Line & Program
f. Modulation
g. Phase
h. RF Power
i. Service
j. Shift
k. Waveform

Airpox Electronics Inc., Seminole Div., d.
American Electronics, Inc., Toller & Cooper Div., e.
American Machine & Foundry Co., Government Products Group, b, d, k.
Antlob Inc., d, f.
Beckmon Instruments, Inc., Berkeley Div., d.
Comes G. Biddle Co., d.
Briggs Associotes, Inc., k.
Centronix Inc., a thru k.
Cage Television Div., Thompson Romo Wooldridge, Inc., k.
Civco-Wayne Electronics, Div.-Divco-Woyne Corp., a, c, d.
Electric Regulotor Corp., d, e, g.
Electronic Communicotions, Inc., g, h.
Elgin Micronics Div.-Elgin National Watch Co., c, h.
Erie Resistor Corp., d.
EXR, Inc., f.
Foto-Video Labs., Inc., e, i, k.
Gilfillon Bros. Inc.
Hammarlund Mfg., Co., Inc., c.
Helipot Div.-Beckmon Instruments Inc., d, e, g.
Hewlett-Packard Co., d.
Hughes Tool Co., Aircroft Div.
Industrial Test Equipment Co., g.
Jahn & Co., Inc., d.
Jampkin Labs., Inc., M. R. Div., d, f.
Jond-Air Inc., d, g.
Jongevin Div., W. L. Maxson Corp., The
Litton Industries, Maryland Div., f.
Magee-Brallo & Associotes
Morconi Instruments, a, d, f, h, k.
Minneapolis-Honeywell Regulotor Co., Dovies Labs. Div., a, c, e, k.
Minneapolis-Honeywell Regulotor Co., Industriol Product Group, d, e, g.

Sangamo Electric Co., a, c, g, i, k.
Sargent Engrg. Corp., d, f, j.
Servomechanisms, Inc., Mechatrol Div., b, g thru k.
Sigma Instruments, Inc., h, i.
Singer Mfg. Co., The, Military Products Div., b, c, e, j, k.
Small Motors Inc., b, c, e, h, i, j, m.
A. D. Smith Corp., c, e, m.
Special Projects Lab., Food Machinery & Chemical Corp., d.
Stratos, Div.-Fairchild Engine & Airplane Corp., d, f.
Talley Corp., The, b, c, e.
Tapco Group, Thompson-Ramo-Wooldridge Inc., f, j.
Task Corp., c, e.
Universal Electric Co., b, c, e, h, i, j, m.
Vickers Inc., Div.-Sperry Rand, d, f, i.
Vickers Inc., Marine & Ordnance Dept., Machinery Hydraulics Div., f.
Waltham Engrg. Corp., k.
Watertown Div., The New York Air Brake Co., d, f, j.
Western Design, Div.-U. S. Industries, Inc.; Santa Barbara Div., b, c, e, f, g, k.
Western Gear Corp., c, e, i, j.
Westinghouse Electric Corp., c, e, j, m.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp., j.
Wincharger Corp., Sub.-Zenith Radio Corp., e, m.
Zenith Radio Corp., c, e.

MOTORS, AC-DC

***ELECTRICAL ENGRG. & MFG. CORP.**

MOUNTING STRIPS

See STRIPS, MOUNTING

MOUNTINGS, METALLIC

Alpitec, Inc.
American Aeroparts
Anchor Metal Spinning Co., The
B. H. Aircraft Co., Inc.
Barry Controls Inc.
Bergen Carbide Co.
E. W. Bliss Co.
Bruce Engrg. Co.
Bud Radio Inc.
Byrne Doors Inc.
California Aircraft Products
Capital City Mfg. Co.
Clark-Aiken Co., The
Colonial Aircraft Corp.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Diversey Engrg. Co.
Federal Shock Mount Corp.-Div. The Korfund Co., Inc.
B. F. Goodrich Industrial Products Co.
J. W. Johnson & Co., Inc.
Kling Metal Spinning & Stamping Co.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Ladish Co.
Mercury Tool & Mfg. Corp.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
Penn Keystone Corp.
Piasecki Aircraft Corp.
Precision Shapes, Inc.
Edw. Renneburg & Sons Co.
Robinson Technical Products, Inc.
Stanley-Judd Div.-The Stanley Works
Stone City Products Co.
Teiner Engrg. Corp.
United Mfg. Co., The
U. S. Industries, Inc.
United States Chemical Milling Corp.
Variety Aircraft Corp.

MOUNTINGS, NON-METALLIC

Allied Plastics Supply Corp.
American Aeroparts
American Latex Products Corp.
Barry Controls Inc.
Bushings, Inc.
Colonial Aircraft Corp.
Continental Rubber Works
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Crystal-X Corp.
Dayton Rubber Co., The
Diversey Engrg. Co.
Dow-Elco, Inc.
Federal Shock Mount Corp.-Div. The Korfund Co., Inc.
General American Transportation Corp.
Gladding, McBean & Co.
B. F. Goodrich Industrial Products Co.
Hamilton Kent Mfg. Co.
Jodee Plastics Co.
Johns-Manville
J. W. Johnson & Co., Inc.
Minnesota Rubber Co.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Norton Co., New Products Dept.
Orchard Industries, Inc., Actionflex Div.
Piasecki Aircraft Corp.
Rubbercraft Corp. of California
A. T. Stevens Co.
Thermal Refractories Corp.
United States Rubber Co.

MOUNTINGS, VIBRATION & SHOCK

American Aeroparts
American Latex Products Corp.
Anchor Metal Spinning Co., The
Applied Design Co.
Barry Controls Inc.
Bushings, Inc.
Champion Co., The
Colonial Rubber Co.
Continental Rubber Works
Dayton Rubber Co., The
Dow-Elco, Inc.
Federal Shock Mount Corp.-Div. The Korfund Co., Inc.
Felters Co., The
Finn Aeronautical Div., T. R. Finn & Co., Inc.
B. F. Goodrich Industrial Products Co.
Hamilton Kent Mfg. Co.
Johns-Manville
J. W. Johnson & Co., Inc.
Wolter Kidde & Co., Inc., Aviation Div.
Litton Industries, Inc.
Litton Industries, Maryland Div.
Lord Mfg. Co.
Lyon Van & Storage Co., Aircraft Div.
MB Mfg. Co.
Mc Dowell-Wellmon Companies, The
Menasco Mfg. Co.
Minnesota Rubber Co.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Orchard Industries, Inc., Actionflex Div.
Raybestos-Manhattan, Inc.
Roberts Toledo Rubber Co., The
Robinson Technical Products, Inc.
Rubbercraft Corp. of California
A. T. Stevens Co.
Ucinite Co., The, Div.-United-Carr Fastener Corp.
U. S. Industries, Inc.
United States Rubber Co.

MOUNTS

American Aeroparts
Anchor Metal Spinning Co., The
Antlab Inc.
Barry Controls Inc.
E. W. Bliss Co.
Bruce Engrg. Co.
Bushings, Inc.
Capital City Mfg. Co.
Champion Co., The
Colonial Aircraft Corp.
Cromer Mfg. & Engrg., Inc.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Federal Machine Co. Inc.
Federal Shock Mount Corp.-Div. The Korfund Co., Inc.
B. F. Goodrich Industrial Products Co.
Hamilton Kent Mfg. Co.
J. W. Johnson & Co., Inc.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Ladish Co.
Lord Mfg. Co.
MB Mfg. Co.
Mercury Tool & Mfg. Corp.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Pacific Scientific Co.
Piasecki Aircraft Corp.
Edw. Renneburg & Sons Co.
Robinson Technical Products, Inc.
Rubbercraft Corp. of California
Stainless Inc.
United Mfg. Co., The
Variety Aircraft Corp.
Vinco Corp.
Winder Aircraft Corp. of Florida

MOUNTS, ENGINE

ACF Industries Inc.
Aircraft Mechanics, Inc.
American Aeroparts
American Machine & Foundry Co., Government Products Group
Anchor Metal Spinning Co., The
Applied Design Co.
Barry Controls Inc.
Basic Tool Industries, Inc.
E. W. Bliss Co.
Bruce Engrg. Co.
Bushings, Inc.
Capital City Mfg. Co.
Champion Co., The
Clark-Aiken Co., The
Colonial Aircraft Corp.
Colonial Rubber Co.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dow-Elco, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
B. F. Goodrich Industriol Products Co.
Houston Fearless Corp.
J. W. Johnson & Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kanarr Corp.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Ladish Co.
***LAVELLE AIRCRAFT CORP.**
Lord Mfg. Co.
MB Mfg. Co.
Mercury Tool & Mfg. Corp.
Oliver Corp., The
Pacific Scientific Co.
Piasecki Aircraft Corp.
Red Lion Cabinet Co., Redco Tool Div.
A. O. Smith Corp.
Solar Aircraft Co.
Southwest Products Co.
Stainless Inc.
Twin Coach Co., Aircraft-Missiles
Washington Aluminum Co., Inc.
Western Arc Welding, Inc.

MOUNTS, SHOCK

American Aeroparts
American Latex Products Corp.
Anchor Metal Spinning Co., The
Applied Design Co.
Barry Controls Inc.
Bushings, Inc.
Champion Co., The
Colonial Rubber Co.
Dayton Rubber Co., The
Dow-Elco, Inc.
Federal Shock Mount Corp.-Div. The Korfund Co., Inc.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
B. F. Goodrich Industrial Products Co.
Hamilton Kent Mfg. Co.
Johns-Manville
J. W. Johnson & Co., Inc.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Lord Mfg. Co.
MB Mfg. Co.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Orchard Industries, Inc., Actionflex Div.
Pacific Scientific Co.
Roberts Toledo Rubber Co., The
Robinson Technical Products, Inc.
Rubbercraft Corp. of California
Southwest Products Co.
A. T. Stevens Co.
United States Rubber Co.
Winder Aircraft Corp. of Florida

MOUNTS, THERMISTOR

Advanced Electronics, Inc.
Aerodex, Inc.
Colonial Rubber Co.
J. W. Johnson & Co., Inc.
Dmega Labs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Telerad Mfg. Corp.
Wilks Precision Instrument Co., Inc.
Yellow Springs Instrument Co., The

MUFFLER ASSEMBLIES, HEATER

See HEATER MUFFLER ASSEMBLIES

MUFFLERS, JET ENGINE INTAKE & EXHAUST

Allied Witan Co., Inc.
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Emhart Mfg. Co., Maxim Div.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
Industrial Acoustics Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Mercury Tool & Mfg. Corp.
Portland Copper & Tank Works Inc.
Edw. Renneburg & Sons Co.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Rohr Aircraft Corp.
Smith-Morris Corp.
Stainless Steel Products, Inc.
Vard Inc.

MUFFS

Allied Witan Co. Inc.
Colonial Aircraft Corp.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Piasecki Aircraft Corp.
Ryan Aeronautical Co.
Thiokol Chemical Corp.

MULTIPLEX SYSTEMS

***ARNOUX CORP.**
Barker Sales Co.
Bell & Gossett Co.
Budelman Electronics Corp.
Centronix Inc.
Collins Radio Co.
Cubic Corp.
Data-Control Systems, Inc.
Electro Tec Corp.
Electronic Communications, Inc.
General Devices, Inc.
General Electric Co., Computer Dept.
Hallicrafters
ITT Federal Div., International Telephone & Telegraph Corp.

Instrument Development Labs., Inc.
Moore Associates, Inc.
Motorola Inc., Military Electronics Div.
***PACKARD-BELL ELECTRONICS CORP.**
Philco Corp., Government & Industrial Div.
Radiation, Inc.
Railway Communications Inc.
Raytheon Mfg. Co.
Raytheon Mfg. Co., Government Equipment Div.
Rixan Electronics Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
Telechrome Mfg. Corp.
Tele-Dynamics Inc.
Transco Products, Inc.

ULTIPLIERS
a. Crystal
b. Diode
c. Electronic
d. Frequency
e. Magnetic
f. Meter
g. Servo

Aircom Inc., a.
Amelco Inc., d.
Ameroc Inc., d.
American Electronics, Inc., d.
American Research & Mfg. Corp., c, d, e.
Atlas Precision Products Co., g.
Avo Ltd., f.
Beckman Instruments, Inc., Berkeley Div., c, g.
Bergen Labs., Inc.
Centronix Inc., c.
Chadwick-Helmuth Co., c.
Clary Dynamics, c.
Coils-Electronics, g.
Dalmotor Div., Yuba Consolidated Industries, Inc., g.
Daven Co., The, f.
Doystrom Pacific Div.-Daystrom, Inc., g.
Demornay-Bonardi, d.
Device Development Corp., c, e.
Di-An Controls, Inc., c.
Donner Scientific Co., c, g.
Douglas Microwave Co., Inc., a, d.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., g.
Electro Precision Corp., g.
Electronic Applications, Inc., d.
Electronic-Tech Equipment Co., f.
Feedback Controls, Inc., g.
General Electric Co., Computer Dept.
General Magnetics, Inc., e.
Good Electronic Corp., c, d.
Pyrex Corp., The, d.
Hamilton Standard, Div.-United Aircraft Corp.
Hoover Electric Co., g.
Walter J. Hyott Co., The, g.
I-L-S Instrument Div., The Meriom Instrument Co., d.
Industrial Test Equipment Co., c.
Instruments for Industry, Inc., c, d.
***KEARFOTT CO., INC., g.**
K E L, Inc., c, d.
Land-Air Inc.,g.
Magnetic Instrument Co., Inc., g.
Manson Labs., Inc., d.
Microwave Associates, Inc., a, b, c.
Minneapolis-Honeywell Regulator Co., Industriol Product Group, g.
Monogram Precision Industries, d.
Moran Instrument Corp., g.
Motorola Inc., Military Electronics Div., a thru d.
Newton Co., The, c.
Ernest Norrmon Laboratories, c.
George A. Philbrick Reseorches, Inc., c.
Philco Corp., Government & Industriol Div.
Physics Reseorch Laboratories, Inc., f.
Precision Resistor Co. Inc., f.
Rodor Design Corp., d.
Reeves Instrument Corp., b, c, g.
Resdel Engrg. Corp., a, d.
Rhallcross Mfg. Co., f.
Simpson Electric Co., f.
Specialty Engrg. & Electronics Co., b, c.
Sperry Electronic Tube Div., Sperry Rand Corp., d.
Tapco Group, Thompson-Ramo-Woodridge Inc.
Technicol Apparatus Builders, d, e, f.
Telechrome Mfg. Corp., c, d.
Telerad Mfg. Corp., d.
Teston Hydraulics Ltd.-Sub., Borg-Worner Corp., g.
Teston Instruments, Div.-Doystrom, Inc., f.

M.-TIVIBRATORS, VIBRATORS
See VIBRATORS, MULTIVIBRATORS,

NALS, SPECIAL

Aluminum Co. of Americo
Anti-Corrosive Metal Products Co., Inc.
Copewell Mfg. Co.
Chase Brass & Copper Co., Inc.
Corbin Products Div.
John Hossoll, Inc.
Illumitronic Engrg. Co.
Republic Steel Corp.
Star Stainless Screw Co.

NAMEPLATES

Cromark Co., The
Dept Industries Inc.
Projet-General Corp.
Rl Specs Corp.

Allied Plastics Supply Corp.
Alpitec, Inc.
American Aeroparts
Bendix Aviation Corp., York Div.
W. H. Brady Co.
Burton-Rodgers, Inc.
Cleveland Metal Specialties Co., Electronics Div.
Conn-Craft Co.
Craname Inc.
Crystal-X Corp.
Henry G. Dietz Co., Inc.
Duralith Corp.
Electric Auto-Lite Co., The
Electrical Insulation Co., Inc.
Eljay Corp.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Emmco Plastic Fabricators – Div.-E. M. McCarthy Machine Co.
Erie Resistor Corp.
Fisher & Crome
Industrial Engravers, Inc.
Jodee Plastics Co.
Keil Engrg. Products
Kerrco Products
Thomas J. Lang, Inc.
Maryland Etching Co. Inc.
Jas. H. Matthews & Co.
Metalphoto Corp.
Mica Insulatar Div.-Minnesota Mining & Mfg. Co.
Mico Instrument Co.
Miller Dial & Nameplate Co.
Minnesota Mining & Mfg. Co.
New England Etching & Plating Co., Inc.
Panel Engrg. Corp.
Park Nameplate Co., Inc.
Pee Cee Tape & Label Co.
Penn Fibre & Specialty Co., Inc.
Q-Circuits, Div.-Etching Co. of Calif.
Roovers-Lotsch Corp.
Milton Ross Metals Co., The
D. A. Schultz Co.
Scioto Sign Co.
Specialty Engrg. & Electronics Co.
Topflight Corp.
United States Radium Corp.
Virginio Plak Co.
Waldom Electronics Inc.
Westloke Plastics Co.
Wilks Precision Instrument Co., Inc.

NAVIGATION CALLING SYSTEMS, SELECTIVE
See CALLING SYSTEMS, SELECTIVE, NAVIGATION

NAVIGATION DOMES

American Aeroparts
American Opticol Co., Instrument Div.
Corning Glass Works
Fletcher Mfg. Co., Inc., The
Hughes Tool Co., Aircraft Div.
Hull Corp.
Kaiser Aircroft & Electronics, Div.-Koiser Industries Corp.
Monogrom Precision Industries
Nationol Pneumatic Co., Inc., Holtzer-Cobot Divs.
Plastic Age Soles, Inc.
Reinhold Engrg. & Plostics Co.
Silicone Insulotion, Inc.
Swedlow Inc.

NAVIGATION EQUIPMENT, GROUND

ACF Industries Inc.
American Missile Products Co., Inc.
Armo Div., Americon Bosch Armo Corp.
Atlos Precision Products, Co.
Bell Aircroft Corp., Niogaro Frontier Div.
Bendix Aviation Corp., York Div.
Communicotions Reseorch Co.
Craig Systems, Inc.
Dota-Control Systems, Inc.
Doyton Aviotion Rodio & Equipment Corp.
Foirchild Astrionics Div., Fairchild Engine & Airplone Corp.
Gilfillan Bros. Inc.
Hazeltine Electronics Div.-Hozeltine Corp.
***KEARFOTT CO., INC.**
Litton Industries, Moryland Div.
W. L. Maxson Corp., The
Motorolo Inc., Military Electronics Div.
Philco Corp., Government & Industriol Div.
Raytheon Mfg. Co., Government Equipment Div.
Seiscor Mfg. Co.
Specialty Engrg. & Electronics Co.
Stromberg-Carlson Div.-General Dynamics Corp.
Thiokol Chemical Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Winder Aircraft Corp. of Florida

NAVIGATION SYSTEMS
***AC ELECTRONICS DIV., GENERAL MOTORS INC.**
ACF Industries Inc.
American Bosch Arma Corp.
Atlos Precision Products Co.
Baird-Atomic, Inc.
Bell Aircraft Corp., Niagoro Frontier Div.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix Radio Div., Bendix Aviatian Corp.
Bendix-Pocific Div., Bendix Aviotion Corp.
Centronix Inc.
Collins Radio Co.
Communications Research Co.
Dayton Aviation Radio & Equipment Corp.
Electronic Communications, Inc.
Emersan Electric Mfg. Co., The, Electranics & Avianics Div.
Emersan Radio & Phanagraph Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Feedback Controls, Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Missile & Space Vehicle Dept.
General Precisian Lab. Inc.
Gilfillan Bros. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Hoffman Labs. Div., Hoffman Electranics Carp.
Hughes Aircraft Co.
Hydra-Power Carp.
International Business Machines Corp.-Military Products Div.
***KEARFOTT CO., INC.**
Land-Air Inc.
Lane Electronics Mfg. Carp.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Librascope Inc.
Littan Industries, Inc.
Litton Industries, Marylond Div.
W. L. Maxson Corp., The
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Motarola Inc., Military Electronics Div.
Northrap Corp.
Narthrap Corp., The, Nartronics Div.
Philca Carp., Gavernment & Industriol Div.
Power-Tronic Systems Inc.
Radiation, Inc.
Ramo-Wooldridge Div., Thampsan Rama Wooldridge of Colif.
Raytheon Mfg. Co., Government Equipment Div.
Ryan Aeronautical Co.
Seiscor Mfg. Co.
Servo Corp. of America
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rond Corp.
Sperry Piedmont Co.-Div.-Sperry Rond Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Summers Gyroscope Co.
Thiokol Chemicol Corp.
U. S. Industries, Inc.
Winder Aircraft Corp. of Florido

NEEDLES, DIAMOND

United Minerol & Chemicol Corp.

NEEDLES, METAL

Audio Devices, Inc.
Copital City Mfg. Co.
Electronic Parts Mfg. Co., Inc.
Monogram Precision Industries
Sphinx-Americon Co.
Torrington Co., The

NEEDLES, STEEL

Audio Devices, Inc.
Duotone Co., Inc.
Koydon Engrg. Corp., The
Sphinx-Americon Co.
Torrington Co., The

NETWORKS
a. Crassover
b. Directional Antenna Phasing
c. Matching
d. Potted
e. Pulse Farming

AMP Inc., e.
Airtron Inc., Div.-Litton Industries, b.
Airtronics Internotionol Corp., e.
Alford Mfg. Co., c.
Atlas Precision Products, Co., e.
Audio Development Co., a, c, d.
Axel Electronics, e.
Barker Sales Co., a.
Blonder-Tonque Labs., Inc., a, e.
CELCO (Constontine Engrg. Labs. Co.), a thru e.
Cornell-Dubilier Electric Corp., e.
Corson Electric Mfg. Corp., e.
Dole Products, Inc., d.
Daven Co., The, c, d.
Double E Products Co., a thru e.
Dresser Industries, Inc., d, e.
Electronic Applications, Inc., a.
Entron, Inc., c.
FXR, Inc., e.
Filtron Co., Inc., d, e.
Forbes & Wagner, Inc., e.
General Electric Co., Apporotus Sales Div., e.
Gudeman Co. of Californio, Inc., The, Monrovia Div., e.
Walter J. Hyott Co., The, a thru e.
Instruments for Industry, Inc., a, c.
JFD Electronics Corp., e.
Jensen Mfg. Co., a, c.
E. F. Johnson Co., c.
***KEARFOTT CO., INC., a, b, c.**
Mepco, Inc., c. d.
Minneapoljs-Honeywell Regulator Co.-Dovies Labs. Div., e.
Motorola Inc., Military Electronics Div., d.
NYT Electronics, Inc., a, i, e.

National Pneumotic Co., Holtzer-Cobot Divs., b, c, d.
Networks Electronic Corp., c, d.
Rolph M. Parsons Co., The, Electronics Div., e.
Perry Plastics, Inc., a.
Power-Tronic Systems Inc., a, c, d.
Milton Ross Metals Co., The, d.
Shallcross Mfg. Co., d.
Stromberg-Carlson Div.-General Dynamics Corp., a.
Technicol Apparatus Builders, a.
Telechrome Mfg. Corp., d, e.
Telectro Industries Corp., a, b, c.
Tobe Deutschmann Corp., e.
Transco Products, Inc., c.
Trionics Corp., d.
University Loudspeakers, Inc., a.
Vanguard Electronics Co., d, e.
Webcor, Inc., Government Div., d, e.

NITROGEN GASES
See GASES, NITROGEN

NITROGEN, LIQUID
See LIQUID NITROGEN

NOISE SUPPRESSORS
See SUPPRESSORS, NOISE

NON-FLEXIBLE DUCTS
See DUCTS, NON-FLEXIBLE

NON-METALLIC BUSHINGS
See BUSHINGS, NON-METALLIC

NON-METALLIC EXTRUSIONS
See EXTRUSIONS, NON-METALLIC

NON-METALLIC FITTINGS
See FITTINGS, NON-METALLIC

NON-METALLIC GASKETS
See GASKETS, NON-METALLIC

NON-METALLIC MOUNTINGS
See MOUNTINGS, NON-METALLIC

NON-METALLIC SLEEVES
See SLEEVES, NON-METALLIC

NOZZLE ASSEMBLIES

ACF Industries Inc.
Aerolab Development Co.
American Bosch Arma Corp.
American Car & Foundry, Div.-ACF Industries, Inc.
American Machine & Foundry Co., Government Products Group
Astrodyne, Inc.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Auto Specialties Mfg. Co., Inc.
B. H. Aircraft Co., Inc.
***BEATON & CORBIN MFG. CO., THE**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Buckeye Iron & Brass Works
California Aircraft Products
***CAMERON IRON WORKS, INC.**
Carmac Aviation
Christie Machine Works
Cleveland Pneumatic Industries, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Crystal-X Corp.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Electro-Mechanical Products Co.
Engineered Products Co., The
Federal Machine Co. Inc.
Fletcher Mfg. Co., Inc., The
Giannini Plasmadyne Corp.
Haveg Industries, Inc.
Herlo Engrg. Corp.
Houston Fearless Corp.
Hufford Corp., The
Hupp Aviation Co.
Hydrodyne Corp., Skinner Seal Div.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Intercontinental Mfg. Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
M. W. Kellogg Co., The
Kolcast Industries-Div. Thompsoa-Rama-Wooldridge Inc.
Marman Div., Aeroquip Corp.
Marquardt Aircraft Co.
Mercury Tool & Mfg. Corp.
National Beryllia Corp.
Newbrook Machine Corp.
Norris-Thermador Corp.
Norton Co., New Products Dept.
Parker-Hartford Corp., The
Parts Engrg. Co., Inc.
Plastic Age Sales, Inc.
Portland Copper & Tank Works Inc.
Precision Sheet Metal, Inc.
Red Lion Cabinet Co., Redco Tool Div.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Rohr Aircraft Corp.
Royal Industries, Inc.
Ryan Aeronautical Co.
Smith-Marris Corp.
Solor Aircroft Co.
Stainless Steel Products, Inc.
Stalker Corp., The
Tapco Group, Thompson-Romo-Wooldridge Inc.
H. I. Thompson Fiber Gloss Co.
Turbo Products, Inc.
Twigg Industries
Vard Inc.
Waste King Corp., Technicol Products Div.
Western Gear Corp.
Young Development Div., Hercules Powder Co.

NOZZLE DIAPHRAGMS

ACF Industries Inc.
Aerolab Development Co.
American Machine & Foundry Co., Government Products Group
Astrodyne, Inc.
Cleveland Pneumatic Industries, Inc.
Cooper Development Corp., Sub.-Morquordt Aircroft Co.
Curtiss-Wright Corp.-Wright Aeronouticol Div.
Diversey Engrg. Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Fletcher Mfg. Co., Inc., The
Haveg Industries, Inc.
Herlo Engrg. Corp.
Houston Fearless Corp.
Hupp Aviotion Co.
Joclin Mfg. Co.
Kaiser Aircraft & Electronics, Div.-Koiser Industries Corp.
Kolcost Industries-Div. Thompson Ramo Wooldridge Inc.
Notional Beryllio Corp.
Ports Engrg. Co., Inc.
Portland Copper & Tonk Works Inc.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Ryon Aeronouticol Co.
Solor Aircroft Co.
Stalker Corp., The
Tapco Group, Thompson-Romo-Wooldridge Inc.
H. I. Thompson Fiber Glass Co.
Turbo Products, Inc.
Twigg Industries
United Stotes Rubber Co.
Vard Inc.

NOZZLES
a. Exhaust
b. Exhaust, Metallic
c. Fuel Injection
d. Racket, Movable

ACF Industries Inc., c.
Aerojet-General Corp., a.
Aerolab Development Co., a, b.
Aeroscience, Inc.
Aircraft Mechanics, Inc., a, b.
Aircraft Precision Products, Inc., a, b.
Alco Products, Inc., b.
American Bosch Arma Corp., c.
American Car & Foundry, Div.-ACF Industries, Inc., a.
American Machine & Foundry Co., Government Products Group, a, b.
Anchor Metal Spinning Co., The, a, b.
Arde-Portland, Inc., a, b.
Associated Engineers, Inc., c.
Astrodyne, Inc., a, b.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., c.
Auto Specialties Mfg. Co., Inc., a.
B. H. Aircraft Co., Inc., a, b, c.
Baldwin Mfg. Co., Inc., The, c.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., d.**
Benson Mfg., Co., The, a.
California Aircraft Products, a, c.
***CAMERON IRON WORKS, INC., a, b.**
Carbone Corp., The, a.
Corborundum Co., Refractories Div., a.
Carmac Aviation
Celco (Constantine Engrg. Labs. Co.), a.
Christie Machine Works, a.
Cleveland Pneumatic Industries, Inc., a, b, c.
Com-Air Products, Div.-A S R Products Corp., c.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., a, b, c.
Curtiss-Wright Corp.-South Bend Div., c.
Curtiss-Wright Corp.-Wright Aeronautical Div., a, b, c.
Diversey Engrg. Co., a, b.
Dresser Industries, Inc., a, b.
Dresser Mfg. Div., Dresser Industries, Inc., a, b.
Eddington Metal Specialty Co., c.
Electro-Mechanical Products Co., c.
Emerson Plastics Corp., a.
Engineered Products Co., The, c.
Federal Machine Co. Inc., a.
Finn Aeronautical Div., T. R. Finn & Co., Inc., a, b.
Fletcher Mfg. Co., Inc., The, a, b, c.
***FLEXONICS CORP., AERONAUTICAL DIV., a.**
Gladding, McBean & Co., a.
Haveg Industries, Inc., a.
Herlo Engrg. Corp.
Hicks Corp., The, b.
Highland Rim Mochine Works Inc., c.
Houston Feorless Corp., c.
Hufford Corp., The, a.
Hupp Aviation Co., a, c.
Hydrodyne Corp., Skinner Seal Div., a, b.
Ingersoll Kolomazoo Div., Borg-Warner Corp., a, b.
Intercontinental Mfg. Co., Inc., a.
Joclin Mfg. Co., a.
Koiser Aircraft & Electronics, Div.-Kaiser Industries Corp., a, b.
Kaiser Metal Products, Inc.-Fleetwings Div., a.
Konarr Corp., a, b.
M. W. Kellogg Co., The, a, b, c.
Kelsey-Hayes Co., a, b.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc., a, b, c.
Kordo Industries, c.
Lodish Co., a, b.
Lomtex Industries, Inc., a.
***LAVELLE AIRCRAFT CORP., b.**
Morquardt Aircroft Co., a, b.
Mercury Tool & Mfg. Corp., a.
Metal Fabricators Corp., a, c.
Minnesoto Mining & Mfg. Co., a.
Morganite, Inc., a.
National Airoil Burner Co., c.
Notionol Beryllio Corp., a, c.
Newbrook Mochine Corp., a, b, c.
Norris-Thermodor Corp., a, b.
Norton Co., a.
Norton Co., New Products Dept., a, b.
Oerlikon Tool & Arms Corp. of Americo, a.
Ohio Carbon Co., The, a.
Porker Aircroft Co., c.
Porker-Hortford Corp., The, a, b, c.
Parts Engrg. Co., Inc., a, b, c.
Plastic Age Soles, Inc., a.
Portlond Copper & Tonk Works Inc.
Pressed Steel Tonk Co., a, b.
Reaction Motors Div., Thiokol Chem. Corp., a, b, c.
Red Lion Cabinet Co., Redco Tool Div.
Reinhold Engrg. & Plastics Co., a.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV., a, b.**
C. F. Roark Welding & Engrg. Co., Inc., a, b.
Rocketdyne Div.-North American Aviotion, Inc., c.
Rohr Aircraft Corp., a, b.
Ronson Hydraulic Units Corp., c.
Royal Industries, Inc., a.
Ryon Aeronoutical Co., a, b.
Silicone Insulation, Inc., a.
Smith-Morris Corp., a, b, c.
Solor Aircraft Co., a.
Special Projects Lob., Food Machinery & Chemical Corp., a, c.
Sproying Systems Co.
Squiers Gage Co., a, b, c.
Stainless Inc., a, b.
Stainless Steel Products, Inc., a, b.
Stalker Corp., The, a.
Swedlow Inc., a.
Tapco Group, Thompson-Ramo-Wooldridge Inc., a, b, c.
Teiner Engrg. Corp., a.
Thermal Refractories Corp., a.
H. I. Thompson Fiber Glass Co.
C. W. Torngren Co., Inc., a.
Tube-Turns Div., Chemetron Corp., b.
Turbo Products, Inc., a, b.
Twigg Industries, a, b, c.
United Aircraft Products, Inc., c.
Universal Moulded Products Corp., a.
Vard Inc., a, b, c.
Veet Industries, c.
Waste King Corp., Technical Products Div., a, b.
Westinghouse Electric Corp., Metals Plant, b.
Wheland Co., The, a.
Young Development Div., Hercules Powder Co., a.

NUCLEAR
a. Analyzers, Caincidence
b. Analyzers, Neutron Absorptian
c. Analyzers, Spectrum
d. Assemblies, Shield
e. Badges, Radiation
f. Controls, Reactar
g. Counters
h. Crystals
i. Detectars
j. Indicatars, Radiatian
k. Manipulatars
l. Meters, Counting Rate
m. Meters, Dasimeter
n. Meters, Nuclear Radiation
a. Processars, Cotaclystic Flaw Rate
p. Shielding, Radiatian
q. Tubes, Scintillatian
r. Tubes, Geiger Counter

ACF Industries Inc., d, p.
Adept Industries Inc., e.
Aerojet-General Corp., f.
Aerotec Corp., The, f.
Alpitec, Inc., p.
American Electronics, Inc., American Nuclear Div., c, d, e, g thru j, l, n, p, q, r.
Americon Lava Corp., b.
American Machine & Foundry Co., Government Products Group, f, k.
American Smelting & Refining Co., p.
Anton Electronic Labs., Inc., b, g, i, j, l, m, n, r.

Assembly Products, Inc., l, m.
Baird-Atomic, Inc., a, c, d, f thru j, l, m, n, p, q.
Bar-Ray Products, Inc., d, p.
*BAUSCH & LOMB OPTICAL CO., i, j, m, n.
Beaver Precision Products Inc., f.
Bell & Howell Co., m.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., f.
Bevo Lab., Inc., a, b, c.
Bios Labs., h.
E. W. Bliss Co., k.
Brooks & Perkins, Inc., d, p.
Central Electronic Mfrs., Div.-Nuclear Corp. of America, q.
Corning Glass Works, d, e, i, p.
Curtiss-Wright Corp., Electronics Div., f, i, j.
Curtiss-Wright Corp., Research Div., f, g.
Diversey Engrg. Co., d, f, k.
Division Lead Co., p.
Eastman Kodak Co., e.
Edgerton, Germeshousen & Grier, Inc., f, i, j, m, n.
Eldorado Electronics, a, c, g, n.
Emerson & Cuming, Inc., p.
Ero Engrg. Inc., i, j, l, n.
FXR, Inc., c, m.
Fisher Research Lab., Inc., i, j.
Flow Corp., h.
Ford Instrument Co., Div.-Sperry Rond Corp., f.
Genolex Div.-British Industries Corp., q, r.
General Electric Co., X-Ray Dept., c.
Hodding, McBeon & Co., p.
Greer Hydraulics, Inc., k.
Hollett Mfg., Co., p.
Horkey-Moore Associates, k.
I.L-S Instrument Div., The Meriam Instrument Co., l.
ITT Labs.- Ft. Wayne, i.
Johns-Manville Sales Corp., p.
Jordon Electronics, Div.-Victoreen Instrument Co., i, j, n.
Keithley Instruments, Inc., f.
Kond-Air Inc., i, j.
Lo Roe Instruments, Inc., g.
Leeds & Northrup Co., f.
Levinthal Electronic Products, Inc., h.
Lithium Corp. of America, Inc., p.
Marquardt Aircraft Co., f.
Menlo Research Lab., g, i, j, n.
Minneapolis-Honeywell Regulator Co., Dovies Labs. Div., f, l.
Minneapolis-Honeywell Regulator Co., Industrial Div., f.
Minneapolis-Honeywell Regulator Co., Industriol Product Group, f, n.
National Beryllio Corp., d.
National Lead Co., d.
National Spectrographic Labs., Inc., c, n.
Norton Co., New Products Dept., p.
Nucleor Corp. of America, c, d, g, i, j, l, m, n.
Nuclear Products-Erco Div.-ACF Industries, Inc., f.
Nucleor-Chicago Corp., d, e, g thru j, l, m, n, p, q, r.
Orbit Instrument Corp., f.
Pacific Coast Engrg. Co., d, p.
Patterson, Moss Div. - Universal Winding Co., Inc., g, i, j, m.
Piosecki Aircraft Corp., i, l, m, n.
Pilot Chemicals, Inc., h.
Portland Copper & Tonk Works Inc., d.
Precision Methods & Machines Div.- Textron Inc., f.
R & R Engrg. Co., d, p.
Radiation Instrument Development Lab., Inc., a, c, f thru j, l, m, p, q, r.
Raytheon Mfg. Co., c, r.
Ryan Aeronautical Co., d.
St. John X-Ray Lab., e.
Sc. Regis Paper Co., Panelyte Div., p.
Smith-Morris Corp., a.
Specialty Engrg. & Electronics Co., i, j.
Spectrum Instruments, Inc., c.
Stanley Aviotion Corp., f, g, i, j.
Sraver Co., Inc., The, p.
Sterns-Roger Mfg. Co.
Strand Engrg. Co., i.
Stromberg-Carlson Div.-General Dynamics Corp., f.
Systems Inc., n.
Tastron Corp., g.
Topco Group, Thompson-Ramo-Wooldridge Inc., d, f, k.
Teleflex Inc., f.
Twenty-First Century Electronics, Inc., i, j.
U. S. Industries, Inc., k.
Ward Inc., f.
Westronics Inc., f, j.
Wm. Wood Counter Lab., g, i, q, r.
Zippertubing Co., The, d, p.

NUCLEAR PRODUCTS
a. Analyzers, Coincidence
b. Analyzers, Neutron Absorption
c. Analyzers, Spectrum
d. Assemblies, Shield
e. Badges, Radiation
f. Chambers, Alpha
g. Counters, Alpha
h. Counters, Radiation
i. Counters, Scintillation
j. Crystal, Scintillation
k. Detectors, Scintillation
l. Equipment, Nuclear Radiation
m. Indicators, Radiation
n. Spectrometers
o. Tubes, Gamma Ray
p. Tubes, Geiger Counter
q. Tubes, Scintillation

ACF Industries Inc.
Adept Industries Inc., e.
Aerotec Corp., The, l.
Alpitec, Inc., d.
Americon Electronics, Inc., e, h, i.
Americon Electronics, Inc., Americon Nuclear Div., c, d, e, h thru q.
Americon Lovo Corp., b.
Anton Electronic Labs., Inc., f, g, h, l, m, o, p.
Applied Radiation Corp., l.
Baird-Atomic, Inc., a thru d, f thru k, m thru q.
*BAUSCH & LOMB OPTICAL CO., e, m, n.
Bevo Lob., Inc., a, b, c, l.
James G. Biddle Co., n.
Bios Labs., Inc., j.
Brooks & Perkins, Inc., d.
Combridge Filter Corp., l.
Central Electronic Mfrs., Div.-Nucleor Corp. of America, q.
Consolidated Electrodynomics Corp., c, n.
Corning Glass Works, e.
Curtiss-Wright Corp., Electronics Div., m.
Eastman Kodak Co., e.
Edgerton, Germeshausen & Grier, Inc., l, m.
Eldorodo Electronics, a, c, h, l, m.
Engrg. Associotes, g.
FXR, Inc., c.
Fisher Reseorch Lob., Inc., h, j.
Ford Instrument Co., Div.-Sperry Rond Corp.
Genolex Div.-British Industries Corp., a, p, q.
General Electric Co., X-Roy Dept., c, n, o.
Gloss Engrg. Div. Broun-Knecht-Heimonn-Co., p.
Hollett Mfg., Co., c.
Harvey-Wells Electronics Inc., n.
High Voltoge Engrg. Corp., l.
Horkey-Moore Associotes, l.
Instruments Div.-Philips Electronics, Inc., i, k, p.
International Electronic Research Corp., h, l, m.
Kollmorgen Opticol Corp., l.
Lond-Air Inc., h, l, m.
Lo Roe Instruments, Inc., h.
Levinthol Electronic Products, Inc., j.
Magnetic Instrument Co. Inc., i, k.
Menlo Reseorch Lob., h, i, k.
Minneopolis-Honeywell Regulator Co., Industrial Product Group, a, l.
Notionol Lead Co., d.
Notionol Spectrographic Labs., Inc., c, n.
Norton Co., New Products Dept., d.
Nuclear Corp. of Americo, c, f thru n.
Nuclear-Chicago Corp., c thru q.
Pocific Coost Engrg. Co., d.
Potterson, Moss Div. - Universol Winding Co., Inc., l.
Piosecki Aircroft Corp., h, i.
Picker X-Ray Corp., e.
Pilot Chemicols, Inc., i, j, k.
Portlond Copper & Tonk Works Inc., f.
R & R Engrg. Co., d.
Rodiotion Instrument Development Lob., Inc., a, c, g thru q.
Roytheon Mfg. Co., c, p.
Riggs Nucleonics Corp., h, l, m.
Ryan Aeronoutical Co., d.
St. John X-Roy Lob., e.
Scientific Engrg. Lobs., Inc., l.
Smith-Morris Corp., c, d.
Speciolty Engrg. & Electronics Co., l, m.
Spectrum Instruments, Inc., c.
Stonley Aviotion Corp., h, i, k, m.
Topco Group, Thompson-Romo-Wooldridge Inc., d, l.
Twenty-First Century Electronics, Inc., l.
U. S. Industries, Inc.
Varian Associates, n.
N. Wood Counter Lab., g, h, i, k, o, p.

NUCLEAR RADIATION EQUIPMENT
See RADIATION EQUIPMENT, NUCLEAR

NUCLEAR SEALERS
See SEALERS, NUCLEAR

NUTS, SELF-LOCKING

Abbott Screw & Mfg. Co.
Aero Bolt & Screw Co., Inc.
All Specs Corp.
Allmetal Screw Products Co., Inc
Anti-Corrosive Metal Products Co., Inc.
Atlas Screw & Specialty Co.
Barrett-Christie Co.
Best Aircraft Corp.
Boots Aircraft Nut Corp.
Century Fasteners Corp.
Columbia Nut & Bolt Co., Inc.
Cooper Industries, Inc.
Corbin Products Div.
Curtiss-Wright Corp., Research Div.
R. C. Dudek & Co.
Eaton Mfg. Co., Reliance Div.
Elastic Stop Nut Corp. of America
Grip Nut Co.
Hi-Shear Rivet Tool Co.
Jacobson Nut Mfg. Corp.
Kaynar Mfg. Co., Inc.
Klincher Locknut Corp.
Lamson & Sessions Co., The
Lucas Aircraft Supply Co.
J. I. Morris Co.
National Screw & Mfg. Co., The
Republic Steel Corp.
Servwell Products Co.
Shur-Lok Corp.
Standard Locknut & Lockwasher Inc.
Standard Pressed Steel Co.
Star Stainless Screw Co.
Tinnerman Products, Inc.
*TOWNSEND CO., CHERRY RIVET DIV.
United Supply Co.
Walthom Precision Instrument Co.

OIL COOLERS
See COOLERS, OIL

OIL SEPARATORS
See SEPARATORS, OIL

OIL-COOLING ENGINES
See ENGINES, OIL-COOLING

OMNIRANGE

Allied Internotional Co.
Atlos Precision Products, Co.
Bendix Rodio Div., Bendix Aviotion Corp.
Collins Rodio Co.
Doyton Aviation Rodio & Equipment Corp.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Labs.
Jonsky & Boiley, Inc.
Litton Industries, Inc.
Litton Industries, Morylond Div.
Motorolo Inc., Military Electronics Div.
Philco Corp., Government & Industriol Div.
Servo Corp. of America
Systems Inc.
Telectro Industries Corp.
Theto Instrument Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.

OMNIRANGE RECEIVERS

Allied Internotional Co.
Bendix Rodio Div., Bendix Aviotion Corp.
Collins Rodio Co.
Doyton Aviotion Rodio & Equipment Corp.
Electronic Communicotions, Inc.
Hoffmon Lobs. Div., Hoffmon Electronics Corp.
ITT Lobs.
Leor, Inc.
Leor, Inc., Grond Ropids Div.
Litton Industries, Morylond Div.
Livingston Electronic Corp.
Motorolo Inc., Military Electronics Div.
Philco Corp., Government & Industriol Div.
Telectro Industries Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.

OPERATOR, VALVE
See VALVE OPERATOR

OPTICAL EQUIPMENT & SPECIALTIES

American Cystoscope Makers, Inc.
Americon Machine & Foundry Co., Government Products Group
Americon Opticol Co., Instrument Div.
Andersen Labs.
Atlontic Reseorch Corp.
Boird-Atomic, Inc.
Bell & Howell Co.
Boonton Rodio Corp.
Buhl Optical Co.
Burke & Jomes Inc.
Comeroflex Corp.
Chrysler Corp., Defense Operations Div.
Consolidated Electrodynomics Corp.
Covel Mfg. Co.
Davidson Mfg. Co., Inc.
Eastman Kodak Co.
Edmund Scientific Corp.
*ELECTROSNAP CORP.
Elgeet Optical Co., Inc.
*ENGIS EQUIPMENT CO.
J. W. Fecker, Inc.
Gaertner Scientific Corp., The
General Scientific Equipment Co.
Gordon Enterprises
Graflex Inc.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co.
Hayward Scientific Glass Corp.
ITT Labs.
Kern Instruments, Inc.
Kinney Mfg. Div., The New York Air Brake Co.
Kollmorgen Optical Corp.
Land-Air Inc.
Landsverk Electrometer Co., The
Lenox Instrument Co.
Librascope Inc.
Mast Development Co., Inc.
National Spectrographic Labs., Inc.
Northrop Corp., The, Nortronics Div.
Optical Coating Lab., Inc.
Pocific Universal Products Corp.
Perkin-Elmer Corp.
Philco Corp., Government & Industrial Div.
Process & Instruments
Republic Lens Co. Inc.
Seiscor Mfg. Co.
Sterling Glass Corp.
Telectro Industries Corp.
Tinsley Lobs., Inc.
Traid Corp.
Valpey Crystal Corp.
Van Keuren Co.
Zenith Optical Laboratory
Zoomar Inc.

OPTICAL MICROSCOPES
See MICROSCOPES, OPTICAL

OPTICAL PYROMETERS
See PYROMETERS, OPTICAL

OSCILLATORS
- a. Audia
- b. Audia Fork Contralled
- c. Audia Frequency
- d. Cavity
- e. Code
- f. Crystal
- g. Grid Dip
- h. Grid Dip-High Frequency & VHF
- i. Microwave
- j. Oven Crystal Cantral
- k. Pulse
- l. Pushbuttan
- m. Radia Frequency
- n. RF
- a. Strain-Gage FM, Valtage-Contralled
- p. Sweep
- q. Tuning Fark
- r. Ultra-Law Frequency
- s. Ultrasonic
- t. Video Pattern
- u. Video Range

Accurate Instrument Co., a, b, c, q.
Adler Electronics, Inc., d, i, n, r.
Aerojet-General Corp.
Aerolab Development Co., a.
Aetna Electronics Corp., r, s.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., d, m, n.
Aircom Inc., i, p.
Alfred Electronics, i, p.
Amelco, Inc., c, m, n, q.
Amerac Inc., d, i, k.
American Machine & Foundry Co., Government Products Group, c.
American Machine & Foundry Co., Greenwich, i, k, m, n.
American Missile Products Co., Inc., a.
Amplifier Corp. of America, b, q.
Andersen Labs., a, b, c, f, j, k, l, a, p, r.
Antlab Inc., b.
Applied Radiation Corp., d, i.
Arenberg Ultrasonic Lab., Inc., k, s.
B & K Instruments, Inc., a, c.
Barker Sales Co., f.
Barker & Williamson Inc., a, c, g, h.
Rex Bassett, Inc., g, h, j, m, n.
Bell & Gossett Co., a, b, k, q.
Bendix Aviation Corp., York Div., i, k.
James G. Biddle Co., c.
Blonder-Tongue Labs., Inc., t, u.
Briggs Associates, Inc., a.
Brush Instruments, Div.-Clevite Corp., a.
Bud Radio Inc., e.
Bulova Watch Co., Electronics Div., a, c, f, j, k, m, n, p, r.
CGS Labs., Inc., d, i.
California Technical Industries, Div.-Textron Inc., i.
Carol Electronics Corp., a, c.
Centronix Inc., a, b, m, n, a.
Chalco Engrg. Corp., a, c, a.
Chrysler Corp., Defense Operations Div., d, i.
Coils-Electronics, a.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., n.
Crosby Laboratories, Inc., n.
Curtiss-Wright Corp., Research Div., s.
Data-Control Systems, Inc., a.
Daven Co., The, a, c, l, p, s.
Di-An Controls, Inc., b.
Donner Scientific Co., a, c, r.
Dorsett Labs., Inc.
Doty Acoustica Electronic Labs., a, c.
Douglas Microwave Co., Inc., d, i.
Dresser Industries, Inc., a, c, p, r.
Dymec Inc., a.
Electronic Communications, Inc., i, m, n.
Electronic Engrg. Co. of California, a, f, k.
Electronic Instrument Co., Inc. (EICD), a, c, g, h, l, m, p.
Electronics Div., Von Norman Industries Inc., d, i, m, n.
Electronics International Co., a, c.
Elgin Micronics Div.-Elgin National Watch Co., a, b.
Engrg. Associates, a, c, i, m, n, r.
Ensco, Inc., a.
Entron, Inc., m, n.
FXR, Inc., p.
Federal Mfg. & Engrg. Corp., a, d, i, k, m.
Ferrotran Electronics Co., Inc., f.
Fisher Research Lab., Inc., c, m.
Foto-Video Labs., Inc., t, u.
General Communication Co., i, n.
General Devices, Inc., a, b, k, m, n, a.
General Electric Co., Apparatus Sales Div., m, n, s.
John Gambos Co., Inc., d.
Good Electronic Corp., f, a.
Gyrex Corp., The, b, q.
Hammarlund Mfg., Co., Inc., a, c.
Hewlett-Packard Co., a, c, i, m, n, p, r, s, u.
Hill Electronics, Inc., c, f, j, m, r, s.
ITT Federal Div., International Telephone & Telegraph Corp., g, i, k, m, n.
Industrial Test Equipment Co., a, b, c, l, p, q.
Instrument Labs., a, c.
Instruments For Industry, Inc., j, m, n.
International Electronic Research Corp., a, c.
J-V-M Microwave Co., i, l.
E. F. Johnson Co., f, m, n.
Kauke & Co., a.
Kay Electric Co., a, c, f, i, k, m, n, p, r thru u.
***KEARFOTT CO., INC.**, d, i.
Kin Tel Div.-Cahu Electranics, Inc., s.
Kinevax Div.-Electromatian Ca., k.
Lampkin Labs., Inc., M.R. Div., m.
La Pointe Industries Inc., d, i.
Lavoie Labaratories Inc., j.
Lear, Inc., m, n.
Levinthal Electronic Products, Inc., i, k.
Litton Industries, Maryland Div.
MF Electronics Co., a, c.
Mansan Labs., Inc., f, j, m.
Marconi Instruments, c, j, m, n, p, s.
Massa Div.-Cohu Electronics, Inc., s.
Mc Kenna Labs., s.
Measurements Div., Mc Graw Edison Co., f, g, h.
Microwave Associates, Inc., i.
Midwestern Instruments, Inc., a.
Miratel, Inc., a, k, m, n, u.
Monogram Precision Industries, h, i.
Motorola Inc., Military Electronics Div., a thru n, p, q, s, u.
Narda Ultrasonics Corp., The, s.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., a, c, f, m, n, p.
National Ultrasonic Corp., s.
Networks Electronic Corp., a, c.
Ernest Norman Laboratories, f, j.
Northeast Electronics Corp., a, c, k, r.
Northern Engrg. Laboratories, Inc., f, j.
Paco Electronics Co., Inc., m, n.
Philco Corp., Government & Industrial Div., a, c, i, k, m thru p, u.
Piasecki Aircraft Corp., a, c.
Polarad Electronics Corp., i, k.
Portchester Instrument Corp., d, f, i.
Power-Tronic Systems Inc., a, b, c, j, p, q, r.
Precise Development Corp., a, c, e, g, h, m, n, p, r, s, t.
Precision Apparatus Co., Inc., a, m, n, p.
Radar Design Corp., i, m, n.
Radiaphone Co. Inc.
Radionics, Inc., k, s.
Reeves-Hoffman Div., c, f, j.
Resdel Engrg. Corp., d, f, i.
Rese Engrg., Inc., k.
Riverbank Labs., Dept.-Engrg., b, q.
Rixon Electronics Inc., a, c.
Rollan Electric Co., a.
Scientific-Atlanta, Inc., i.
Southwestern Industrial Electronics Co., a.
Specialty Engrg. & Electronics Co., a, k.
Spectrum Instruments, Inc., a, c, r.
Sperry Electronic Tube Div., Sperry Rand Corp., d, i.
H. W. Sullivan Ltd., a, b, c.
Systron Corp., c.
Tapco Group, Thompson-Ramo-Wooldridge Inc., b, f, q.
Technitrol Engrg. Co., p, u.
Telechrome Mfg. Corp., c, a, t, u.
Telectro Industries Corp., a, c, j thru n.
Tele-Dynamics Inc., a.
Telerad Mfg. Corp., d, i.
Teletronics Lab. Inc., l.
Tel-Instrument Electronics Corp., a, b, c, f, j, l, m, n, p, q, t.
Telonic Industries, Inc., a, c, d, f, k, m, n, p.
Trionics Corp., a, s.
Triplett Electrical Instrument Co., n, p.
United Electrodynamics, Inc., a.
U. S. Science Corp., Div.-Topp Industries, Inc., a, n.
Valpey Crystal Corp., f, j.
Varian Associates, d, i, m, n.
Vari-L Co., Inc., p.
Varo Mfg. Co., Inc., b, c, q.
Victor R. F. & Microwave Co., q.
Walkirt Co., a, b, c, f, j, q.
Waltham Electronics Corp., n, p.
Wang Labs., Inc., k.
Waveline, Inc., i.
Weinschel Engrg., b, d, i, n.
Wilks Precision Instrument Co., Inc., i.

OSCILLOGRAPHS
- a. Cathode Ray
- b. Cathode Ray Camera
- c. Cathode Ray Recording, Multi-Chonnel
- d. Direct Writing
- e. Multi-Channel
- f. Multi-Element
- g. Portable
- h. Projectian
- i. Radar
- j. Recording
- k. Transient Study

Acton Labs. Inc., d, e.
Advanced Electronics Mfg. Corp., a.
Allegany Instrument Co., Inc., a, c, e, k.
Applied Science Corp. of Princeton, j.
Brush Instruments, Div.-Clevite Corp., a thru j.
Centronix Inc., c thru g, j, k.
Century Electronics & Instruments, Inc., d, e, g, j.
Chicago Aerial Industries, Inc., b.
Consolidated Electrodynamics Corp., a, b, c thru g, j.
Data-Control Systems, Inc., e.
Dresser Industries, Inc., a, c thru g, j, k.
E. I. Du Pont De Nemours & Co. Inc., Photo Products Dept., j.
Edgerton, Germeshausen & Grier, Inc., a, b, c, j.
Edin-Div.-Epsco, Inc., d, e, g, j.
Electro-Medical Lab., Inc., d.
Electronic Tube Corp., a, b, c.
Epic, Inc., e, j.
General Electric Co., Apparatus Sales Div., a, e, f, g, j, k.
General Electric Co., X-Ray Dept., b.
Gardan Enterprises, b, c, g.
Hamilton Watch Co., Hathaway Instrument Div., a, c,
Hamilton Watch Co., Industrial Div., j.
Heiland Div.-Minneapolis-Honeywell, d thru g, j, k.
Hogan Laboratories, Inc., e, f, j.
Hughes Aircraft Co., d, g.
ITT Labs.-Ft. Warth, a, b, h, i, k.
Industrial Televisian Inc., a.
Land-Air Inc., a, g.
Legris Co.
Lumatron Electronics, Inc., b, i.
Magnetic Instrument Co. Inc., d.
Massa Div.-Cohu Electranics, Inc., d thru g, j, k.
Midwestern Instruments, Inc., d, e, g, j.
Minneapolis-Haneywell Regulotor Co., Industrial Praduct Group, d thru g, j, k.
Miratel, Inc., a, i.
Motarala Inc., Military Electranics Div., i.
New England Scientific Instruments Co., c, f, j, k.
Offner Electronics Inc., d, e, g, j.
Paco Electronics Co., Inc., a.
Photron Instrument Co., d thru g, j.
Precise Development Corp., a, c, e, g, k.
Precision Apparatus Co., Inc., a.
Sanborn Co., a, c, d, e, j.
Scientific-Atlanta, Inc., j.
Seiscor Mfg. Co., e, j.
Southwestern Industrial Electronics Co.
Strand Engrg. Co., b, i.
Sun Electric Corp., Aeronautical Div., d, e, f, j, k.
Technology Instrument Corp., d, e, g, j.
Waterman Products Co., Inc., a, e, g, i, j.
Wollensak Optical Co., j, k.

OSCILLOSCOPE, SCALES
See SCALES, OSCILLOSCOPE

OSCILLOSCOPES
- a. Cathode Ray
- b. Cathode Ray-Multiple Channel
- c. Portable
- d. Portable Projectian

Carol Electronics Corp., a, c.
Daven Co., The, a.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp., a, c.
Dresser Industries, Inc., a, b, c.
Edgerton, Germeshausen & Grier, Inc., a.
Edin-Div.-Epsco, Inc., c.
Electro Instruments, Inc., a.
Electronic Industries, c.
Electronic Instrument Co., Inc. (EICO), a.
Electronic Tube Corp., a, b, c.
Electro-Tech Equipment Co., a, c.
Foto-Video Labs., Inc., a.
Generol Communication Co., a.
Hewlett-Packard Co., a, b, c.
ITT Labs.-Ft. Worth, a.
Industrial Television Inc., a.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., a, c.
Kingston Electronics-Div.-Kingston Industries Inc., a, c.
Land-Air Inc., a, c.
Lavoie Laboratories Inc., a, b.
Levinthal Electronic Products, Inc., b.
Lumatron Electronics, Inc., a, b, c.
Marconi Instruments, a.
Miratel, Inc., a.
Paco Electronics Co., Inc., a.
Philco Corp., Government & Industrial Div., a, c.
Pioneer Industries Div., Almar-York Co. Inc., a, c.
Precise Development Corp., a, b, c.
Precision Apparatus Co., Inc., a.
Probescope Co. Inc., a.
Railway Communications Inc., b.
Sanborn Co., a, b.
Scopes Co., Inc., The, a, b, c.
Simpson Electric Co., a, c.
Southwestern Industrial Electronics Co.
Specialty Engrg. & Electronics Co., a.
Telectro Industries Corp., a.
Triplett Electrical Instrument Co., a, c.
Waterman Products Co., Inc., a, b, c.
Wright Engrg. Co., a, b.

OUTLETS, ANTENNA

Entron, Inc.
Javex Electronics
E. F. Johnson Co.
Mark Products Co.
Technicol Appliance Corp.

OVENS
- a. Crystal
- b. Environmental Testing
- c. Infra-Red Drying
- d. Temperature Contralled

Aerojet-General Corp., d.
Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co., a.
American Felt Co., a.
American Gas Furnace Co., d.
American Instrument Co., Inc., b, d.
***ASSOCIATED TESTING LABS., INC.**, b, d.
Astravac Corp., b.
Rex Bassett, Inc., a.
Blue M Electric Co., b, d.
Bulova Watch Co., Electronics Div., a.
Central Scientific Co., d.

incinnati Cleaning & Finishing Machinery, a thru d.
lork Crystal Co.
ax & Co., Inc., a.
urtiss-Wright Corp., Santa Barboro Div., b, d.
iversey Engrg. Co., d.
l Ray Motar Co., Inc., a.
isher Scientific Co., d.
ardner Laboratory, Inc., b, d.
eneral Testing Labs., Inc., b, d.
rant Chemical Co., Inc., d.
rieve-Hendry Co., Inc., a, c.
uardite Co., Div. of American Marietta Co., b.
aul Hardeman, Inc., b.
evi-Duty Electric Co., b, d.
igh Vacuum Equipment Corp., b.
ull Corp., b.
unt Corp., The, a, d.
uppert, K. H., Co., b, d.
ternotional Radiant Corp., b, d.
inney Mfg. Div., The New York Air Brake Co., b, d.
irk & Blum Mfg. Co., The, b, d.
avoie Laboratories Inc., a, d.
agee-Bralla & Associates, b, d.
agnetic Controls Co., a.
inson Labs., Inc., a.
c Coy Electronics Co., a.
iskella Infra-Red Co., The, c.
issimers Inc., b.
atarola Inc., Military Electronics Div., a.
arthern Engrg. Laboratories, Inc., a.
acific Scientific Co., d.
apesch & Kolstad, Inc., d.
iezo Crystal Co., a.
remier Research Labs., Inc., a, d.
& R Engrg. Co., d.
eeves-Hoffman Div., a.
ixan Electronics Inc., a.
cientific Engrg. Labs., Inc., b, d.
las Corp. of America, d.
ate Testing Lab. Inc., b, d.
atikil, Inc., Div.-The J. E. Doyle Co., c.
. J. Stokes Corp., a.
urface Combustion Corp., d.
emperature Engrg. Corp., b, c, d.
enney Engrg., Inc., b, d,
. S. Industries, Inc., b.
alpey Crystal Corp., a, d.
altham Electronics Corp., a, d.
right Electronics Inc., a.
oung Brothers Co., b, d.

CIDIZERS

ir Products, Inc.
ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.
llied Chemical Corp., Nitrogen Div.
merican Rocket Co.
ecco Chemical Div.-Food Mochinery & Chemical Corp.
scambia Chemical Corp.
ithium Corp. of America, Inc.
SA Research Corp.
lin Mathieson Chemical Corp., Energy Div.
ennsalt Chemicals Corp.
hell Chemical Corp., Industrial Chemicals Div.
pecial Projects Lab., Food Machinery & Chemical Corp.

CYGEN APPARATUS & BREATHING EQUIPMENT

eronautical & Instrument Div., Robertshaw-Fulton Controls Co.
AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
iro Equipment Corp.
endix Aviation Corp., Pioneer-Central Div.
obrick Mfg. Corp.
ambridge Co.-Div.-Carrier Corp.
erbert Cooper Co., Inc.
isher Scientific Co.
eneral Scientific Equipment Co.
alter Kidde & Co., Inc., Aviation Div.
. Koch & Sons
inde Co., Div.-Union Carbide Corp.
line Safety Appliances Co.
. J. Monaghan Co., Inc.
Oxygen Equipment & Service Co.
uritan Compressed Gas Corp., Aviation Div.
red T. Roberts & Co.
cott Aviation Corp.
uperior Air Products Co.
inzen Research Inc.

CYGEN EQUIPMENT CONNECTOR
ee CONNECTOR, OXYGEN EQUIPMENT

CYGEN EQUIPMENT DEHYDRATORS
ee DEHYDRATORS, OXYGEN EQUIPMENT

CYGEN, LIQUID
ee LIQUID OXYGEN

CYGEN SYSTEMS & CONTROLS

erojet-General Corp.
erotec Corp., The
ir Products, Inc.
AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
iro Equipment Corp.
endix Aviation Corp., Pioneer-Central Div.
obrick Mfg. Corp.
Bowser, Inc., Defense Dept.
Cambridge Co.-Div.-Carrier Corp.
Consolidated Controls Corp.
Dynamic Devices, Inc.
Essex Mfg., Co., Inc.
G. W. Galloway Co.
Hagan Chemicals & Controls, Inc.
Paul Hardeman, Inc.
Hofman Labs., Inc.
***HYDRO-AIRE CO., DIV.-CRANE CO.**
Hydromatics, Inc.
Kahn & Co., Inc.
Walter Kidde & Co., Inc., Aviation Div.
Linde Co., Div.-Union Carbide Corp.
MSA Research Corp.
Minneapolis-Honeywell Regulator Co.,-Aeronautical Div.
Oxygen Equipment & Service Co.
Parts Engrg. Co., Inc.
Pneu-Hydro Valve Corp.
Project Fabrication Corp.
Puritan Compressed Gas Corp., Aviation Div.
Research Controls
Sargent Engrg. Carp.
Scott Aviation Carp.
Sterns-Roger Mfg. Co.
Superior Air Products Co.
***ULTRA-VIOLET PRODUCTS, INC.**
United Electric Controls Co.
Vinson Mfg. Co. Inc.
Winzen Research Inc.

PACK SETS

Collins Radio Co.
Double E Products Co.
Electronic Communicotions, Inc.
ITT Labs.
L E L, Inc.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Motorola Inc., Military Electronics Div.
Telectro Industries Corp.
Winder Aircraft Corp. of Florida

PACKAGING, ELECTRONIC EQUIPMENT, SERVICE ONLY

Applied Design Co.
Armour & Co., Armour Alliance Industries
Bendix Aviation Corp., York Div.
Carmody Corp.
Centronix Inc.
Champion Co., The
Cleveland Metal Specialties Co., Electronics Div.
Continental Technical Service, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Craig Systems, Inc.
Crystal-X Corp.
Curtiss-Wright Corp., Santa Barbara Div.
Double E Products Co.
Eckol Packaging Co.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
First Electronics Corp., The
Ford Instrument Co., Div.-Sperry Rond Corp.
Good Electronic Corp.
Lyon Van & Storage Co., Aircraft Div.
Ralph M. Parsons Co., The, Electronics Div.
Pneumofil Corp.
Reinhold Engrg. & Plastics Co.
Roberts Industries Inc.
Sheltered Workshops
Skydyne, Inc.
Specialty Engrg. & Electronics Co.
Topper Mfg. Co., Inc.
Vendorlator Mfg. Co.
Wintronics

PACKAGING MATERIALS

Allied Plastics Supply Carp.
Applied Design Co.
Bemis Brothers Bag Co.
Champion Co., The
Colonial Rubber Co.
Crystal-X Corp.
Dayton Rubber Co., The
Dow Chemical Co., The
Enfab Inc.
Fidelity Chemical Products Corp.
General Box Co.
Gering Products, Inc.
Gilmon Brothers Co., The
B. F. Goodrich Co., The
Krylon, Inc.
Lyon Van & Storage Co., Aircraft Div.
Minnesota Mining & Mfg. Co.
Mosinee Paper Mills Co.
Plastic Film Co., Inc.
Pry Welding & Mfg., Inc.
Roberts Industries Inc.
Seal-Peel, Inc.
Thiokol Chemical Corp.
United States Plywood Corp.
Vendorlator Mfg. Co.
Western Coating Co.
Winzen Research Inc.
Young & Rioux Woodworking Co., Inc.
Zophar Mills Inc.

PAINT, METALLIC

Arco Co., The
Bel Fuse Inc.
Barden Chemical Co.
Samuel Cabot Inc.
Carboline Co.
Cooper Industries, Inc.
Dennis Chemical Co.
B. F. Drakenfeld & Co., Inc.
E. I. Du Pont De Nemours & Co., Inc.
Dyna-Therm Chemical Corp.
Emerson & Cuming, Inc.
Fidelity Chemical Products Corp.
Krylan, Inc.
Maas & Waldstein Co.
Micra-Circuits Co.
Organic Products Co.
Pratex-A-Cate, Inc.
Varac Co., The

PAINTS

Arca Co., The
Barden Chemical Co.
Samuel Cabot Inc.
Carboline Co.
Cooper Industries, Inc.
Dennis Chemical Co.
E. I. Du Pont De Nemours & Co. Inc.
Dyna-Therm Chemical Corp.
Maas & Waldstein Co.
Micra-Circuits Co.
Midland Industrial Finishes Co.
Minnesota Mining & Mfg. Co.
National Lead Co.
Protex-A-Cate, Inc.
United States Varnish Co.
Varac Co., The
Waldam Electronics Inc.

PAINTS, FLUORESCENT & PHOSPHORESCENT

***ULTRA-VIOLET PRODUCTS, INC.**

PANEL ASSEMBLIES, JACK
See JACK PANEL ASSEMBLIES

PANEL BOARDS, ELECTRIC

Accurate Electronics Corp., Dept. D.
Aerodex, Inc.
Aerolite Electronics Corp.
Allied Plastics Supply Corp.
Allis-Chalmers
American Electronics, Inc., Taller & Cooper Div.
Anchor Metal Spinning Co., The
Anchor Specialty Mfg. Co. Inc.
Bernco Engrg. Corp.
Carmody Corp.
Chrysler Corp., Defense Operations Div.
Cole Electric Co.
Comco Plastics Inc.
Continental Diamond Fibre Corp.
Continental Technical Service, Inc.
Control Engrg. Co., Div.-Jervis B. Webb Co.
Cutler-Hammer Inc.
Devco Engrg. Inc.
Electromath Corp.
Electro-Mechanical Products Co.
***ELECTROSNAP CORP.**
Eljay Corp.
Emmco Plastic Fabricators-Div.-E. M. McCarthy Machine Co.
First Electronics Corp., The
General Electric Co., Apparatus Sales Div.
Good Electronic Corp.
Gunnar Laborotories
Paul Hardeman, Inc.
A. F. Holden Co., The
I-T-E Circuit Breaker Co.
Jeta, Inc.
Johns-Manville
Johns-Manville Sales Corp.
Kelsey-Hayes Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Keystone Electronics Corp.
Kirk & Blum Mfg. Co., The
Mansfield Fabricators Inc.
Miller Dial & Nameplate Co.
Mullenbach Div.-Electric Machinery Mfg. Co.
George L. Nankervis Co.
National Electronics
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
North Electric Co.
Panel Engrg. Corp.
Projects Unlimited Inc.
Richardson Scale Co.
Rimak, Inc.
St. Regis Paper Co., Panelyte Div.
Schaffer Air Industries, Inc.
Standord Electric Time Co., The
Talley Corp., The
Taylor Electric Inc.
Telectro Industries Corp.
Tucson Instrument Corp.
United Aircroft Products, Inc.

PANELS

a. Fibre
b. Instrument
c. Jack
d. Receiver & Transmitter
e. Relay Rack
f. Wood & Plywood

A & P Metal Products Mfg. Corp., e.
Accurate Electronics Corp., Dept. D, a, b, c.
Ackerman Engravers, Inc., b.
Acramark Co., The, b.
Aeralite Electronics Corp., a, b, c.
Allied Plastics Supply Corp., a.
Alpitec, Inc., c, d, e.
Amphenol Connectar Div., Amphenol-Borg Electronics Corp., c.
Anchar Metal Spinning Ca., The
Anchor Specialty Mfg. Ca. Inc., b thru f.
Audia Development Co., c.
Belack Instrument Corp., b.
Bergen Carbide Co., b.
Bristal Co., The, b.
Bud Radia Inc., b thru e.
Canadian Radium & Uranium Carp., b.
Carmody Corp., b, c, e, f.
Centranix Inc., d.
Chemold Co., a.
Coaxial Connectar Ca. Inc., c.
Camco Plastics Inc., a.
Continental Diamand Fibre Carp., a.
Carnell Deep Drawing Ca., Div.-Lanes Industries Carp., b.
Craig Systems, Inc., b, e.
Croname Inc., b.
Dahlstrom Metallic Daar Co., c, d, e.
Doyton Aviation Radio & Equipment Corp., b, d.
Detranic Industries, a, b, d.
Devco Engrg. Inc., b.
Henry G. Dietz Co., Inc., b.
Donner Scientific Co., c.
Duralith Carp., a, b.
Electric Auto-Lite Ca., The, b.
Electrical Insulation Co., Inc., a, b, c.
Electrocraft, Inc., c.
Electro-Mechanical Products Ca., a thru e.
*ELECTROSNAP CORP., a, b, f.
Eljay Corp., o thru e.
Elzee Metal Products Co., Inc., b thru e.
Emersan Plastics Corp., a.
Emmca Plastic Fabricatars-Div.-E. M McCarthy Machine Ca., a, f.
Engineered Plastics, Inc., a, b.
Etched Products Corp., b.
*ETS-HOKIN & GALVAN, b, c, e.
Falstrom Ca., b.
Fischer & Parter Ca., b.
Fisher & Crame, a thru e.
Fletcher Mfg. Co., Inc., The, a thru f.
Foto-Video Labs., Inc., b, c.
Franklin Fibre-Lamitex Corp., a.
Gunnar Labaratories, a, e.
Hagan Chemicals & Cantrols, Inc., b.
Harco Labs., Inc., c.
Ludwig Honold Mfg. Co., d.
Industriol Engrg. Corp., b.
Industrial Engravers, Inc., b.
Intercontinental Dynomics Corp., b.
ITT-Kellogg, c, e.
Jodee Plastics Co.
Johns-Manville, a.
Kohn & Co., Inc., b.
Kerrco Products, b.
Keystone Electronics Corp., a, c.
Kirk & Blum Mfg. Co., The, b, e.
Liss Products, Inc., a, f.
Thomas J. Long, Inc., a thru f.
R. H. Lynch Mfg. Co., b, e.
Monsfield Fabricators Inc., a.
Maryland Etching Co. Inc., b, d.
Met-L-Wood Corp., f.
Mid-West Metal Products, Inc., d, e.
Miller Dial & Nameplate Co., b.
Minneapolis-Honeywell Regulotor Co., Industriol Div., b, c.
Minneapolis-Honeywell Regulotor Co., Industriol Product Group, b, c.
Minnesota Mining & Mfg. Co., a.
*MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV., b.
Monogram Precision Industries, a, e, f.
Mullenboch Div.-Electric Machinery Mfg. Co., c.
Notional Electronics, b.
Notional Pneumotic Co., Inc., Holtzer-Cobot Divs., c, d, e.
North Electric Co., c, e.
Panel Engrg. Corp., a, b, d.
Papesch & Kolstad, Inc., b.
Penn Fibre & Specialty Co., Inc., a.
Pilgrim Products Inc., b.
Plasteck, Inc., b.
Pneumatil Corp., b.
Premier Metal Products Co., e.
Prereg Mfg. Inc., a thru d.
Projects Unlimited Inc., c, d, e.
Q-Circuits, Div.-Etching Co. of Colif., b.
Railway Communications Inc., e.
Ravenno Metal Products, Div.-Standard Screw Co., c.
Reinhold Engrg. & Plastics Co., a.
Edw. Renneburg & Sons Co., b.
Rimok, Inc., a thru e.
Rogers Corp., a.
Smith-Marris Corp., b.
Space Corp., b.
Spaulding Fibre Co., Inc., a.
Stanley Aviation Corp., a, c.
Sun Dial Corp., b, c.
Switchcraft, Inc., c.
Trimount Instrument Co., b.
Tucson Instrument Corp., b.
United Stotes Rodium Corp., b.
Universal Moulded Products Corp., a,f.
Universal Unlimited, Inc., b, d.
Waldam Electronics Inc., b.
Waltham Haralagical Corp., c.
Watsan Mfg. Ca., Inc., b.
Westronics Inc., b.
Wilmington Fibre Specialty Ca., a.
Wyca Metal Products, e.
Young & Riaux Woodworking Ca., Inc., f.

PANELS, PATCH
See PATCH PANELS

PAPER, INSULATION

Allied Plastics Supply Carp.
Auburn Mfg. Co., The
Carborundum Co., Refractories Div.
Electrical Insulation Co., Inc.
Franklin Fibre-Lamitex Corp.
Integrated Mica Corp.
Jadee Plastics Ca.
Jahns-Monville
Johns-Manville Soles Corp.
Thomas J. Long, Inc.
Mansfield Fabricators Inc.
Mico Insulatar Div.-Minnesota Mining & Mfg., Co.
Minnesota Mining & Mfg. Ca.
Managram Precision Industries
Masinee Paper Mills Co.
Natva Carp.
Penn Fibre & Specialty Co., Inc.
Pilgrim Products Inc.
Rogers Corp.
Peter J. Schweitzer Div.
Spaulding Fibre Co., Inc.,
Unian Asbestos & Rubber Ca.
Wilmington Fibre Specialty Co.

PAPER, RECORDING

Alfax Paper & Engrg. Co.
Bristol Co., The
E. I. Du Pont De Nemaurs & Co. Inc.
E. I. Du Pant De Nemaurs & Co. Inc., Photo Products Dept.
Eastman Kodak Co.
Hogan Loboratories, Inc.
Minneapolis-Haneywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulatar Ca., Industriol Product Graup
Minnesota Mining & Mfg. Ca.
Sanborn Ca.
Peter J. Schweitzer Div.

PAPERS, FACSIMILE RECORDING

Alfax Paper & Engrg. Co.
Hogan Loboratories, Inc.
Kay Electric Co.
Minnesota Mining & Mfg. Co.

PARABOLAS, MICROWAVE

Alpor Mfg. Corp.
American Machine & Foundry Co., Greenwich
Brooks & Perkins, Inc.
Bulow Electric Co.
Dresser Industries, Inc.
Houston Feorless Corp.
ITT Labs.
Intercontinentol Mfg. Co., Inc.
J-V-M Microwave Co.
D. S. Kennedy & Co.
Mork Products Co.
McMillon Industrial Carp.
Monogram Precision Industries
Philco Corp., Government & Industrial Div.
Rodiation, Inc.
Republic Aviotion Corp.
Sperry Microwove Electronics Co., Div.-Sperry Rond Corp.
Teiner Engrg. Corp.

PARACHUTE HARDWARE

Amotom Electronic Hordware Co., Inc.
American Aluminum Co.
Capewell Mfg. Co.
Cormoc Aviotion
Century Fosteners Corp.
Cooper Development Corp., Sub.-Morquordt Aircroft Co.
Corbin Products Div.
*FLEXONICS CORP., AERONAUTICAL DIV.
Gentex Corp.
*HARTFORD MACHINE SCREW CO., DIV.-STANDARD SCREW CO.
H. Koch & Sons
Pacific Scientific Co.
Pioneer Parachute Co., Inc.
Precision Shapes, Inc.

PARACHUTES

Cooper Development Corp., Sub.-Marquordt Aircraft Co.
Gentex Corp.
Pioneer Parachute Co., Inc.
Relionce Mfg. Co.-Industriol Products & Parachute Div.
Stonley Aviation Corp.

PARTICLE ACCELERATORS
See ACCELERATORS, PARTICLE

PASSIVE MICROWAVE REPEATERS
See REPEATERS, PASSIVE, MICROWAVE

PASTE & CEMENT, GASKET
See GASKET PASTE & CEMENT

PASTE, SILVER
See SILVER PASTE

PATCH CORDS

AMP Inc.
Aerolite Electronics Corp.
Alden Products Co.
Amatom Electronic Hardware Ca. Inc.
Associated Engrg. Corp.
Atlantic Instrument Corp., Sub.-American Electranics, Inc.
Audio Development Co.
W. A. Beauchain & Sans Inc.
Bernca Engrg. Corp.
Birnbach Radio Co., Inc.
Coaxiol Connectar Co. Inc.
Detranic Industries
Electromath Carp.
Entron, Inc.
First Electranics Corp., The
ITT-Kellogg
Milgo Electronic Corp.
National Pneumatic Co., Holtzer-Cabat Divs.
North Electric Co.
Paul Nurches Co.
Miltan Rass Metals Co., The
Sequoia Wire & Coble Co.-Div.-Mandrel Industries, Inc.
Switchcraft Inc.
Telectro Industries Corp.
Vector Electranic Ca.
Virginia Electranics Co., Inc.
Waltham Horological Carp.
Webcor, Inc., Gavernment Div.
Western International Co.
Westwood Cable Carp.

PATCH CORDS, CONNECTORS

AMP Inc.
Aerolite Electronics Corp.
Audia Development Co.
W. A. Beauchaine & Sons Inc.
Birnbach Radio Co., Inc.
Coaxial Connectar Co. Inc.
Detronic Industries
First Electranics Carp., The
Milgo Electranic Carp.
National Pneumatic Co., Inc., Haltzer-Cabot Divs.
North Electric Co.
Milton Ross Metals Co., The
Switchcroft, Inc.
Telectro Industries Corp.
Virginio Electronics Co., Inc.
Waltham Horological Corp.
Western Internotionol Co.
Westwood Cable Corp.

PATCH CORDS, STUDIO

Audio Development Co.
First Electronics Corp., The
Mullenboch Div.-Electric Mochinery Mfg. Co.
Notionol Pneumotic Co., Inc., Holtzer-Cobot Divs.
Switchcraft, Inc.
Virginia Electronics Co., Inc.
Westwood Coble Corp.

PATCH PANELS

AMP Inc.
Aerolite Electronics Corp.
Amelco, Inc.
Americon Missile Products Co., Inc.
Audio Development Co.
Cambridge Thermionic Corp.
Duralith Corp.
Electrocraft, Inc.
Engineered Plastics, Inc.
*ETS-HOKIN & GALVAN
First Electronics Corp., The
Kilgen Aircraft Div.
Kirk & Blum Mfg. Co., The
Milgo Electronic Corp.
Miller Diol & Nomeplote Co.
Mullenbach Div.-Electric Mochinery Mfg. Co.
Nationol Pneumotic Co., Inc., Holtzer-Cobot Divs.
North Electric Co.
Switchcroft, Inc.
United Electrodynomics, Inc.
United Stotes Rodium Corp.
Vector Electronic Co.
Virginio Electronics Co., Inc.
Woltham Horologicol Corp.
Webcor, Inc., Government Div.
Western Internationol Co.

PEDESTALS

ACF Industries Inc.
Adept Industries Inc.
Alpor Mfg. Corp.
Americon Machine & Foundry Co., Government Products Group
Americon Mochine & Foundry Co., Greenwich
Anchor Metol Spinning Co., The
Antlab Inc.
Atlos Precision Products, Co.
Bosic Tool Industries, Inc.

opital City Mfg. Co.
liversey Engrg. Co.
abriel Co., The, Gabriel Electronics Div.
oodyear Aircraft Corp.
ouston Fearless Corp.
T-E Circuit Breaker Co.
iosecki Aircraft Corp.
remier Metal Products Co.
dw. Renneburg & Sons Co.
cientific-Atlanta, Inc.
einer Engrg. Corp.
nited Shoe Machinery Corp., Ordnance Dept.
ayne Pump Co., The, Div.-Symington Wayne Corp.
estern Gear Corp.

PISCOPE TYPE SEXTANTS
e SEXTANTS, PERISCOPE TYPE

PI MANENT MAGNETS
e MAGNETS, PERMANENT

PI MEAMETERS, HIGH H
iokol Chemical Carp.

PIMEATERS, RF
iokol Chemical Corp.

PISE MODULATORS
e MODULATORS, PHASE

PISEMETERS
Logistics Corp.
tronics Co.
ic, Inc.
milton Watch Co.-Industrial Div.
ustrial Test Equipment Co.
opp Inc.
ms Clarke Co., Div.-Vitro Corp. of America
w Englond Scientific Instruments Co.
rth Atlantic Industries, Inc.
iscor Mfg. Co.
eta Instrument Corp.
io Laboratories, Inc.
ston Instruments, Div.-Daystrom, Inc.
htronics

PHSING & COUPLING UNITS
e COUPLING & PHASING UNITS

PHSPHORS, FLUORESCENT COMPOUNDS
e FLUORESCENT COMPOUNDS, PHOSPHORS

PHTO ETCHED COMPONENTS
curate Electronics Corp., Dept. D.
ept Industries Inc.
ndix Aviation Corp., York Div.
ched Products Corp.
ndsverk Electrometer Co., The
ryland Etching Co. Inc.
torola Inc., Military Electronics Div.
cific Moulded Products
Circuits, Div.-Etching Co. of Colif.
ited States Chemical Milling Corp.
srep Corp.
nith Opticol Loboratory

PHTOCELLS & PHOTOTUBES
erican Elite, Inc.
irex Corp.
tman Kodak Co.
erton, Germeshausen & Grier, Inc.
c, Inc.
ronti Electric Inc.
eral Electric Co., Apparatus Sales Div.
erol Electrodynamics Corp.
flex Inc.
fman Electronics Corp., Semicounductor Div.
Labs.-Ft. Wayne
rnational Rectifier Corp.
Electronics Corp.
lco Corp., Government & Industrial Div.
onic Semi Conductor Corp.
Corp., The, Sub.-American Enka
ling Precision Corp., Instrument Div.

HOELECTRIC CELLS
Clirex Corp.
Eitman Kodak Co.
Eierton, Germeshausen & Grier, Inc.
Ectron-Radar Products
Ec, Inc.
Fronti Electric Inc.
General Electric Co., Apparatus Sales Div.
Hfman Electronics Corp., Semiconductor Div.
I Labs.-Ft. Wayne
J Electronics Corp.
Ma Bolancing, Inc.
Pto-Crystals, Inc.
Wton Instruments, Div.-Daystrom, Inc.

HOELECTRIC COLORIMETERS
S COLORIMETERS, PHOTOELECTRIC

HOFLASH EQUIPMENT, ELECTRONIC
Arlcon Speedlight Corp.
Bttie-Coleman, Inc.
Crles Beseler Co.
Bke & Jomes Inc.
Cdwick-Helmuth Co.
Denport Mfg. Co.
Edgerton, Germeshausen & Grier, Inc.
Elcor Div.-Scranton
General Electric Co., X-Ray Dept.
Gordon Enterprises
Graflex Inc.
Heiland Div.-Minneapolis-Honeywell
Indikon Co., Inc., The
Kemlite Laboratories, Inc.
Madelectric Products Corp.
Nems Clarke Co., Div.-Vitro Corp. of America
Sterling-Howard Corp.
Technical Apparatus Builders

PHOTOGRAPHIC EQUIPMENT
Bor-Ray Products, Inc.
Bell & Howell Co.
Charles Beseler Co.
Burke & James Inc.
Camera Mart Inc., The
Cameraflex Corp.
Chadwick-Helmuth Co.
Chicago Aerial Industries, Inc.
Eastman Kodak Co.
Edgerton, Germeshausen & Grier, Inc.
Elgeet Optical Co., Inc.
J. W. Fecker, Inc.
Federal Mfg. & Engrg. Corp.
Flight Research, Inc.
General Electric Co., X-Ray Dept.
Generol Photo Products Co., Inc.
Gordon Enterprises
Graflex Inc.
Houstan Feorless Corp.
Jansky & Bailey, Inc.
Land-Air Inc.
Logetronics Inc.
Lux Clock Mfg. Co., Inc.
Metalphoto Corp.
Mitchell Comera Corp.
Morse Instrument Co., The
Neumade Products Corp.
Optomechanisms Inc.
Poragon-Revolute Corp.
Peck & Harvey Mfg. Corp.
Peerless Photo Products Inc.
Reed Research Inc.
Sequoia Wire & Cable Co., Div.-Mandrel Industries, Inc.
Sterling-Howard Corp.
Traid Corp.
Transmares Corp.
Vought Co.
Weston Instruments, Div.-Daystrom, Inc.
Wollensak Optical Co.
Zoomar Inc.

PHOTOGRAPHIC MATERIALS, SPECTROGRAPHIC INSTRUMENTS
***BAUSCH & LOMB OPTICAL CO.**
E. I. Du Pont De Nemours & Co. Inc.
Eastman Kodak Co.
General Electric Co., X-Ray Dept.
Gordon Enterprises
Nationol Spectrographic Labs., Inc.
New England Scientific Instruments Co.
Vought Co.

PHOTOGRAPHIC MATERIALS, X-RAY FILMS
Eastman Kodak Co.
General Electric Co., X-Ray Dept.
Gordon Enterprises

PHOTOMETERS
Eldorado Electronics
J. W. Fecker, Inc.
Fisher Scientific Co.
Nationol Spectrographic Lobs., Inc.
Optomechanisms Inc.
Photovolt Corp.
Process & Instruments
Weston Instruments, Div.-Daystrom, Inc.
Zoomor Inc.

PHOTOTUBES & PHOTOCELLS
See PHOTOCELLS & PHOTOTUBES

PICKUP ARMS
Duotone Co., Inc.
H. H. Scott, Inc.
Webcor, Inc., Government Div.

PICKUPS
a. Industrial
b. Pressure
c. Temperature
d. Vibration

Aero Research Instrument Co. Inc., b, c.
***ARNOUX CORP., c.**
Atlantic Instrument Corp., Sub.-American Electronics, Inc., c.
Atlantic Research Corp., b.
B & K Instruments, Inc., d.
Chesapeake Instrument Corp., d.
G. L. Collins Corp., b, d.
Consolidated Diesel Electric Corp., b, c.
Consolidated Electrodynomics Corp., b, d.
Curtiss-Wright Electronics Div., IMI Branch, b.
Datran Electronics, Div.-Mid-Continent Mfg., Inc., b.
Doystrom Pacific Div.-Daystrom, Inc., b, c.
Dresser Industries, Inc., b, c, d.
Electro Products Laborotories, Inc., a, d.
Electronic Control Corp., c.
Endevco Corp., b, d.
Fischer & Porter Co., a, b, c.
Gulton Industries, Inc., b, c, d.
Kin Tel Div.-Cohu Electronics, Inc., b, d.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., b.
Lond-Air Inc., d.
Leeds & Northrup Co., c.
MB Mfg. Co., d.
Micrometrical Mfg. Co., d.
Minneapolis-Honeywell Regulator Co., Boston Div., d.
Minneapolis-Honeywell Regulotor Co., Industriol Div., a, b, c.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, c.
Norwood Controls Unit Detroit Controls Div., b.
Pacific Scientific Co., c, d.
Rosemount Engrg. Co., b, c.
Arthur C. Ruge Associates, Inc., c.
Schaevitz Engrg., b.
H. H. Scott, Inc., d.
Standard Controls, Inc., b.
Statham Instruments, Inc., a, b.
Tel-Instrument Electronics Corp., d.
Thermo Electric Co., Inc., c.
Trans-Sonics, Inc., b, c.
Ultradyne, Inc., b.
Yellow Springs Instrument Co., The, c.

PILOT LIGHT ASSEMBLIES
Accurate Electronics Corp., Dept. D
Aerolite Electronics Corp.
Alden Products Co.
Amotom Electronic Hordware Co. Inc.
American Machine & Foundry Co., Government Products Group
Carling Electric, Inc.
Cutler-Hammer Inc.
Dialight Corp.
Eagle Electric Mfg. Co. Inc.
Eldema Corp.
***ELECTROSNAP CORP.**
Electro-Tech Equipment Co.
Fidelity Amplifier Co.
Generol Electric Co., Apparatus Sales Div.
Green Rectifier Co.
Grimes Mfg. Co.
E. F. Johnson Co.
Korry Mfg. Co.
Marco Industries Co.
Scam Instrument Corp., The
Signolite Inc.
Telectro Industries Corp.
Transistor Electronics Corp.

PILOTS, AUTOMATIC
Atlas Precision Products, Co.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Fletcher Mfg. Co., Inc., The
Hamilton Standard, Div.-United Aircraft Corp.
ITT Labs.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Minneapolis-Honeywell Regulotor Co.-Aeronautical Div.
Northrop Corp.
Philco Corp., Government & Industriol Div.
Ryan Aeronautical Co.
Servomechanisms, Inc.
Southwestern Industrial Electronics Co.
Sperry Forragut Co., Div.-Sperry Rand Corp.
Sperry Piedmont Co.-Div.-Sperry Rand Corp.

PINS, TUBULAR
American Brass Co., The
Baldwin Mfg. Co. Inc., The
Blond Burner Co., The
Cooper Industries, Inc.
Elastic Stop Nut Corp. of America
Keystone Electronics Corp.
Stondord Pressed Steel Co.
United Mfg. Co., The

PITOT TUBES
Aero Research Instrument Co. Inc.
Airtronics International Corp.
Flow Corp.
E. Vernon Hill & Co.
Peerless Machine Co.
Precision Sheet Metal, Inc.
Servomechanisms, Inc.
Wilks Precision Instrument Co., Inc.

PLASTIC, ELECTRICALLY CONDUCTIVE
American Aerophysics Corp.
American Insulator Corp.
American Printed Circuits Co., Inc.
Brilhart Plostics Carp.
Brook Molding Corp.
Crystal-X Corp.
DBM Research Corp.
Dayton Aircroft Products, Inc.
Emerson & Cuming, Inc.
Franklin Fibre-Lamitex Corp.
Furane Plastics Corp. of New Jersey
Goodyeor Tire & Rubber Co., The, Aviotion Products Div.

Gront Chemicol Co., Inc.
Haveg Industries, Inc.
Houghton Laboratories, Inc.
Jessall Plastics
Lebec Chemical Corp.
Lone Star Plastics Co., Inc.
Marblette Corp., The
Micro-Circuits Co.
Minnesota Mining & Mfg. Co.
New England Tape., Div.-United-Carr Fastener Corp.
Republic Aviation Corp.
W. S. Shamban & Co.
Sierracin Corp., The
Silicone Insulotion, Inc.
Swedlow Inc.
Topper Mfg. Co., Inc.
Waterbury Companies, Inc.
Zippertubing Co., The

PLASTIC LIGHTING PLATES
See PLATES, PLASTIC, LIGHTING

PLASTIC MOLDERS
See MOLDERS, PLASTIC

PLASTICS FABRICATORS & FINISHERS

Accurate Electronics Corp., Dept. D.
Adept Industries Inc.
Aerolite Electronics Corp.
Air Logistics Corp.
Aircraft Precision Products, Inc.
Allied Plastics Supply Corp.
American Aerophysics Corp.
American Agile Corp.
American Latex Products Corp.
American Rocket Co.
Anchor Specialty Mfg. Co. Inc.
Apex Reinforced Plastics, Div.-White Sewing Machine Corp.
Associated Engrg. Corp.
Atkins & Merrill, Inc.
Auburn Mfg. Co., The
W. A. Beauchaine & Sons Inc.
Blossom Mfg. Co. Inc.
Bonny Mfg. Corp.
Brilhart Plastics Corp.
Calfibe Co., Inc.
Chemold Co.
Chemplast, Inc.
Chicago Gasket Co.
Chicago Molded Products Corp.
Colonial Aircraft Corp.
Comco Plastics Inc.
Conn-Croft Co.
Continental Diamond Fibre Corp.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Crystal-X Corp.
Curtiss-Wright Corp.-Utica Div.
DBM Research Corp.
Dayton Aircraft Products, Inc.
Delta Products Div.-Air Accessories, Inc.
Devcon Corp.
Double E Products Co.
Duralith Corp.
Electrical Insulation Co., Inc.
Eljay Corp.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Emmco Plastic Fabricators Div. E. M. McCarthy Machine Co.
Engineered Plastics, Inc.
Erie Resistor Corp.
Fabri-Form Co., The
Fisher & Crome
Fletcher Mfg. Co., Inc., The
Flexrock Co.
Formica Corp.
Franklin Fibre-Lamitex Corp.
Furone Plastics, Inc.
GAR Mfg. Corp.
General American Transportation Corp.
General Gasket Inc.
Gering Products, Inc.
Globe Electrical Mfg. Co.
Goodyear Aircraft Corp.
Grant Chemical Co., Inc.
Hampden Mfg. Co., Inc.
Hardman Tool & Engrg. Co.
Haveg Industries, Inc.
Hoosier Tarpaulin & Canvas Goods Co., Inc.
Haughton Laboratories, Inc.
Joclin Mfg. Co.
Jodee Plastics Co.
Johns-Manville
Johns-Manville Sales Corp.
Kerrco Products
Keystone Electronics Corp.
H. Koch & Sons
Kurz-Kasch, Inc.
Lamtex Industries, Inc.
Liss Products, Inc.
Lone Stor Plastics Co. Inc.
Thomas J. Long, Inc.
Luminous Resins Inc.
Lux Clock Mfg. Co., Inc.
Luzerne Rubber Co.
M & Q Plastic Products
Mansfield Fabricators Inc.
Maryland Etching Co., Inc.
Mc Millan Industrial Corp.
Mica Insulator Div.-Minnesota Mining & Mfg., Co.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Minnesota Mining & Mfg. Co.
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
J. J. Monaghan Co., Inc.
Monrovia Aviation Corp.
Mueller Brass Co.
National Vulcanized Fibre Co.
M. M. Newman Corp.
Orange Products, Inc.
Panel Engrg. Corp.
Peerless Products Industries
Penn Fibre & Specialty Co., Inc.
Perry Plastics, Inc.
Piasecki Aircraft Corp.
Pilgrim Products, Inc.
Plasteck, Inc.
Plastic Age Sales, Inc.
Polyken Sales Div., The Kendall Co.
Polymer Corp., The
Prewitt Aircraft Co.
Republic Aviation Corp.
Resistoflex Corp.
Rex Corp., The, Sub.-American Enko
Rogers Corp.
Russell Reinforced Plastics Corp.
St. Regis Paper Co., Panelyte Div.
Schlegel Mfg. Co.
D. A. Schultz Co.
Scientific-Atlanta, Inc.
W. S. Shamban & Co.
Sierracin Corp., The
Slip Ring Co. of America
Sparta Mfg. Co., Div.-U.S. Ceramic Tile Co.
Spaulding Fibre Co., Inc.
Swedlow Inc.
Sylvania Electric Products Inc., Parts Div.
Taylor Electric Inc.
H. I. Thompson Fiber Glass Co.
Topper Mfg. Co., Inc.
Tri-Point Plastics Inc.
Turbo Products, Inc.
U. S. Fiber & Plastics Corp.
United States Chemical Milling Corp.
Universal Moulded Products Corp.
Virginia Plak Co.
Vlchek Tool Co., The
Westlake Plastics Co.
Winzen Research Inc.
Yardley Plastics Co.
Young Development Div., Hercules Powder Co.
Zippertubing Co., The

PLASTICS, REINFORCED
See REINFORCED PLASTICS

PLATE & SHEET MICA
See MICA, PLATE & SHEET

PLATES, INSTRUCTION

Acromark Co., The
Adept Industries Inc.
Allied Plastics Supply Corp.
W. H. Brady Co.
Croname Inc.
Duralith Corp.
Emeloid Co., Inc., The
Industrial Engravers, Inc.
Jodee Plastics Co.
Maryland Etching Co. Inc.
Jas. H. Matthews & Co.
Miller Dial & Nameplate Co.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
Q-Circuits, Div.-Etching Co. of Calif.
Roovers-Lotsch Corp.
D. A. Schultz Co.
United States Radium Corp.
Virginia Plak Co.
Waterbury Companies, Inc.

PLATES, METAL OR PLASTIC

Acromark Co., The
Adept Industries Inc.
All Boro Metal Products Co., Inc.
Allied Plastics Supply Corp.
Aluminum Co. of America
American Agile Corp.
Aristocrat Plastics, Inc.
Atkins & Merrill, Inc.
Bergen Carbide Co.
Carl H. Biggs Co.
W. H. Brady Co.
Bridgeport Brass Co.
Bud Radio Inc.
Challenge Machinery Co., The
Chemplast, Inc.
Continental Diamond Fibre Corp.
Croname Inc.
Division Lead Co.
Dow Chemical Co., The
Duralith Corp.
Electrical Insulation Co., Inc.
Electro-Mechanical Products Co.
Eljay Corp.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Erie Resistor Corp.
Etched Products Corp.
Farwell Metal Fabricating
Ferris-Mfg. Co., The
Fisher & Crome
Fletcher Mfg. Co., Inc., The
Franklin Fibre-Lamitex Corp.
GAR Mfg. Corp.
Industriol Engravers, Inc.
International Nickel Co., The
Javex Electronics
Jodee Plastics Co.
Kaiser Aluminum & Chemical Sales, Inc.
Lamtex Industries, Inc.
Lone Star Plastics Co. Inc.
M & Q Plastic Products
Maryland Etching Co. Inc.
Jas. H. Matthews & Co.
Metals & Controls Corp., General Plate Div.
Miller Dial & Nameplate Co.
Minnesota Mining & Mfg. Co.
Monogram Precision Industries
National Vulcanized Fibre Co.
Perry Plastics, Inc.
Plasteck, Inc.
Polymer Corp., The
Q-Circuits, Div.-Etching Co. of Calif.
Roovers-Lotsch Corp.
Milton Ross Metals Co., The
Russell Reinforced Plastics Corp.
Joseph T. Ryerson & Son, Inc.
Sanford Plastics Corp.
D. A. Schultz Co.
Smith-Morris Corp.
Stanley-Judd Div.-The Stanley Works
Tranter Mfg., Inc.
United States Radium Corp.
Virginia Plak Co.
Waldom Electronics Inc.
Wrought Washer Mfg., Co.

PLATES, PLASTIC LIGHTING

Allied Plastics Supply Corp.
W. H. Brady Co.
Duralith Corp.
Eljay Corp.
Emeloid Co., Inc., The
Fisher & Crome
Jodee Plastics Co.
Miller Dial & Nameplate Co.
Ponel Engrg. Corp.
Perry Plastics, Inc.
Plastic Age Sales, Inc.
Russell Reinforced Plastics Corp.
United States Radium Corp.

PLATFORMS, FIRING

Acco Equipment Div.- American Chain & Cable Co., Inc.
*ALUMINUM SAFETY PRODUCTS, INC.
Chicago Bridge & Iron Co.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Diversey Engrg. Co.
Jack & Heintz, Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Land-Air Inc.
Monogram Precision Industries
Newbrook Machine Corp.
Opelika Welding, Machine & Supply Inc.
Robot Industries Inc.
Smith-Morris Corp.
*R. D. WERNER CO., INC.

PLATING, PRECIOUS METAL

Alloys Unlimited Inc.
J. Bishop & Co., Platinum Works
Bram Metallurgical & Chemical Co.
Brooks & Perkins, Inc.
Brown Engrg. Co., Inc.
Cohan Epner Co. Inc.
Electro Development Co.
Engelhard Industries, Inc.
Etched Products Corp.
Graflex Inc.
Kelsey-Hayes Co.
Land-Air Inc.
M-W Labs. Inc.
Metalectro Lab.
Metals & Controls Corp., General Plate Div.
Pacific Scientific Co.
Precision Electroplating Co.
Precision Plating Co., Inc., The
Q-Circuits, Div.-Etching Co. of Calif.
Savage-Rowe Plating Co., Inc.
Sel-Rex Corp.
Slip Ring Co. of America
Spectronic Plating Co., Inc., Div.-Spectranome Plating Co., Inc.
Steel Improvement & Forge., The
Sylvania Electric Products Inc., Parts Div.
Technical Apparatus Builders
United Plating Works
United States Chemical Milling Corp.

PLATING, TIN ZINC

chor Metal Co. Inc.
Oaks & Perkins, Inc.
han Epner Co. Inc.
triss-Wright Corp.-South Bend Div.
Graflex Inc.
H-Cann Chrome Co.
lsey-Hayes Co.
k Clock Mfg. Co., Inc.
Malectra Lab.
nnesota Mining & Mfg. Co.
cision Plating Co., Inc., The
Stage-Rowe Plating Co., Inc.
Sel Improvement & Forge., The
chnical Apparatus Builders
ra Electroforming & Mfg. Co.
ited Plating Works

PLIERS

rrett-Christie Co.
llings & Spencer Co., The
nter Tool Co.
I. Morris Co.
ap-On-Tools Corp.
Ides Kohinoor, Inc.

PLOTTERS, X-Y

wac Corp.
nson-Lehner Corp.
stol Co., The
ush Instruments, Div.-Clevite Corp.
ntronix Inc.
rysler Corp., Defense Operations Div.
ectro Instruments, Inc.
more Industries, Inc.
fford Corp., The
ustrial Engravers, Inc.
eds & Northrup Co.
brascope Inc.
igo Electronic Corp.
nneapolis-Honeywell Regulator Co., Industrial Product Group
L. Moseley Co.
torola Inc., Military Electronics Div.
w England Scientific Instruments Co.
ilco Corp., Government & Industrial Div.
diation, Inc.
born Co.
lly Register Corp.
lechrome Mfg. Corp.
S. Science Corp., Div.-Topp Industries, Inc.
ldorf Electronics, Div.-F. C. Huyck & Sons
stronics Inc.

PLOTTING BOARDS
See BOARDS, PLOTTING

PLUG BOARDS
See BOARDS, PLUG

PLUG-IN-CIRCUIT UNITS

fflyte Electronics Co.
den Products Co.
erican Missile Products Co., Inc.
rker Sales Co.
ckman-Systems Div.
ndix Aviation Corp., York Div.
rton-Rodgers, Inc.
ntralab, Div.-Globe-Union
ntronix Inc.
alco Engrg. Corp.
le Electric Co.
ystrom Pacific Div.-Daystrom, Inc.
-An Controls, Inc.
etz Design & Mfg. Co.
ty Acoustica Electronic Labs.
esser Industries, Inc.
ectramath Corp.
ectronic Engrg. Co. of California
erson Electric Mfg. Co., The, Electronics & Avionics Div.
e Resistor Corp.
rranti Electric Inc.
to-Video Labs., Inc.
neral Electric Co., Computer Dept.
od Electronic Corp.
ffman Electronics Corp., Semiconductor Div.
nd-Air Inc.
Electronics Co.
torola Inc., Military Electronics Div.
tional Pneumatic Co., Inc., Holtzer-Cabot Divs.
ACKARD-BELL ELECTRONICS CORP.
orge A. Philbrick Researches, Inc.
ilco Corp., Government & Industrial Div.
ecision Circuits, Inc.
bjects Unlimited Inc.
diaphone Co. Inc.
diation, Inc.
se Engrg., Inc.
ton Rosa Metals Co., The
ecial Instruments Div., British Industries Corp.
pper Mfg. Co., Inc.
tro Labs.
lkirt Co.
bcor, Inc., Government Div.

PLUGS

a. Computer Board
b. Connector
c. Dehydrator
d. Expansion
e. Hardware
f. Metallic
g. Non-Metallic
h. Printed Circuit
i. Telephone
j. Terminal

AMP Inc., h, j.
Accurate Electronics Corp., Dept. D, a, b, e thru h, j.
Aerolite Electronics Corp., b.
Alden Products Co., b.
Amatom Electric Hardware Co. Inc., e, h, j.
American Felt Co., g.
American Missile Products Co., Inc., a.
American Standard Products, Inc., b, e, f.
Amphenol Connector Div., Amphenol-Borg Electronics Corp., b.
Antan Electronic Labs., Inc., b.
Armel Electronics, Inc., b, g, h.
Arrow-Hart & Hegeman Electric Co., The, b.
Atma Seal Co., j.
Audio Development Co., i.
W. A. Beauchaine & Sons Inc., b.
Best Aircraft Corp., e.
Birnbach Radio Co., Inc., b, h, i, j.
Bland Burner Co., The, e.
Burndy Corp., Omaton Div., b, h, j.
Burroughs Corp., a.
Cable Electric Products Inc., b.
Calinoy-Div.-Illinois Tool Works, e, f, g.
Cambridge Thermionic Corp., a, b, h, j.
***CANNON ELECTRIC CO., b.**
Carmac Aviation
Centralab, Div.-Globe-Union, g, h.
Century Fasteners Corp., b, e, f, j.
Chandler Evans Corp., c.
Clover Industries, Inc., b, f, g.
Coaxial Connector Co. Inc., b, f.
Cole Electric Co., a, b.
Eagle Electric Mfg. Co. Inc., b.
Elco Corp., b, h.
Electrical Insulation Co., Inc., g.
Electrocraft, Inc., b, i.
Garde Mfg. Co., b, h.
Gladding, McBean & Co., b, g, h.
Good Electronic Corp., h.
Harco Labs., Inc., b.
Hobson Brothers, Inc., b, j.
ITT-Kellogg, i.
Javex Electronics, b, f, g.
Joclin Mfg. Co., g.
E. F. Johnson Co., b.
Howard B. Jones Div.-Cinch Mfg. Corp., b.
Keystone Electronics Corp., e, j.
Kickhaefer Mfg. Co., d.
Korda Industries, b.
Kulka Electric Corp., b.
La Pointe Industries Inc., h.
Litton Industries, U. S. Engrg. Co., Div., e, f, j.
Malco Mfg. Co., h, j.
P. R. Mallory & Co. Inc., a, b, e.
J. E. Menaugh Co., g, j.
Metal Textile Corp., Electronics Div., f.
Milgo Electronic Corp., a.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, g.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., b, i, j.
National Tel-Tronics Corp., i, j.
North Electric Co., i.
Norton Co., New Products Dept., g.
***PACKARD-BELL ELECTRONICS CORP., a, h.**
Milton Ross Metals Co., The, b, h, j.
Rubbercraft Corp. of California, g.
Silicone Insulation, Inc., g.
Slip Ring Co. of America, a.
Specialty Engrg. & Electronics Co.
Specialty Plug & Cap. Co., g.
Standard Electric Time Co., The, b.
Stromberg-Carlson Div.-General Dynamics Corp., i.
Superex Electronics Corp., i.
Switchcraft, Inc., i.
Tower Mfg. Corp., b.
Transistor Electronics Corp., a.
Ucinite Co., The, Div.-United-Carr Fastener Corp., b, h, i.
Vector Electronic Co., b.
W-S Fittings Works, Forge & Fittings Div., H. K. Porter Co. Inc., f.
Waldom Electronics Inc., j.
Waltham Horological Corp., b, i.
Webcor, Inc., Government Div., h.
Western International Co., b, f, g, i.
Wrought Washer Mfg., Co., d.

PLYWOOD MANUFACTURERS

***AIRESEARCH MFG. CO. OF ARIZ.**
Liss Products, Inc.
United Electric Controls Co.
United States Plywood Corp.
Universal Moulded Products Corp.

PNEUMATIC CONTROLS & SYSTEMS

Adel Precision Products of California, Div.-General Metals Corp.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Aro Equipment Corp.
***ASSOCIATED TESTING LABS., INC.**
Barber-Colman Co.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Bendix Utica Div., Bendix Aviation Corp.
Bristol Co., The
Cadillac Gage Co.
Carruthers & Fernandez, Inc.
Canaflow Corp.
Consalidated Controls Corp.
Consalidated Diesel Electric Corp.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Cornelius Co., The, Aero Div.
Dresser Industries, Inc.
Dumont Aircraft Fitting Co.
Dynamic Controls Corp.
Gardner-Denver Co.
General Electric Co., Apparatus Sales Div.
Graflex Inc.
Greer Hydraulics, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Hannifin Co., Div.-Parker-Hannifin Corp.
Haskel Engrg. & Supply Co.
Walter J. Hyatt Co., The
Hydra-Power Corp.
Hydramatics, Inc.
Integral Corp.
Intercantinental Dynamics Corp.
Interstate Engrg. Corp.
Kahn & Co., Inc.
***KEARFOTT CO., INC.**
Walter Kidde & Co., Inc., Aviation Div.
Koehler Aircraft Products Co.
Lear, Inc.
Leslie Co.
Marotta Valve Corp.
Marquardt Aircraft Co.
Mason-Neilan
McDowell-Wellman Companies, The
Menasco Mfg. Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
National Instrument Laboratories, Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Ozone Metal Products Corp.
Pacific Scientific Co.
Pneu-Hydro Valve Corp.
Pneumafil Corp.
Reinhold Engrg. & Plastics Co.
Ryan Aeronautical Co.
Sargent Engrg. Corp.
Scientific Instrument Co.
Southwest Products Co.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Surface Combustion Corp.
Toctair Valve Div.-Aircraft Products Co.
Talley Corp., The
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Turbo Products, Inc.
United Aircraft Products, Inc.
United Control Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Vinson Mfg. Co. Inc.
Waldorf Fluid Systems. Div.-F. C. Huyck & Sons
Webcor, Inc., Government Div.
Westinghouse Air Brake Co., Industrial Products Div.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp.
Westronics Inc.

PNEUMATIC STARTERS
See STARTERS, PNEUMATIC

PNEUMATIC SYSTEMS RESERVOIRS
See RESERVOIRS, PNEUMATIC SYSTEMS

POINTERS, DIAL

Adept Industries Inc.
Atlas Precision Products, Co.
Carmody Corp.
Dale Products, Inc.
Jodee Plastics Co.
Lux Clock Mfg. Co., Inc.
Maryland Etching Co. Inc.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Panel Engrg. Corp.
Research Development Mfg. Inc.
Milton Ross Metals Co., The
United States Radium Corp.
Waldom Electronics Inc.
J. H. Winn Inc.

PORTABLE COMPRESSORS
See COMPRESSORS, PORTABLE

PORTABLE TRANSCEIVERS
See TRANSCEIVERS, PORTABLE

POSITION INDICATORS

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Antlab Inc.
Atlas Precision Products, Co.
Bristol Co., The
Centronix Inc.
Chrysler Corp., Defense Operations Div.
G. L. Collins Corp.
Colorado Research Corp.
Daystrom Pacific Div.-Daystrom, Inc.
Electro Products Laboratories, Inc.
Ferronti Electric Inc.
General Electric Co., Aircraft Sales Div.
***KEARFOTT CO., INC.**
Land-Air Inc.
Lear, Inc.
Liquidometer Corp., The
Minneapolis-Honeywell Regulator Co., Industrial Div.

Motorola Inc., Military Electronics Div.
New England Scientific Instruments Co.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Panel Engrg. Corp.
Philco Corp., Government & Industriol Div.
Raytheon Mfg. Co., Government Equipment Div.
Scientific-Atlanta, Inc.
Servomechanisms, Inc.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Waldorf Electronics, Div.-F. C. Huyck & Sons
Wind Turbine Co.
Wintronics

POTENTIOMETER TRIMMERS

Aero Electronics Corp.
Amelco, Inc.
Analogue Controls, Inc.
Bourns Labs., Inc.
Carter Mfg. Corp.
Centralab, Div.-Globe-Union
Clorostat Mfg. Co., Inc.
Colvin Labs., Inc.
Components Corp.
Dole Products, Inc.
Daystrom Pacific Div.-Daystrom, Inc.
Edcliff Instruments
Electromath Corp.
Fairchild Controls Corp., Components Div.
Gamewell Co.
Helipot Div.-Beckman Instruments Inc.
New England Instrument Co.
Precision Line Inc.
George Rattray & Co.
Reon Resistor Corp.
Rinco, Inc.
Technology Instrument Corp.
Wesrep Corp.

POTENTIOMETERS

a. Absolute Pressure
b. Differential Pressure
c. High Resistance
d. High Voltage
e. Induction
f. Linear & Non-Linear Precision Carbon Film
g. Linear & Non-Linear Precision Wire Wound
h. Metallic Film
i. Portable Instrument
j. Precision
k. Precision Auto-Transformer
l. Precision Carbon Film
m. Printed Circuit
n. Rectilinear
o. Slidewire

Ace Electronics Associates, Inc., g, j, n.
Allegony Instrument Co., Inc., i.
American Electronics, Inc., e, j.
American Electronics, Incorporated, e.
American Electronics, Inc.-Instrument Div., e.
Analogue Controls, Inc., g, i, j.
Anton Electronic Labs., Inc., g, j, n, o.
B & H Instrument Co., Inc., g, i, j, o.
Bendix Aviation Corp., Friez Instrument Div., a.
Borg Equipment Div., Amphenol-Borg Electronics Corp., g, j, n.
Bourns Labs., Inc., a, b, c, f, g, i, j, m, n.
Carter Mfg. Corp., g, j.
Centralab, Div.-Globe-Union, f, g, m, n, o.
Chicago Aerial Industries, Inc., g, i, j, m, n, o.
Clarostat Mfg. Co., Inc., c, d, f, g, j, l, m, n.
G. L. Collins Corp., e, k.
Colorado Research Corp.
Colvin Labs., Inc., a, f, m.
Components Corp., g, i, j.
Computer Instruments Corp., a, b, c, f, j, l, n.
Continental Carbon, Div.-Wirt Co., g, m.
Control Circuits Inc., k.
Curtiss-Wright Corp., Electronics Div., g, j, m.
Dale Products, Inc.
Datran Electronics, Div.-Mid-Continent Mfg. Co., Inc., i.
Daystrom Pacific Div.-Daystrom, Inc., c, g, h, j.
Daystrom Transicoil Div., Daystrom Inc., e, j.
Dejur-Amsco Corp., Electronic Sales Div., c, g, j, n.
Diehl Mfg. Co., g, j.
Edcliff Instruments, a thru d, g, j, m.
Electromath Corp., c, g, i, j.
Electro-Measurements Inc., g, j.
Electro-Mec Lab. Inc., g.
Electro-Tech Equipment Co., i.
Engelhard Industries, Inc., a.
Epic, Inc., i, j.
Fairchild Controls Corp., Components Div., a, b, g, h, n.
Formingdale Mfg. Corp., g, h, j.
Fischer & Porter Co., a, b.
Fisher Research Lab., Inc., i.
Gamewell Co., The, g, j.
G. M. Giannini & Co., Inc., a thru g, j, n, a.
Harco Labs., Inc., i.
Helipot Div.-Beckman Instruments Inc., c, e, g, h, j, n, o.
Hoffman Labs. Div., Hoffman Electronics Corp., n.
Hoover Electric Co., g, j.
Hughes Tool Co., Aircraft Div.
Humphrey, Inc., g, i, m.
International Resistance Co., h, i.
Jovex Electronics, g.
*KEARFOTT CO., INC., e.
Ketay Dept., Norden Div., United Aircraft Corp., e thru a.
Langevin Div., The W. L. Maxson Corp., k.
Leeds & Northrup Co., e, i, j, a.
Litton Industries, Inc., g.
P. R. Mallory & Co. Inc., f, g, h, m.
Markite Corp., c, f, j, n.
Minco Products, Inc., n.
Minneapolis-Honeywell Regulator Co., Aeronautical Div., g, j.
Minneapolis-Honeywell Regulator Co., Industrial Div., i, j, a.
Minneapolis-Honeywell Regulotor Co., Industrial Product Group, a, b, c, i, j, o.
New England Instrument Co., g, n, o.
Dsborne Electronic Sales Corp., g.
Pacific Scientific Co., g, j, n.
Palo Alto Engrg. Co., g.
Perkin-Elmer Corp., k.
Physics Research Laboratories, Inc., i.
Pickering & Co., Inc., e.
Precision Line Inc., c, d, g, j, m, n, o.
Rahm Instruments, Div.-American Machine & Metals, Inc., a, b.
George Rattray & Co., g, j.
Rawson Electrical Instrument Co., g.
Raymond Engrg. Lab., Inc., g, j, k.
Reon Resistor Corp., c, m.
Rinco, Inc., g, i, j, o.
San Fernando Electric Mfg. Co., g, j, a.
Shallcross Mfg. Co., c, g, i.
Special Instruments Div., British Industries Corp., a, b.
Spectrol Electronics Corp., c, d, g, i, m, a.
H. W. Sullivan Ltd., a.
Technique Associates Div., Duncan Electric Co., Inc., i.
Technology Instrument Corp., a thru a.
Thermo Electric Co., Inc., g, i, j.
Thwing-Albert Instrument Co., i.
Trans-Sonics, Inc., a, b.
Tucson Instrument Corp., g, j, n.
U. S. Science Corp., Div.-Topp Industries, Inc., c, g, j, k, n.
Vernistat Div., The Perkin-Elmer Corp., k.
Wesrep Corp., g, i, j, n, o.
Weston Instruments, Div.-Daystrom, Inc., h, j.
Westronics Inc., i.
Wright Engrg. Co., g, j, k.

POTS, SOLDERING

Alloys Unlimited Inc.
American Gas Furnace Co.
Dee Electric Co.
Electro-Tech Equipment Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
A. F. Holden Co., The
Seal-Peel, Inc.
Temperature Engrg. Corp.
Waage Electric, Inc.

POTS & TANKS, HEATING

ACF Industries Inc.
American Gas Furnace Co.
Anchor Metal Spinning Co., The
Brighton Corp.
Electric Heater Co., The
Fidelity Chemical Products Corp.
General Electric Co., Apparatus Sales Div.
A. F. Holden Co., The
Hull Corp.
Pacific Scientific Co.
Reinhold Engrg. & Plastics Co.
Rolock Inc.
Seamless Products Co., Inc.
Temperature Engrg. Corp.
Waage Electric, Inc.
Western Coating Co.

POWDERED METAL GEARS

See GEARS, POWDERED METAL

POWDERED METAL PARTS FABRICATORS

See FABRICATORS, POWDERED METAL PARTS

POWER ABSORBERS

Consolidated Diesel Electric Corp., Test Equip. Div.
*MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.
Pacific Scientific Co.
Sun Electric Corp., Aeronautical Div.
Western Gear Corp.

POWER CONNECTORS

See CONNECTORS, POWER

POWER SOURCES, AUXILIARY

See AUXILIARY POWER SOURCES

POWER SOURCES, GROUND

a. Electric
b. Hydraulic
c. Mechanical
d. Pneumatic
e. Prime Movers

Adel Precision Products of California, Div.-General Metals Corp., b.
*AIRESEARCH MFG. CO. OF ARIZ., e.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, d.
Allied Internationol Co., a.
Amelco, Inc., a.
American Bosch Arma Corp., b.
Americon Brake Shoe Co., b.
American Electronics, Inc., Electric Machinery & Equipment Div., a, d.
American Machine & Foundry Co., Greenwich, a, c, e.
Apex Reinforced Plastics, Div.-White Sewing Mac Corp., d.
Associated Engineers, Inc., b, c, d.
Barker Sales Co., e.
Bendix Aviation Corp., York Div., a.
Bendix Utica Div., Bendix Aviation Corp., b, c, d
Bogue Electric Mfg., Co., a thru d.
Bulow Electric Co., a, b.
Cardinal Instrumentation Corp., a.
Chrysler Corp., Defense Dperotions Div.
Consolidated Diesel Electric Corp., a thru d.
Continental Aviation & Engrg. Corp., d.
Cornelius Co., The, Aero Div., d.
Cummins Engine Co., Inc., e.
Curtiss-Wright Corp.-Utica Div., a, d, e.
Davenport Mfg. Co., a.
Delco-Remy Div., General Motors Corp., a.
Denison Engrg. Div., American Brake Shoe Co., b.
Dresser Industries, Inc., a, e.
Dumont Aircraft Fitting Co., b, d.
Eagle-Picher Co., The, a.
Eastern Industries Inc., b.
Electric Products Co., The, a.
Electro-Mechanical Products Co., a.
FWD Corp., a thru e.
Foote Bros. Gear & Machine Corp., c.
Gardner-Denver Co., d.
General Electric Co., Apparatus Sales Div., a, e.
Green Rectifier Co., a.
Greer Hydraulics, Inc., a thru d.
Guided Missile Div.-DeHavilland Aircraft of Canada, Ltd., a.
Hannifin Co., Div.-Parker-Hannifin Corp., b.
Haskel Engrg. & Supply Co., b, d.
Hertner Electric Co., The, a, e.
Hoover Electric Co., a, c.
Hycon Mfg. Co., a, b, d.
Hydro-Power Corp., b, d.
Industrial Engrg. Corp., b.
International Fermont Machinery Co., Inc., a, b, c,
Jack & Heintz, Inc., a, b, c.
Jeto, Inc., a thru e.
Kahn & Co., Inc., a, b, d.
*KEARFOTT CO., INC., a.
Kelsey-Hayes Co., b.
Kemp Aero Products, b, c, d.
Leoch Corp., a.
Lear, Inc., Grond Rapids Div., a.
Minneapolis-Honeywell Regulator Co., Ordnance Div., b.
*MOTOR GENERATOR CORP., a.
Motoreseorch Co., a.
Mullenbach Div.-Electric Machinery Mfg. Co., a.
Multi-Amp Corp., a.
Dil-Dyne, Inc., b.
D. W. Dnan & Sons Inc., a, e.
Perkin Engrg. Corp., a.
Power Supplies Inc., a.
Pre-Flite Industries Corp.-Sub.-Avco Corp., a thru
Racine Hydraulics & Machinery Inc., b.
Red Lion Cabinet Co., Redco Tool Div., b.
Republic Aviation Corp., a.
Rucker Co., The, b, d.
Safety Electricol Equipment Corp., a.
Sargent Engrg. Corp., b, d.
Schaffer Air Industries, Inc., b.
Skyline Electric & Mfg. Co., a thru d.
Solar Aircraft Co., a, c, d, e.
Space Corp., b, e.
Stratos, Div.-Fairchild Engine & Airplane Corp., d.
Sun Electric Corp., Aeronautical Div., a, b, d.
Talley Corp., The, a, c, d.
Tapco Group, Thompson-Ramo-Wooldridge Inc., a, b d.
Technical Apparatus Builders, a.
Telectro Industries Corp., a.
United Aircraft Products, Inc., a thru d.
U. S. Relay Co., a.
Universal Metal Products Inc., a.
Vickers Inc., Div.-Sperry Rand, b.
Vickers Inc., Marine & Ordnance Dept., Machinery Hydraulics Div., b.
Waste King Corp., Technicol Products Div., c.
Watertown Div., The New York Air Brake Co., b.
Western Geor Corp., a thru e.
Westinghouse Electric Corp., a, e.
*WHITE DIESEL ENGINE DIV., THE WHITE MOTOR CO., e.
Wickfield, Inc., b, c, d.
Winchorger Corp., Sub.-Zenith Rodio Corp., a.

POWER SOURCES, PROPELLANT CARTRIDGES

*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.

POWER SUPPLIES

a. AC
b. DC
c. Emergency, Mobile
d. 400 CPS
e. High Voltage
f. Klystron
g. Magnetic
h. Regulated
i. Seals
j. Transmitter
k. Transistor

l. Variable
m. Voltage Regulated

C ELECTRONICS DIV., GENERAL MOTORS CORP.,
F Industries Inc., a, b, h.
P Inc., h, l, m.
me Electric Corp., a, b, g, h, k, l, m.
rojet-General Corp., a, b, d, m.
rolab Development Co., a thru e, g thru m.
Logistics Corp., a, c, j, l, m.
Reduction Sales Co., Div.-Air Reduction Co., Inc., a, b.
com Inc., f.
IRESEARCH MFG. CO. OF ARIZ., a, b.
IRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a thru e, m.
pax Electronics Inc., Seminole Div., d.
co Products, Inc. c.
red Electronics, e, f, h, m.
ied Internatianal Co., a, b, c.
o Scientific Co., Inc., k.
elco, Inc., a, b, d thru h, j thru m.
erican Electronics, Inc., a, b, d, e, g, h, k, l.
erican Electronics, Inc., Electric Machinery & Equipment Div., a, d, h, k, l, m.
erican Electronics, Inc., Taller & Cooper Div., a.
erican Machine & Foundry Co., Greenwich, m.
erican Missile Products Co., Inc., a, b, j, k, m.
erican Research & Mfg. Corp., a, b, d, e, g, h, k, m.
plifier Corp. of America, a, b, d, h, k, l, m.
oheim Electronics Co., Inc., b, h, k, m.
plied Research Labs., Inc., a, b, e, l.
RNOUX CORP., a, b, d, e, g, h, j, k, m.
sociated Engineers, Inc., h, k, m.
sociated Research, Inc., a, b, e.
tronetics, Inc., c, g, k, l.
lantic Research Corp., b, m.
los Engrg. Co. Inc., a thru m.
dio Development Co., a, b, d, h, k, m.
tamatic Switch Co., c.
bcock Radio Engrg., Inc., b, j.
rker & Williamson Inc., a, b, e, k.
rwood Electronics Inc., a, b, d, h.
x Bassett, Inc., b, e, j, k, m.
EHLMAN ENGRG. CO., a, d, l.
ll Aircraft Corp., Niagara Frontier Div., k.
lock Instrument Corp., a, b, d, e, j, k.
ndix Aviation Corp., Red Bank Div., a thru h, j thru m.
ndix Aviation Corp., York Div., d, e, h, j, k, m.
ndix Utica Div., Bendix Aviation Corp., a, b, d.
vo Lab., Inc., e, m.
gue Electric Mfg., Co., a thru d, f, g, j thru m.
ach Mfg. Corp., Div.-General Bronze, a thru e, g, h, k, l, m.
acke-Seib X-Roy Co., Inc., a, b, e, l.
own Engrg. Co., Inc., d, k.
delman Electronics Corp., a, b, j.
lova Watch Co., Electronics Div.
low Electric Co., a, b, d, k.
ble Electric Products Inc., b.
lifornia Technical Industries, Div.-Textron Inc., f.
rdinal Instrumentation Corp., a, b, d thru h, k, l, m.
rol Electronics Corp., b.
rruthers & Fernandez, Inc., a, b, d, g, h, k, m.
lco (Constontine Engrg. Labs. Co.), a, b, d thru h, k.
ntral Transformer Co., b, e.
alco Engrg. Corp., a, b, d, e, g, h, k, l, m.
icago Aerial Industries, Inc., a, h, l, m.
icago Standard Transformer Corp., k.
ristie Electric Corp., b, d, g, h, k, l.
L. Collins Corp., a.
lorado Research Corp., b, h, m.
mputer Engrg. Associates, Inc., a thru d, g, k.
nsolidated Avionics Corp., a thru l.
nsolidated Controls Corp., c.
nsolidated Diesel Electric Corp., a thru d, k.
nsolidated Diesel Electric Corp., Western Div., a thru e, l, m.
nsolidated Electrodynamics Corp., a, b, d, h.
ntrol Circuits Inc., a, b, e, k, l, m.
oper Development Corp., Sub.-Marquardt Aircraft Co., e, h, k.
bic Corp., f.
mmins Engine Co., Inc., a thru d, m.
rtiss-Wright Corp., Electronics Div., a, b, d, h, m.
rtiss-Wright Corp., Research Div., b, l.
rtiss-Wright Corp., Santa Barbara Div., c.
rtiss-Wright Corp., Utica Div., c.
& R. Ltd., g, h.
almotor Div., Yuba Consolidated Industries, Inc., a, b, d, e, g, k, m.
ta-Control Systems, Inc.
tascan Inc., b, c, h, k, l, m.
ven Co., The, a thru e, g thru m.
venport Mfg. Co., a, b, e thru h, k, l, m.
yton Aircraft Products, Inc., e, l, m.
yton Aviation Radio & Equipment Corp., a, b, d, h, j, k, m.
l Electronics Corp., a thru e, h, k.
lco-Remy Div., General Motors Corp., a, b, h, k, m.
lco-Wayne Electronics, Div.- Divco-Wayne Corp., a thru e, g, h, l.
nner Scientific Co., b, l, m.
rsett Labs., Inc., b, d, j, k, m.
resser Industries, Inc., a thru e, h, i, k, l, m.
resser Mfg. Div., Dresser Industries, Inc., b, h, m.
ynamic Controls Co., b, d, g, h, k, m.
agle-Picher Co., The, b.
lcor Div.-Scronton, a, d, k.
Elcor, Inc., b, e, h, k, l, m.
Electric Auto-Lite Co., The, b, e.
Electric Machinery Mfg. Co., d.
Electric Products Co., The, a thru d, l, m.
Electro Engrg. Works, a, b, d, e, h, j, l, m.
Electro Products Laboratories, Inc., b, l.
Electromoth Corp.
Electro-Mechanical Products Co., a thru d, h, j, m.
Electronic Assembly Co., Inc., a thru h, j thru m.
Electronic Communications, Inc., a, b, d, e, g, h, j thru m.
Electronic Engrg. Co. of California, b, h, k, l, m.
Electronic Instrument Co., Inc. (EICO), k.
Electronic Research Associates, Inc., a, b, d, e, g, h, k, l, m.
Electronic Specialty Co., a, b, h, k.
Electronic Tube Corp., a, b, h, m.
Electronics of Clearfield, Inc., b.
Electronics International Co., a, d.
Electro-Tech Equipment Co., a, h, l, m.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., a, b.
Emerson Radio & Phonograph Corp., a thru l.
Empire Products Sales Corp., a, f.
Endevco Corp., a, b.
Engineered Magnetics, Div.-Gulton Industries, Inc., a thru d, g, h, j, k, m.
Engrg. Associates, e, f.
Ensco, Inc., b, d, e, g.
Entron, Inc., h, m.
*ETS-HOKIN & GALVAN, a, b, c.
FXR, Inc., f.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., a, b, d, h, l, m.
Fairfield Engrg. Corp., a, b, g, h, k-1, s-1, b-2,
Ferrotran Electronics Co., Inc., a, b, h, k, l, m.
First Electronics Corp., The, a, b, e thru h, k, l, m.
Fisher Research Lab., Inc., k.
John Fluke Mfg. Co., Inc., b, e, f, h, l, m.
Fluorocarbon Co., The, i.
Foto-Video Labs., Inc., b, e, h, m.
Freed Transformer Co., Inc., b, m.
General Communication Co., b.
General Devices, Inc., a, b, d, e, g, i thru l.
General Electric Co., Apparatus Sales Div., a thru e, g, h, k, l, m.
General Magnetics, Inc., g, m.
Georator Corp., a thru d, l, m.
Geotronic Labs. Inc., d, e, g, h, k, m.
Good Electronic Corp., a, b, h, l, m.
Good-All Electric Mfg. Co., a, b, c, e, f, h, j thru m.
Gordon Enterprises, a, b, d.
Goslin Electric & Mfg. Co., a, b, d thru h, j, k, m.
Green Rectifier Co., a, b, d thru h, l, m.
Gremco, Inc., a thru d, m.
Guided Missile Div.-DeHovilland Aircraft of Canada, Ltd., a thru d, g, h, k, m.
Gulton Industries, Inc., b, d, g, h, k, m.
Hagan Chemicals & Controls, Inc., b.
Hollicrafters, b, e, h, j, k, m.
Hamilton Standard, Div.-United Aircraft Corp.
Harrison Labs., Inc., b, e, g, k, l, m.
Harvey-Wells Electronics Inc., a, e, g, j thru m.
Hertner Electric Co., The, a, b, d, e, h, l, m.
Hevi-Duty Electric Co., e, h, l.
Hewlett-Packard Co., a, f, l, m.
Hoffman Electronics Corp., Semiconductor Div., b.
Hoover Electric Co., a thru e, k, m.
Hughes Tool Co., Aircraft Div.
Hycon Mfg. Co., a, b, c, h, l, m.
*HYDRO-AIRE CO., DIV.-CRANE CO., a, b, k.
I-L-S Instrument Div., The Meriam Instrument Co., d, l.
Industrial Television Inc., d.
Industrial Test Equipment Co., a, d, h, l, m.
Instruments For Industry, Inc., b, h, j, k, m.
International Electronic Research Corp., a, d.
International Fermont Machinery Co., Inc., a thru d, h, m.
Internotional Research Associates, a, b, d, f, g, j, k, l.
Interstate Electronics Corp., b.
Itek Corp., l.
Jack & Heintz, Inc., a thru e, g, h, k, l, m.
Jansky & Bailey, Inc., b, h, m.
Jeta, Inc., a thru e.
Johnson Electronics Inc., j.
Jordan Electronics, Div.-Victoreen Instrument Co., a, b, d, k.
Kahn & Co., Inc., b.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., d, h, k.
Kay Electric Co., k.
*KEARFOTT CO., INC., a thru d, h, m.
Keithley Instruments, Inc., b, h, l, m.
Kinney Mfg. Div., The New York Air Brake Co., a, b, e, h, l, m.
Kin Tel Div.-Cohu Electronics, Inc., b.
Kingston Electronics-Div.-Kingston Industries Inc., b.
Lambda Electronics Corp., a, d, f, h, j thru m.
Land-Air Inc., a, b, d, e, j.
Langevin Div., The W. L. Maxson Corp., a, b, d, e, g, h, m.
Leach Corp., a, b, d, g, h, k, l, m.
Lear, Inc., a, b, d, g, h, k, m.
Lear, Inc., Grand Rapids Div., a, d.
Leeds & Northrup Co., m.
Leland Airborne Products, Div.-American Machine & Foundry Co., a thru e, g, h, l, m.
Levinthol Electronic Products, Inc., e, f, j.
Litton Industries, Marylond Div., h.
Livingston Electronic Corp., j, k.
Macarr, Inc., a, b, g, h, l.
Magnetic Controls Co., a, b, d, g, h, k, m.
Magnetic Research Corp., b, d.
Manson Labs., Inc., a, b, e, f, h, j, l, m.
Marquardt Aircraft Co., c.
Master Specialties Co., a, b, d, h, m.
W. L. Maxson Corp., The, h.
Menlo Research Lab., a.
Micrometrical Mfg. Co.
Sanford Miller Co., b, k.
Minneapolis-Honeywell Regulator Co., Boston Div., a, d, m.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, h, m.
Minneapolis-Honeywell Regulator Co., Ordnance Div., a, b, d, k, m.
Miratel, Inc., b, e, h, j, l, m.
Model Rectifier Corp., b, k, l.
Moran Instrument Corp., b, e, m.
Morse Instrument Co., The, b, m.
*MOTOR GENERATOR CORP., a thru e.
Motoresearch Co., a thru d, h, m.
Motorola Inc., Military Electronics Div., a, b, d thru h, j thru m.
Mucon Corp., a thru h, j thru m.
Heinz Mueller Eng. Co., Inc., b.
Mullenbach Div.-Electric Machinery Mfg. Co., b.
Multi-Amp Corp., a, b, e, g, h, l, m.
Munston Mfg. & Service, Inc., a, e, j, k.
NYT Electronics, Inc., a, b, d, e, g, h, j, k, m.
George L. Nankervis Co., a, b.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., a, b, j, k, m.
Navigation Computer Corp., b.
Neff Instrument Corp., b, k.
Networks Electronic Corp., b, c, d, g, h, i, k, l, m.
Neutronic Associates, b, e, h, l, m.
North Electric Co., a, b, m.
North Hills Electric Co., Inc., b, e, h, l, m.
Northeast Electronics Corp., b, e, h, k, l, m.
Northeast Scientific Corp., e, f, m.
Northrop Corp., a thru h, k, l.
Paul Nurches Co., b, h, k, l, m.
Nutron Mfg. Co. Inc., a, b, g, j, k, l.
D. W. Onan & Sons Inc., a thru d, h, m.
Orbitran Co., Inc., k, m.
Pacific Magnetic Corp., a, b, d, g, h.
*PACKARD-BELL ELECTRONICS CORP., b, h, m.
Ralph M. Parsons Co., The, Electronics Div., b, d, m.
Patterson, Moos Div.-Universal Winding Co., Inc., a, b.
Perkin Engrg. Corp., a thru m.
Perry Plastics, Inc., a, b, d.
Peschel Electronics, Inc., a, b, d, e, f, l.
Pesco Products Div.-Borg-Warner Corp., a, b, c.
George A. Philbrick Researches, Inc., h.
Philco Corp., Government & Industrial Div., a, b, c, e, f, h, j thru m.
Pioneer Tool & Engrg. Co., a, b, e.
Pollarod Electronics Corp., f.
Polytechnic Research & Development Co., Inc., f.
Potter Co., The, b, d, e, h, m.
Power Designs Inc., a, b, d, f, h, k, l, m.
Power Sources, Inc., a thru d, g, h, k, l, m.
Power Supplies Inc., a thru e, g, h, j thru m.
Power-Tronic Systems Inc., a, b, d, k, l, m.
Precise Development Corp., a, b, e, h, k, l, m.
Q. O. S. Corp., e, j.
Quan-Tech Labs., b, h, k, m.
RS Electronics Corp., e, j, k.
Radiaphone Co. Inc., b, h, j, k, m.
Radiation Dynamics, Inc., e.
Radiation, Inc., b.
Radiation Instrument Development Lab., Inc., e.
Ramo-Wooldridge Div., Thompson Ramo Wooldridge of Calif., a, b.
Rapid Electric Co., b, h, k, l.
Raytheon Mfg. Co., a, b, g, h, m.
Reflectone Corp., The, g, h, k, l, m.
Republic Aviation Corp., b, h, l, m.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV., d, j, m.
Rixon Electronics Inc., a, b, d, h, k.
Safety Electrical Equipment Corp., a thru d, h, m.
Sangamo Electric Co., a, b, d, e, h.
Schaevitz Engrg., a.
Scientific Engrg. Labs., Inc., e, l, m.
H. H. Scott, Inc., a, l.
Seco Mfg. Co., l.
Seeburg Corp., The, a, b, j, k, m.
Sel-Rex Corp., b, c, g, h, l, m.
Sequoia Wire & Cable Co.,-Div.-Mandrel Industries, Inc., a, b, h, k, l, m.
Servomechanisms, Inc.
Servomechanisms, Inc., Mechatrol Div., d.
Shallcross Mfg. Co., b.
Sherman Industrial Electronics, Div.-Engrg. Design Inc., e.
Solor Aircraft Co., b.
Sorensen & Co., Inc., a thru e, g, h, j thru m.
Southwestern Industrial Electronics Co., a thru m.
Special Instruments Div., British Industries Corp., f.
Specialty Engrg. & Electronics Co., h, m.
Spectrol Electronics Corp., a, b, d, e, h, k, m.
Sperry Microwove Electronics Co., Div.-Sperry Rand Corp., f.
State Testing Lob. Inc., a, b, h, l, m.
Stromberg-Carlson Div.-General Dynamics Corp.,
Suffolk Products Corp.

Sun Electric Corp., Aeronautical Div., a, b.
Superior Electric Co., The, a, b.
Syntron Co., b, e, h, m.
Talley Corp., The, a, b, c, g, h, l, m.
Tapco Group, Thompson-Ramo-Wooldridge Inc., a, b, c, d, j, m.
Technical Apparatus Builders, a thru m.
Telectro Industries Corp., a thru e, g, h, j thru m.
Tele-Dynamics Inc., k.
Telerad Mfg. Corp., f.
Tel-Instrument Electronics Corp., a, b, d, e, h, m.
Torwico Electronics, Inc., b, g, h, m.
Trans Electronics, Inc., a, b, d, e, h, k, l, m.
Transdyne Corp., a, b, d, h, l, m.
Turbo Machine Co., a, b, h, m.
United Electrodynamics, Inc., a, b, d, h, j, k, m.
U. S. Industries, Inc., a, b, m.
U. S. Science Corp., Div.-Topp Industries, Inc., a, b, d, g, h, j thru m.
Universal Electronics Co., b, d, e, g, h, k, l, m.
Varian Associates, b, d, e, f, h, j, l, m.
Varo Mfg. Co., Inc., a, b, d, e, h, k, m.
Video Instruments Co., Inc., b, d, h, k, l, m.
Virginia Electronics Co., Inc.
Waldorf Electronics. Div.-F. C. Huyck & Sons, k.
Western Design, Div.-U. S. Industries, Inc.; Santa Barbara Div., a, b, d.
Western Gear Corp., a thru e, k, l, m.
Westinghouse Electric Corp., a, b.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., a, b, d, k.
*WHITE DIESEL ENGINE DIV., THE WHITE MOTOR CO., a thru e, m.
Wincharger Corp., Sub.-Zenith Radio Corp., a thru d, k.

POWER SYSTEMS, ELECTRIC
See ELECTRIC POWER SYSTEMS

POWER UNITS, RECTIFIER
See RECTIFIER POWER UNITS

PRECIOUS METAL PLATING
See PLATING, PRECIOUS METAL

PRECIPITATORS, ELECTROSTATIC

Air-Maze Corp.
Bendix Utica Div., Bendix Aviation Corp.
Dayton Aircraft Products, Inc.
Koppers Co., Inc.
Merix Chemical Co.
Rodex Corp.
Trion, Inc.
Westinghouse Electric Corp.

PRECISION APPROACH RADAR
See RADAR, PRECISION APPROACH

PRECISION DRILL PRESSES
See DRILL PRESSES, PRECISION

PRECISION GEARS
See GEARS, PRECISION

PRE-SELECTORS

Barker Sales Co.
Bendix Aviation Corp., York Div.
Electronic Communications, Inc.
ITT Federal Div., International Telephone & Telegraph Corp.
Meridian Metalcraft, Inc.
Motorola Inc., Military Electronics Div.
Telerad Mfg. Corp.

PRESET PANELS LIGHTING EQUIPMENT
See LIGHTING EQUIPMENT, PRESET PANELS

PRESS FORGINGS
See FORGINGS, PRESS

PRESSES, METAL FORMING

American Brake Shoe Co.
E. W. Bliss Co.
Chambersburg Engrg. Co.
Cincinnati Shaper Co., The
Farrel Birmingham Co. Inc.
Hannifin Co., Div.-Parker-Hannifin Corp.
Hufford Corp., The
Hydraulic Press Mfg. Co., The, Div.-Koehring Co.
Kenco Mfg. Co.
E. Konigslow Stamping & Tool Co.
Montgomery Engrg., Co.
Oliver Corp., The
Oliver Corp., The-A. B. Farquhar Div.
O'Neil-Irwin Mfg. Co.
Rotex Punch Co., Inc.
Rucker Co., The
Transmares Corp.
United States Chemical Milling Corp.
Verson Allsteel Press Co.
Wales Strippit Inc., Unit of Houdaille Industries, Inc.
Wasley Products, Inc.

PRESSES, PUNCH
See PUNCH PRESSES

PRESSURE INSTRUMENTS

Aerotec Corp., The
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Bendix Aviation Corp., Friez Instrument Div.
Bristol Co., The
Captive Seal Corp.
Colvin Labs., Inc.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Consolidated Electrodynamics Corp.
Curtiss-Wright Electronics Div., IMI Branch
Dynametrics Corp.
Electro-Mechanical Research, Inc.
Fairchild Controls Corp., Components Div.
Fischer & Porter Co.
Fisher Governor Co.
General Design
Glassco Instrument Co.
Hagan Chemicals & Controls, Inc.
Industrial Engrg. Corp.
Kahn & Co., Inc.
Lear, Inc., Grand Rapids Div.
*WALLACE O. LEONARD, INC.
Mason-Neilan
Matheson Co., Inc., The
Meriam Instrument Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Rochester Mfg. Co. Inc.
Sanborn Co.
Scientific Instrument Co.
Servomechanisms, Inc.
Statham Instruments, Inc.
A. U. Stone & Co., Inc.
Technology Instrument Corp.
Trans-Sonics, Inc.
Trimount Instrument Co.
Ultradyne, Inc.
United Electric Controls Co.
Wallace & Tiernan Inc.
Weksler Instruments Corp.
Wilks Precision Instrument Co., Inc.

PRESSURE MEASURING EQUIPMENT
See MEASURING EQUIPMENT, PRESSURE

PRESSURE RELIEF DEVICES–COLUMN FAILURE

*ANDERSON, GREENWOOD & CO.

PRESSURIZATION UNITS

Accessory Products Co., Div.-Textron Inc.
*AIRESEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Aro Equipment Corp.
Associated Engineers, Inc.
Bar-Roy Products, Inc.
Bendix Utica Div., Bendix Aviation Corp.
Consolidated Diesel Electric Corp., Test Equip. Div.
Cornelius Co., The, Aero Div.
Desomatic Products, Inc.
Hydromatics, Inc.
Kahn & Co., Inc.
Lear, Inc.
*McCORMICK SELPH ASSOCIATES
N. R. K. Mfg. & Engrg. Co.

PRESSURIZED CONNECTORS
See CONNECTORS, PRESSURIZED

PRINTED CIRCUIT COPPER LAMINATES
See COPPER LAMINATES, PRINTED CIRCUIT

PRINTED CIRCUIT SHEETS, METAL CLAD
See SHEETS, METAL CLAD, PRINTED CIRCUIT

PRINTED CIRCUIT SOLDERING EQUIPMENT
See SOLDERING EQUIPMENT, PRINTED CIRCUIT

PRINTED CIRCUITS

*AC ELECTRONICS DIV., GENERAL MOTORS CORP.
ACF Industries Inc.
Adept Industries Inc.
Aerolite Electronics Corp.
Amelco, Inc.
American Printed Circuits Co., Inc.
Arthur Ansley Mfg. Co.
Bendix Aviation Corp., York Div.
Brown Engrg. Co., Inc.
Cleveland Metal Specialties Co., Electronics Div.
Corning Glass Works
Croname Inc.
Dale Products, Inc.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Dorsett Labs., Inc.
Eaton Electronics Corp.
Electralab Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Gladding, McBean & Co.
Globe Electrical Mfg. Co.
Good Electronic Corp.
B. F. Goodrich Aviation Products
ITT Federal Div., International Telephone & Telegraph Corp.
Integrated Mica Corp.
ITT-Kellogg
Keil Engrg. Products
Lamtex Industries, Inc.
Land-Air Inc.
La Pointe Industries Inc.
Litton Industries, U. S. Engrg. Co., Div.
Motorola Inc., Military Electronics Div.
Panel Engrg. Corp.
Philco Corp., Government & Industrial Div.
Precise Development Corp.
Printronics Corp.
Ravenna Metal Products, Div.-Standard Screw Co.
Rogers Corp.
Milton Ross Metals Co., The
St. Regis Paper Co., Panelyte Div.
D. A. Schultz Co.
Stanley Aviation Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Technograph Printed Electronics, Inc.
Unison Products, Inc.
United Aircraft Products, Inc.
United States Chemical Milling Corp.
Webcor, Inc., Government Div.
Westinghouse Electric Corp.
Zenith Optical Laboratory

PRINTED, STAMPED, ETCHED CIRCUITS
See CIRCUITS, PRINTED, STAMPED, ETCHED

PROBES

a. Crystal
b. High Frequency
c. High Voltage
d. Measurement
e. Microwave
f. Pitot Static
g. Pressure
h. Temperature

Advanced Electronics, Inc., g, h.
Aero Research Instrument Co. Inc., f, g, h.
Ainslie Corp., e.
Air Logistics Corp., h.
Aircom Inc., a, e.
Aircom Inc. of New Jersey, e.
Airtron Inc., Div.-Litton Industries, e.
Allegany Instrument Co., Inc., h.
Allen Tool Corp.
*ARNOUX CORP., h.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., h.
Bendix Aviation Corp., York Div., e.
Bogart Mfg. Corp., e.
Branson Instruments, Inc., a.
Budd Stanley Co. Inc., e.
Bulow Electric Co., h.
Cardinal Instrumentation Corp., h.
Chesapeake Instrument Corp., a.
Christie Machine Works, b, d.
Consolidated Controls Corp., h.
Consolidated Diesel Electric Corp., f, g, h.
Crescent Engrg. & Research Co., h.
Demornay-Bonardi, e.
Diamond Antenna & Microwave Corp., a, e.
Douglas Microwave Co., Inc., e.
E-Z-Hook Test Products
Edcliff Instruments, f, g.
Electro-Mechanical Products Co., h.
Electronic Instrument Co., Inc. (EICO), a, b, c.
FXR, Inc., a, b, d, e.
Fenwal Electronics, Inc., h.
Fenwal Inc., h.
Ferrotherm Co., The, g, h.
Flow Corp., f, g, h.
General Electric Co., Apparatus Sales Div., h.
G. M. Giannini & Co., Inc., d, f, g, h.
John Gombos Co., Inc., e.
Claud S. Gordon Co., g.
Harca Labs., Inc., f, g, h.
Hesco Engrg., h.
Hewlett-Packard Co., b, d, e.
Holex, Inc., d.
Illinois Testing Laboratories, Inc., h.
Industrial Television Inc., a.
International Resistance Co., e.
Interstate Engrg. Corp., g, h.
Javex Electronics, c.
Kay Electric Co., b.
*KEARFOTT CO., INC., e.
Keithley Instruments, Inc., d.
Keystone Electronics Corp., c.
Leeds & Northrup Co., h.
*LEWIS ENGRG. CO., THE, h.
Magnaflux Corp., a, d.
Marconi Instruments, b, d.
Measurements Div., McGraw Edison Co., b, d.
Microlab, b, e.
Munston Mfg. & Service, Inc., b.
Narda Microwave Corp., The, e.
National Beryllia Corp., h.
Omega Labs., Inc., e.
Pacific Scientific Co., h.
Paco Electronics Co., Inc., a, b, c.
Pioneer Industries Div., Almar-York Co. Inc., a.
Polytechnic Research & Development Co., Inc., e.
Precision Apparatus Co., Inc., a, b, c.
Projects Unlimited Inc.
Radar Design Corp., e.
Rosemount Engrg. Co., g, h.
Arthur C. Ruge Associates, Inc., h.
Sage Labs., Inc., e.
Sanford Plastics Corp., b, c.
Scaico Controls, Inc., h.
Scala Radio Co., a, b, c.
Servomechanisms, Inc., f, g.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., I
Simpson Electric Co., a, b, c, h.
Sperry Microwave Electronics Co., Div.-Sperry Ran Corp., e.
T-C Div., Dyna-Empire, Inc., h.
Telerad Mfg. Corp., e.
Temperature Engrg. Corp., h.
Thermal Refractories Corp., g, h.
Thermo Electric Co., Inc., h.
Turbo Machine Co., e.

ited Cantral Corp., h.
S. Science Corp., Div.-Topp Industries, Inc., g, h.
ctar R. F. & Microwave Co., a, e.
ctory Engrg. Corp., h.
ste King Corp., Technical Products Div., f, g, h.
terman Products Co., Inc., a, d.
veline, Inc., e.
bcar, Inc., Government Div.
ntronics, c.
llow Springs Instrument Co., The, h.

PICESSING EQUIPMENT, MOTION PICTURE

ll & Howell Co.
lack Instrument Corp.
mera Mart Inc., The
stman Kodak Co.
gerton, Germeshausen & Grier, Inc.
rdon Enterprises
-Speed Equipment, Inc.
oustan Fearless Corp.
ffard Corp., The

PIJECTION LAMPS
e LAMPS, PROJECTION

P)PELLANT CASES, SOLID ROCKET

erojet-General Corp.
ca Products, Inc.
luminum Co. of America
nerican Aluminum Co.
nerican Cor & Foundry, Div.-ACF Industries, Inc.
nerican Machine & Foundry Co., Government Products Group
nchor Metal Spinning Co., The
trodyne, Inc.
lantic Research Corp.
ker Perkins Inc.
ll Aircraft Corp., Niagara Frontier Div.
ENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
enson Mfg., Co., The
W. Bliss Co.
idgeport Brass Co.
CAMERON IRON WORKS, INC.
hompion Co., The
hrysler Corp., Defense Dperations Div.
ooper Development Corp., Sub.-Marquardt Aircraft Co.
rtiss-Wright Corp.-Propeller Div.
rtiss-Wright Corp.-Utica Div.
rtiss-Wright Corp.-Wright Aeronautical Div.
versey Engrg. Co.
esser Mfg. Div., Dresser Industries, Inc.
unbar-Kopple Inc.-Aircraft Components Div.
ynamic Devices, Inc.
F. Goodrich Aviation Products
oodyeor Aircraft Corp.
ohn & Cloy
aveg Industries, Inc.
ufford Corp., The
gersoll Kalamazoo Div., Borg-Warner Corp.
tercontinental Mfg. Co., Inc.
aiser Metol Products, Inc.-Fleetwings Div.
norr Corp.
W. Kellogg Co., The
elsey-Hayes Co.
mtex Industries, Inc.
LYCOMING DIV., AVCO MFG. CORP.
erz Engrg., Inc.
innesota Mining & Mfg. Co.
ewbrook Mochine Corp.
orris-Thermador Corp.
orthrop Corp., The, Nortronics Div.
uclear Products-Erco Div.-ACF Industries, Inc.
lastic Age Sales, Inc.
rtland Copper & Tonk Works Inc.
ecision Sheet Metol, Inc.
essed Steel Tonk Co.
ed Lion Cobinet Co., Redco Tool Div.
einhold Engrg. & Plostics Co.
RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
ohr Aircraft Corp.
yan Aeronautical Co.
nford Plastics Corp.
D. Smith Corp.
olar Aircraft Co.
oinless Steel Products, Inc.
rong Scott Mfg. Co., The
apco Group, Thompson-Ramo-Wooldridge Inc.
opper Mfg. Co., Inc.
wigg Industries
nited States Chemicol Milling Corp.
nited States Rubber Co.
niversal Moulded Products Corp.
aste King Corp., Technical Products Div.
estern Arc Welding, Inc.
ilks Precision Instrument Co., Inc.
ardley Plastics Co.
oung Development Div., Hercules Powder Co.

P)PELLANT CHEMICALS, NITRATED

PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.

P)PELLANT TANKS

erojet-Generol Corp.
ir Products, Inc.
lca Products, Inc.
luminum Co. of Americo
American Aluminum Co.
American Machine & Foundry Co., Government Products Group
Anchor Metal Spinning Co., The
Bell Aircraft Corp., Niagara Frontier Div.
Benson Mfg., Co., The
Bowser, Inc., Defense Dept.
Cambridge Co.-Div.-Carrier Corp.
Champion Co., The
Chemplast, Inc.
Chrysler Corp., Defense Dperatians Div.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Cramer Mfg. & Engrg., Inc.
Curtiss-Wright Corp.-Propeller Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Doyle & Rath Mfg. Co., Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Hahn & Clay
Paul Hardeman, Inc.
Huffard Corp., The
Ingersoll Kalamazoo Div., Borg-Worner Corp.
Joclin Mfg. Co.
Kaiser Metal Products, Inc.-Fleetwings Div.
M. W. Kellogg Co., The
Lamtex Industries, Inc.
Mercury Tool & Mfg. Carp.
Minnesota Mining & Mfg. Co.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Newbrook Machine Corp.
Nuclear Products-Erco Div.-ACF Industries, Inc.
Opelika Welding, Machine & Supply Inc.
Portland Copper & Tonk Works Inc.
Precision Sheet Metol, Inc.
Pressed Steel Tonk Co.
Project Fobrication Corp.
Reoction Motors Div., Thiokol Chem. Corp.
Edw. Renneburg & Sons Co.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Rohr Aircraft Corp.
Ryan Aeronoutical Co.
Santo Anita Engrg. Co.
Scoife Co.-Div.-Wilson Bros.
A. D. Smith Corp.
Solar Aircroft Co.
Stoinless Steel Products, Inc.
Sterns-Roger Mfg. Co.
Topco Group, Thompson-Romo-Wooldridge Inc.
Twigg Industries
U. S. Industries, Inc.
United Stotes Chemicol Milling Corp.
Universol Moulded Products Corp.
Young Development Div., Hercules Powder Co.

PROPELLANTS, LIQUID ROCKET

Aerojet-Generol Corp.
Air Products, Inc.
***ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.**
Allied Chemicol Corp., Nitrogen Div.
Americon Rocket Co.
Becco Chemicol Div.-Food Machinery & Chemicol Corp.
Bell Aircroft Corp., Niogara Frontier Div.
Collery Chemical Co.
Escombia Chemicol Corp.
Fulton-Irgon Corp., The
Hercules Powder Co.
Koiser Metol Products, Inc.-Fleetwings Div.
Olin Mathieson Chemicol Corp., Energy Div.
Pennsolt Chemicals Corp.
***REDEL INC.**
Rohm & Haos Co., Redstone Arsenal Reoerch Div.
Shell Chemicol Corp., Industriol Chemicol Div.
Speciol Projects Lab., Food Mochinery & Chemicol Corp.

PROPELLANTS, SOLID ROCKET

Aerojet-General Corp.
Americon Lotex Products Corp.
***AMERICAN POTASH & CHEMICAL CORP.**
Americon Rocket Co.
Amoco Chemicals Corp.
Astrodyne, Inc.
Atlontic Reoerch Corp.
Collery Chemicol Co.
Cooper Development Corp., Sub.-Morquordt Aircraft Co.
Dynomic Devices, Inc.
Escombia Chemical Corp.
Foote Mineral Co.
Fulton-Irgon Corp., The
B. F. Goodrich Aviotion Products
Hercules Powder Co.
Kaiser Metol Products, Inc.-Fleetwings Div.
Derlikon Tool & Arms Corp. of America
Dlin Mathieson Chemical Corp., Energy Div.
Pennsolt Chemicols Corp.
***REDEL INC.**
Rohm & Haos Co., Redstone Arsenol Research Div.
Shell Chemicol Corp., Industrial Chemicols Div.
Standard Dil Co. of Indiana
Topper Mfg. Co., Inc.
United Stotes Rubber Co.

PROPULSION SYSTEMS

Accessory Products Co., Div.-Textron Inc.
Aerojet-General Corp.
Aerolab Development Co.
Aeroscience, Inc.
Astrodyne, Inc.
Atlantic Research Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Christie Machine Works
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Dynamic Devices, Inc.
Fulton-Irgon Corp., The
B. F. Goodrich Aviation Products
Hercules Powder Co.
Marquardt Aircraft Co.
***McMORMICK SELPH ASSOCIATES**
Pneu-Hydra Valve Corp.
Reaction Motars Div., Thiokol Chem. Corp.
***REDEL INC.**
Rocketdyne Div.-Narth American Aviation, Inc.
Ryan Aeronautical Co.
Special Projects Lab., Food Machinery & Chemical Corp.
Strong Scott Mfg. Co., The
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Thiokol Chemical Corp.

PROTECTIVE SEALERS
See SEALERS, PROTECTIVE

PSYCHOGALVANOMETERS

Associated Research, Inc.
Electro-Medicol Lob., Inc.
Dffner Electronics Inc.

PSYCHROMETERS

Bendix Aviation Corp., Friez Instrument Div.
Bristol Co., The
Fisher Scientific Co.
Generol Scientific Equipment Co.
E. Vernon Hill & Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industriol Product Group
Polmer Thermometers, Inc.
Precision Thermometer & Instrument Co.
Scientific Instrument Co.
Specialty Engrg. & Electronics Co.
Universal Dynomics Corp.
Weksler Instruments Corp.

PUBLIC ADDRESS SYSTEMS

Bliss Electronic Corp.
Blonder-Tongue Labs., Inc.
Budelman Electronics Corp.
Dorsett Lobs., Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Du Kone Corp.
Executone, Inc.
ITT-Kellogg
Precise Development Corp.
Stromberg-Carlson Div.-Generol Dynomics Corp.
Telectro Industries Corp.

PULSATION CONTROL

Consolidoted Controls Corp.
Consolidated Diesel Electric Corp.

PULSATION DAMPERS
See DAMPERS, PULSATION

PULSE MODULATORS
See MODULATORS, PULSE

PUMP SYSTEMS, FLUID METERING
See FLUID METERING PUMP SYSTEMS

PUMPS

a. Air
b. Alcohol
c. Booster
d. Combination Air & Hydraulic
e. Fuel
f. Hydraulic, Fixed Displacement
g. Hydrogen Peroxide
h. Liquid Nitrogen
i. Liquid Oxygen
j. Metering
k. Oil
l. Oxygen Transfer
m. Pneumatic
n. Speed Density Metering
o. Transfer
p. Turbine
q. Vacuum
r. Water Injection
s. Wobble

ACF Industries Inc., a, b, e, k, m, q, r.
Adel Precision Products of California, Div.-Generol Metals Corp., b, c, e, f, k, a, p, r, s.
Aerojet-General Corp., g, h, i, k, p.
Air Products, Inc., a, h, i, l, s.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**, c thru f, h, i, a, p, r.
Americon Aeroparts, a, b, c, e, f, j, q, s.
Americon Bosch Arma Corp., e, j.
Americon Brake Shoe Co., f.
Americon Brake Shoe Co., Kellogg Div., f.
American Felt Co., a, c, d, g, l.
Americon Instrument Co., Inc., m.
American Machine & Foundry Co., Greenwich, f.
Applied Dynamics Corp., a, d, f.
Aro Equipment Corp., q.

Associate Aircroft Tool & Mfg., Inc., a, c thru f, j, m, q.
Associated Engrg. & Mfg. Corp., q.
Associated Engineers, Inc., b, c, e, f, k, o.
*BALCRANK INC., MACHINE TOOL DIV., b, g, k, a.
Beach-Russ Co., a, c, q.
Bell Aircroft Corp., Niagoro Frontier Div., c, p.
Bell & Gossett Co., Marlow Pumps Div., b, c, k, a.
*BENDIX AVIATION CORP., HAMILTON DIV., f, g, j, k, n, a.
Bendix-Pacific Div., Bendix Aviotion Corp., f.
Bendix Utico Div., Bendix Aviation Corp., a, b, c, e, f, g, j, k, m, p, q, r.
Blackhawk Mfg. Co., f.
Blackmer Pump Co., b, e, g, k, a.
Bowser, Inc., Defense Dept., e, h, i.
Byron-Jackson Pumps Inc., Sub.-Borg-Worner Corp., b, c, e, g thru m, o, p, r.
Cambridge Co.-Div.-Corrier Corp., h, i, l.
J. C. Corter Co., The, b, c, e, g, h, i, l, o, p, r.
Centrol Scientific Co., q.
Chondler Evons Corp., e, h, j, n, o, p, r.
Chempump Corp., b, c, e, g, h, i, l, a.
Chicago Pneumatic Tool Co., q.
Christie Machine Works, e, i, p.
Clork Equipment Co., f.
Collins Engrg. Corp., i, r.
Com-Air Products, Div.-A S R Products Corp., e, f, s.
Commercial Shearing & Stamping Co., f.
Components Corp., a, b, d, e, g thru k, m, o, q.
Consolidated Electrodynamics Corp., Rochester Div., q.
Cornelius Co., The, Aero Div., a, d, f, m, q.
Croll-Reynolds Co. Inc., q.
Curtiss-Wright Corp., Santa Borbaro Div., a thru f, p, r.
Deon & Benson Research, Inc., a.
Deming Co., The, b, c, f, k, o, p, s.
Denison Engrg. Div., American Brake Shoe Co., f, j, k.
Dresser Industries, Inc., a, b, d thru i, k, l, m, p.
Dumont Aircroft Fitting Co., g, h, l.
Dynamic Filters Inc., c.
Eastern Industries Inc., a thru g, j, k, a thru r.
Eco Engrg. Co., b, f, g, j.
Electronic Communications, Inc., e, o.
Finnell System, Inc., q.
Fischer & Porter Co., j.
Fisher Scientific Co., a, q.
Gardner-Denver Co., a, d, f, m, q.
Gardner Laboratory, Inc., a, q.
General Electric Co., Apparatus Sales Div., c, e, p.
Gorman-Rupp Co., The, a.
Goulds Pumps Inc., b, c, e, g, h, i, k, a, r.
Groy Co., Inc., b, k, m, a.
Green Rectifier Co., q.
Hamilton Standard, Div.-United Aircroft Corp., f, k.
Hardmon Tool & Engrg., Co., d, a.
Haskel Engrg. & Supply Co., c, d, f, k, m.
High Vacuum Equipment Corp., q.
Hills-McCanna Co., j.
Hofman Labs., Inc., h, i, l.
Hoof Products Co., e, f.
Hoover Electric Co., a thru i, k, a, p, r.
Hull Corp., q.
Hupp Aviation Co., f, a.
Hydraulic Press Mfg. Co., The, Div.-Koehring Co., f.
*HYDRO-AIRE CO., DIV.-CRANE CO., a thru l, p, q.
Hydrodyne Corp., Skinner Seal Div., e, g, h, i, p.
Hydromatics, Inc., b, g, h, i.
International Pump & Machine Works, q.
Joy Mfg. Co., q.
Kinney Mfg. Div., The New York Air Brake Co., c, j, a, q.
Korda Industries, e, f, j, k, n.
Horold Kruger Instruments, j.
Lawrence Pumps Inc., b, g, h, i, l.
Lear, Inc., a, b, c, e thru i, k, m, o, q, r, s.
Lear, Inc., Grand Rapids Div., a, c thru f, j, k, o, q, r.
Lear Inc., Lear-Romec Div., a thru s.
Ledeen Inc., c, d.
Leiman Brothers, Inc., a, c, q.
Linde Co., Div-Union Carbide Corp., h, i, l, a, p.
Litton Engrg. Labs., q.
M. C. Mfg. Co., e.
Marquardt Aircroft Co., e, r.
J. J. Monaghan Co., Inc., a.
NRC Equipment Corp., q.
Nosh Engrg. Co., The, a thru e, g, h, i, l, a, q.
Nationol Airoil Burner Co., k, a.
National Research Corp., q.
Natl. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc., e, f.
Nelson Vacuum Pump Co., q.
Newton Hydroulic Tooling Co., f.
W. H. Nichols Co., f, j, k, a.
Northern Drdnance Inc., Sub.-Northern Pump Co., e, f, k, a.
Dil-Dyne, Inc., f.
Dliver Corp., The, f.
Dwatonna Tool Co., f.
Dxygen Equipment & Service Co., q.
Peerless Pump Div., Food Machinery & Chemical Corp., b, e, g, i.
Penberthy Mfg. Co., q, r.
Pennsylvania Pump & Compressor Co., q.
Pesco Products Div.-Borg-Warner Corp., a thru g, i, k, p, q, r.
H. K. Porter Co., Inc., f.
Project Fabricotion Corp., h, i, l, a.
Pyles Industries, Inc., d.
Quincy Compressor Co., q.
Racine Hydroulics & Machinery Inc., f.
Reoction Motors Div., Thiokol Chem. Corp., i, a, p.
Red Point Corp., q.
Republic Mfg. Co., f, j, k, s.
Research Applionce Co., a, b, f, j, k.
Rocketdyne Div.-North American Aviation, Inc., e, i.
Milton Roy Co., j.
Rucker Co., The, c.
Sargent Engrg. Corp., f.
Schutte & Koerting Co., q.
Scientific Engrg. Labs., Inc., q.
Sier-Bath Gear & Pump Co., Inc., e, k, a.
Sigmamotor, Inc., j.
Solar Aircraft Co., f, p.
Southwestern Industries, Inc., a, b, c, e, g, h, i, k, o, r.
Special Projects Lab., Food Machinery & Chemicol Corp., g.
F. J. Stokes Corp., q.
Stratos, Div.-Fairchild Engine & Airplone Corp., a, d, e, f, h, i, j, m.
Superior Air Products Co., h, i, l, a.
Tapco Group, Thompson-Ramo-Wooldridge Inc., a thru i, m, a, p, r.
Task Corp., a, b.
Temperature Engrg. Corp., q.
Thermech Engrg. Corp., h, i.
Turbo Products, Inc., p.
United Aircraft Products, Inc., s.
United Supply Co., a, b.
Varion Associates, q.
Veeco Vacuum Corp., q.
Vickers Inc., Div.-Sperry Rand, c, e, f.
Vickers Inc., Marine & Ordnance Dept., Machinery Hydraulics Div., f.
Waldorf Fluid Systems, Div.-F. C. Huyck & Sons, a, b, k, m.
Wallace & Tiernan Inc., j.
Watertown Div., The New York Air Broke Co., f.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Whittaker Controls, Div.-Telecomputing Corp., b, e, k, o.
Wilks Precision Instrument Co., Inc., b, c, k, a, r.

PUMPS, TURBO
See TURBO PUMPS

PUNCH PRESSES

Acromark Co., The
E. W. Bliss Co.
Clover Industries, Inc.
Denison Engrg. Div., American Brake Shoe Co.
Montgomery Engrg., Co.
Dliver Corp., The
Dliver Corp., The-A. B. Farquhor Div.
D'Neil-Irwin Mfg. Co.
Popesch & Kolstad, Inc.
Rotex Punch Co., Inc.
Joseph T. Ryerson & Son, Inc.
U. S. Industries, Inc.
Verson Allsteel Press Co.
Wales Strippit Inc., Unit of Houdaille Industries, Inc.

PUNCHES

Acromark Co., The
Bergen Carbide Co.
Hughes Tool Co., Aircraft Div.
D'Neil-Irwin Mfg. Co.
Joseph T. Ryerson & Son, Inc.
Tally Register Corp.
Torrington Co., The
Wales Strippit Inc., Unit of Houdaille Industries, Inc.
Wilks Precision Instrument Co., Inc.
J. H. Williams & Co.

PYROMETERS, OPTICAL

Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Electro-Tech Equipment Co.
Epic, Inc.
Fisher Scientific Co.
Claud S. Gordon Co.
Leeds & Northrup Co.
Pyrometer Instrument Co., Inc.
Thwing-Albert Instrument Co.

PYROMETERS, RADIATION

Aetna Electronics Corp.
Bristol Co., The
Electro-Tech Equipment Co.
Epic, Inc.
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Perkin-Elmer Corp.
Pyrometer Instrument Co., Inc.
Servo Corp. of Americo

PYROMETERS, RESISTANCE

Aero Research Instrument Co. Inc.
B & H Instrument Co., Inc.
Bristol Co., The
Electro-Tech Equipment Co.
Epic, Inc.
General Electric Co., Apparatus Sales Div.
Claud S. Gordon Co.
Illinois Testing Loborotories, Inc.
Leeds & Northrup Co.
*LEWIS ENGRG. CO., THE
Minneapolis-Honeywell Regulator Co., Industrial Di
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Arthur C. Ruge Associotes, Inc.
T-C Div., Dyno-Empire, Inc.
Thermo Electric Co., Inc.
Thwing-Albert Instrument Co.
West Instrument Corp.

PYROTECHNIC DEVICES

*AMERICAN POTASH & CHEMICAL CORP.

RACKS

a. Cabinet
b. Disc Staroge
c. Equipment
d. Mounting & Relay

A & P Metal Products Mfg. Corp., a.
Abolon Precision Mfg. Corp., a, d.
Alden Products Co., a, d.
Alpitec, Inc., a thru d.
Amelco, Inc., a, d.
American Aeroparts, a, b.
American Aluminum Co., a thru d.
American Machine & Foundry Co., Government Products Group, a, b, c.
American Machine & Foundry Co., Greenwich, a, d.
Anchor Metal Spinning Co., The, a thru d.
Anchor Specialty Mfg. Co. Inc., a, c, d.
Atkins & Merrill, Inc., a.
Automatic Electric Sales Corp., d.
Borrett-Christie Co., a, c.
Barry Controls Inc., c, d.
Basco Metal Products, Inc., a.
Benson Mfg., Co., The, a.
Brooks & Perkins, Inc., a.
Bud Rodio Inc., a, d.
Buffolo Metal Container Corp., a, b, c.
Butler Mfg. Co.
Byrne Doors Inc., b, c, d.
Carmody Corp., a, c.
Albert H. Coyne Equipment Corp., a, c.
Centronix Inc., d.
Champion Co., The, a, b.
Chrysler Corp., Defense Dperations Div., a, d.
Colonial Aircraft Corp., a thru d.
Conco Engrg. Works, d.
Cooper Industries, Inc., a, c.
Craig Systems, Inc., c, d.
Cutler Metal Products Co., a thru d.
Dohlstrom Metallic Door Co., a.
Detronic Industries, a, d.
Devco Engrg. Inc., c, d.
Du Kane Corp., c, d.
Electro-Mechanicol Products Co., a, d.
Electronic Engrg. Co. of Californio, d.
Elzee Metal Products Co., Inc., a thru d.
*ETS-HOKIN & GALVAN, d.
Folstrom Co., a, c.
Forwell Metal Fobricating, a, c, d.
Ferris-Mfg. Co., The, a, b.
Frick Gallogher Mfg. Co., The, c.
Heiland Div.-Minneopolis-Honeywell, d.
Ludwig Honold Mfg. Co., a thru d.
Instrument Corp. of Fla., c.
Intercontinental Dynamics Corp., c.
ITT-Kellogg, c, d.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., a thru d.
Kirk & Blum Mfg. Co., The, a, d.
Lofstrand Co., The, b, c.
R. H. Lynch Mfg. Co., a, d.
Lynch Corrier Systems Inc., d.
Mercury Tool & Mfg. Corp., a, b, c.
Metol Fabricators Corp., a.
Mid-West Metal Products, Inc., a thru d.
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV., a, c, d.
Monogram Precision Industries, a thru d.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., c, d.
Neumade Products Corp., a, b.
North Electric Co., d.
Northeastern Engrg. Inc., a, c, d.
Pic Design Corp., Sub.-Benrus Watch Co., Inc.
Pneumafil Corp., a thru d.
Precision Sheet Metal, Inc., a.
Premier Metol Products Co., a, b, c, d.
Prereg Mfg. Inc., d.
Radiatronics, Inc., a, d.
Railway Communications Inc., d.
Red Lion Cabinet Co., Redco Tool Div., a.
Reinhold Engrg. & Plastics Co., a.
Edw. Renneburg & Sons Co., a thru d.
Republic Steel Corp., a.
Rimak, Inc., a, c, d.
Roberts Industries Inc., a, b, c.
Roll Formed Products Co., a.
Santo Anita Engrg Co., a.
Sequoia Wire & Coble Co.-Div.-Mondrel Industries, Inc., a thru d.
Skyline Electric & Mfg. Co., a thru d.
Skyline Products, Inc., a.
Specialty Engrg. & Electronics Co., a.
Stanley Aviation Corp., d.
Stromberg-Carlson Div.-General Dynamics Corp., d.
Teiner Engrg. Corp., a, d.
Twin Cooch Co., Aircraft-Missiles, a thru d.
United Aircraft Products, Inc., a, c.

U. Relay Co., d.
V Zelm Associates, Inc., d.
Vety Aircraft Corp., c, d.
Wded Construction Inc., c.
Wzlau Engrg. Co., a.
Aert Wesling & Sons Inc., c.
Wder Aircraft Corp. of Florida, c, d.
Wo Metal Products, a, c, d.
Ying & Rioux Woodworking Co., Inc., a.

AIR, AIRBORNE

AF Industries Inc.
Als Precision Products, Co.
*VCO MFG. CORP., CROSLEY DIV.
B Aircraft Corp., Niagara Frontier Div.
Bock Instrument Corp.
Bdix-Pacific Div., Bendix Aviation Corp.
Bdix Rodio Div., Bendix Aviation Corp.
Clogo Div., Underwood Corp.
Ctronix Inc.
Dco-Wayne Electronics, Div.-Divco-Wayne Corp.
Ectronic Communicatians, Inc.
Erson Electronic Mfg. Co., The, Electronics & vionics Div.
Erson Radio & Phanograph Corp.
Fchild Astrionics Div., Fairchild Engine & irplane Corp.
Fd Instrument Co., Div.-Sperry Rand Corp.
Geral Communication Co.
Gillan Bros. Inc.
Gdyear Aircraft Corp.
Hlicrafters
Heltine Electronics Div.-Hazeltine Corp.
Hman Labs. Div., Hoffman Electronics Corp.
Hhes Aircraft Co.
IT Federal Div., International Telephone & Telegraph Corp.
IT Labs.
Lon Industries, Inc.
Lon Industries, Maryland Div.
Lkheed Aircraft Corp., Missiles & Space Div.
WL. Maxsan Corp., The
Mogram Precision Industries
Morala Inc., Military Electronics Div.
Nthrap Corp., The, Nortronics Div.
Pco Carp., Government & Industrial Div.
Rlatian, Inc.
Rtheon Mfg. Co.
Rtheon Mfg. Co., Government Equipment Div.
Rublic Aviation Corp.
Rn Aeronautical Co.
Sders Associates, Inc.
Satran Electronics & Televisian Carp.
Svid Engrg., Inc.
Tectra Industries Carp.
Terad Mfg. Carp.
Ured States Chemicol Milling Carp.
Vian Associates
Wcar, Inc., Government Div.
Wstinghouse Electric Carp.

AIR BEACONS

AF Industries Inc.
Adlab Development Co.
Adco, Inc.
Arican Machine & Foundry Co., Greenwich
Aenno & Radome Research Associates
Bdix Aviation Corp., York Div.
Bdix-Pacific Div., Bendix Aviation Corp.
Clogo Div., Underwood Corp.
Ctronix Inc.
Cper Development Corp., Sub.-Marquardt ircraft Co.
DM Research Corp.
Dco-Wayne Electronics, Div.-Divco-Wayne Corp.
Ectronic Communicatians, Inc.
Erson Radio & Phonograph Carp.
Frotron Electranics Co., Inc.
Fd Instrument Co., Div.-Sperry Rand Corp.
Geral Communication Co.
Geral Devices, Inc.
Gillan Bros. Inc.
Hlomare Electranics Co.
Heltine Electronics Div.-Hazeltine Corp.
Hon Mfg. Co.
IT Federal Div., International Telephone & Telegraph Corp.
IT Labs.
Iruments for Industry, Inc.
LL, Inc.
Laie Labaratories Inc.
Lon Industries, Inc.
Lian Industries, Maryland Div.
Lkheed Aircraft Corp., Missiles & Space Div.
Mquardt Aircraft Co.
WL. Maxson Corp., The
Man Instrument Corp.
Morola Inc., Military Electranics Div.
*ACKARD-BELL ELECTRONICS CORP.
Rph M. Parsons Co., The, Electronics Div.
Filco Carp., Government & Industrial Div.
Farad Electronics Corp.
RElectronics Corp.
Rliation, Inc.
Rtheon Mfg. Co., Government Equipment Div.
Rves Instrument Corp.
Rdel Engrg. Carp.
Satron Electronics & Television Corp.
Svid Engrg., Inc.
Srling Precisian Corp., Instrument Div.
Tectro Industries Carp.
Telerad Mfg. Carp.
Varian Associates
Webcar, Inc., Government Div.
Westinghouse Electric Corp.

RADAR, PRECISION APPROACH

ACF Industries Inc.
Atlas Precision Products, Co.
*AVCO MFG. CORP., CROSLEY DIV.
Aviation Textile Associates
Bendix Radio Div., Bendix Aviation Corp.
Centranix Inc.
Gilfillan Bros. Inc.
Hazeltine Electranics Div.-Hazeltine Carp.
ITT Labs
Litton Industries, Inc.
Litton Industries, Maryland Div.
Matarala Inc., Military Electranics Div.
Philco Carp., Government & Industrial Div.
Raythean Mfg. Co., Government Equipment Div.
Telectro Industries Corp.
Varian Associates
Webcor, Inc., Government Div.
Westinghouse Electric Corp.

RADAR REFLECTORS

See REFLECTORS, RADAR

RADAR, SURVEILLANCE

ACF Industries Inc.
American Machine & Foundry Co., Government Products Group
*AVCO MFG. CORP., CROSLEY DIV.
Aviation Textile Associates
Bell Aircraft Corp., Niagara Frantier Div.
Belack Instrument Carp.
Bendix Radio Div., Bendix Aviatian Corp.
Centronix Inc.
Continental Electranics Mfg. Co.
Edgertan, Germeshausen & Grier, Inc.
Emersan Electric Mfg. Co., The, Electranics & Avionics Div.
Empire Products Sales Carp.
Ford Instrument Co., Div.-Sperry Rand Carp.
Gilfillan Bras. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Hoffman Labs. Div., Hoffman Electranics Carp.
Hughes Aircraft Co.
ITT Federal Div., International Telephone & Telegraph Corp.
ITT Labs.
Littan Industries, Inc.
Littan Industries, Maryland Div.
W. L. Maxsan Carp., The
Miller Associates
Motarala Inc., Military Electronics Div.
Philco Carp., Government & Industriol Div.
Radiation, Inc.
Raythean Mfg. Co.
Raythean Mfg. Co., Government Equipment Div.
Reeves Instrument Corp.
Sanders Associates, Inc.
Skyline Electric & Mfg. Co.
Sperry Piedmant Co. - Div.-Sperry Rand Corp.
Telectro Industries Corp.
Telerad Mfg. Carp.
U. S. Industries, Inc.
Varian Associates
Webcar, Inc., Government Div.
Westinghouse Electric Carp.

RADAR TEST SETS

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
American Electranic Labs., Inc.
American Machine & Foundry Co., Government Products Group
American Missile Products Co., Inc.
Andersen Labs.
Atlas Precision Products, Co.
Aviation Textile Associates
Bell Aircraft Corp., Niagara Frantier Div.
Bendix Aviation Carp., York Div.
Bendix Radio Div., Bendix Aviation Corp.
Bernco Engrg. Carp.
CGS Labs., Inc.
California Technical Industries, Div.-Textran Inc.
Canaga Div., Underwood Carp.
Centranix Inc.
Chemalloy Electronics Corp.
Cooper Development Carp., Sub-Marquardt Aircraft Co.
Divco-Wayne Electronics Div., Divco-Wayne Corp.
Douglas Microwave Co., Inc.
Electranic Communicatians, Inc.
Emerson Electric Mfg. Co., The, Electronics & Emersan Radio & Phanograph Corp.
Engrg. Associates
FXR, Inc.
Fairchild Astrianics Div., Fairchild Engine & Airplane Corp.
General Communicatian Co.
Gilfillan Bras. Inc.
Hallicrafters
Hazeltine Electranics Div.-Hazeltine Carp.
Hoffman Labs. Div., Haffman Electranics Carp.
Hycan Mfg. Co.
ITT Federal Div., International Telephone & Telegraph Carp.
ITT Labs
Instruments for Industry, Inc.
Kaiser Aircraft & Electranics, Div.-Kaiser Industries Carp.
Kay Electric Co.
*KEARFOTT CO., INC.
*KEARFOTT CO., INC., MICROWAVE DIV.
Lockheed Aircraft Carp., Missiles & Space Div.
Manson Labs., Inc.
Marconi Instruments
Marquardt Aircraft Co.
Miller Associates
Missouri Research Labs., Inc.
Matarala Inc., Military Electronics Div.
Narda Microwave Carp., The
Northeastern Engrg. Inc.
*PACKARD-BELL ELECTRONICS CORP.
Philco Carp., Government & Industrial Div.
Polarad Electranics Carp.
Polytechnic Research & Development Co., Inc.
Radar Design Carp.
Radiatian, Inc.
Raytheon Mfg. Co., Government Equipment Div.
Skiatran Electronics & Televisian Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Telechrame Mfg. Carp.
Telectra Industries Carp.
Telerod Mfg. Corp.
Thomas Electranics, Inc.
Twenty-First Century Electranics, Inc.
Varian Associates
Waldarf Electronics Div.-F. C. Huyck & Sons
Waveline, Inc.
Webcar, Inc., Government Div.

RADIATION BADGES

See BADGES, RADIATION

RADIATION DETECTORS

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Automation Dynamics Carp.
B J Electranics, Borg-Warner Carp.
Baird-Atamic, Inc.
Beva Lab., Inc.
A. Biederman, Inc.
Centranix Inc.
Eastman Kodak Co.
General Electric Co., X-Ray Dept.
Haffman Labs. Div., Hoffman Electranics Carp.
ITT Labs.
ITT Labs.-Ft. Warth
Jardan Electranics, Div.-Victareen Instrument Co.
Land-Air Inc.
Landsverk Electrameter Co., The
Lockheed Aircraft Carp., Missiles & Space Div.
Minneapalis-Haneywell Regulator Co., Industrial Div.
National Pneumatic Co., Inc., Haltzer-Cabat Divs.
Nuclear Measurements Carp.
Nuclear-Chicago Corp.
Piasecki Aircraft Carp.
Radiatian Instrument Development Lab., Inc.
Sperry Microwave Electranics Co., Div.-Sperry Rand Corp.
Stanley Aviation Carp.
Telectro Industries Carp.
Wintranics
N. Wood Counter Lab.

RADIATION EQUIPMENT, NUCLEAR

Applied Radiatian Carp.
Baird-Atamic, Inc.
Beaver Precisian Products Inc.
Beva Lab., Inc.
Cambridge Filter Corp.
Centranix Inc.
Communicatians Research Co.
Curtiss-Wright Corp., Electronics Div.
Curtiss-Wright Corp., Research Div.
Edgerton, Germeshausen & Grier, Inc.
General Electric Co., Apparatus Sales Div.
High Valtage Engrg. Carp.
ITT Labs.
ITT Labs.-Ft. Warth
Jardan Electranics, Div.-Victareen Instrument Co.
Kollmargen Optical Carp.
Land-Air Inc.
Landsverk Electrameter Co., The
Lockheed Aircraft Carp., Missiles & Space Div.
Minneapalis-Haneywell Regulator Co., Industrial Product Group
Newbrook Machine Carp.
Nuclear Measurements Carp.
Nuclear-Chicago Carp.
Patterson Maas Div.-Universal Winding Co., Inc.
Radiation Instrument Development Lab., Inc.
Stanley Aviation Carp.
United States Radium Carp.
Westinghouse Electric Carp.

RADIATION PYROMETERS

See PYROMETERS, RADIATION

RADIATORS

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Alpar Mfg. Carp.
Dunham-Bush Inc.
Engelhard Industries, Inc.
Griscom-Russell Co., The
Meridian Metalcraft, Inc.
Tranter Mfg., Inc.
United Aircraft Products, Inc.

RADIATORS, COOLANT

Aro Equipment Corp.
Dunham-Bush Inc.
E. I. Du Pont De Nemours & Co. Inc.
Eastern Industries Inc.
Griscom-Russell Co., The
Tranter Mfg., Inc.
United Aircraft Products, Inc.

RADIATORS, ENGINE-COOLING

Drayer-Hansan Div., National-U. S. Radiator Corp.
Griscom-Russell Co., The
South Wind Div., Stewart Warner Corp.
United Aircraft Products, Inc.

RADIATORS, OIL-COOLING

American Aeroparts
Dunham-Bush Inc.
Griscom-Russell Co., The
South Wind Div., Stewart Warner Corp.
Tranter Mfg., Inc.
United Aircraft Products, Inc.

RADIO COMPASS INDICATORS

Allied International Co.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Collins Radio Co.
ITT Labs.
Lear, Inc., Grand Rapids Div.
Litton Industries, Maryland Div.
Magnovox Co., The
Motorola Inc., Military Electronics Div.
Telectro Industries Corp.
Webcor, Inc., Government Div.

RADIO DIRECTION FINDERS

Allied International Co.
***AVCO MFG. CORP., CROSLEY DIV.**
Bendix Radio Div., Bendix Aviation Corp.
Collins Radio Co.
Doyton Aviation Radio & Equipment Corp.
Hollicrafters
ITT Labs.
Jonsky & Bailey, Inc.
***KEARFOTT CO., INC.**
Lane Electronics Mfg. Corp.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Litton Industries, Marylond Div.
Magnovox Co., The
Munston Mfg. & Sercice, Inc.
National Pneumotic Co., Inc., Holtzer-Cabot Divs.
Philco Corp., Government & Industrial Div.
Precise Development Corp.
Roytheon Mfg. Co.
Raytheon Mfg. Co., Government Equipment Div.
Royal Industries, Inc.
Servo Corp. of America
Specialty Engrg. & Electronics Co.
Sperry Piedmont Co.-Div.-Topp Industries, Inc.
Telectro Industries Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Webcor, Inc., Government Div.

RADIO & INSTRUMENT GEARS
See GEARS, RADIO & INSTRUMENT

RADIO & RAOAR ALTIMETERS
See ALTIMETERS, RADIO & RAOAR

RADIOACTIVE CHEMICALS
See CHEMICALS, RADIOACTIVE

RADIOACTIVITY EQUIPMENT

Beaver Precision Products Inc.
Edgerton, Germeshausen & Grier, Inc.
Hallicrafters
Jordan Electronics, Div.-Victoreen Instrument Co.
Land-Air Inc.
Nuclear-Chicago Corp.
Specialty Engrg. & Electronics Co.
Stanley Aviation Corp.
Telerad Mfg. Corp.
United States Radium Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
N. Wood Counter Lab.

RADIOSONOES

American Printed Circuits Co., Inc.
B J Electronics, Borg-Worner Corp.
Bendix Aviation Corp., Friez Instrument Div.
Cooper Development Corp., Sub.-Marquardt Aircroft Co.
Daven Co., The
Emerson Radio & Phonograph Corp.
Ferrotran Electronics Co., Inc.
ITT Federal Div., International Telephone & Telegraph Corp.
ITT Labs.
Lieco, Inc.
Motorola Inc., Military Electronics Div.
Reinhold Engrg. & Plastics Co.
Space Corp.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Telectro Industries Corp.
Tele-Dynamics Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.

RADIOTELEPHONE TRANSMITTERS, PORTABLE & MOBILE
See TRANSMITTERS, PORTABLE & MOBILE, RADIOTELEPHONE

RADOMES

Air Logistics Corp.
Allied Internotional Co.
American Aeroparts
American Insulator Corp.
American Machine & Foundry Co., Greenwich
Antenna & Radome Research Associates
Atkins & Merrill, Inc.
Berger Brothers Co., The
Birdair Structures, Inc.
Continental Con Co., Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Corning Glass Works
Curtiss-Wright Corp., Santa Barbara Div.
C. R. Daniels, Inc.
Diamond Antenno & Microwave Corp.
Diversey Engrg. Co.
Emerson & Cuming, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Emerson Plastics Corp.
Fletcher Mfg. Co., Inc., The
Gladding, McBean & Co.
B. F. Goodrich Industrial Products Co.
Goodyear Aircraft Corp.
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Honeycomb Co. of America, Inc.
Houston Fearless Corp.
Hughes Aircraft Co.
Hughes Tool Co., Aircraft Div.
Hull Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Kelsey-Hayes Co.
Walter Kidde & Co., Inc., Aviation Div.
H. Koch & Sons
Lamtex Industries, Inc.
Lone Star Plastics Co., Inc.
Mark Products Co.
McMillan Industriol Corp.
Metaplast Corp.
Minnesoto Mining & Mfg. Co.
Narmco Mfg. Co.
National Beryllia Corp.
Newbrook Mochine Corp.
Perry Plostics, Inc.
Philco Corp., Government & Industrial Div.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Republic Aviation Corp.
***RHEEM MFG. CO., OEFENSE & TECHNICAL PRODUCTS DIV.**
Russell Reinforced Plastics Corp.
Silicone Insulation, Inc.
Specialty Engrg. & Electronics Co.
Teiner Engrg. Corp.
Tel-Labs, Inc.
H. I. Thompson Fiber Glass Co.
Topper Mfg. Co., Inc.
United States Chemicol Milling Corp.
Universal Moulded Products Corp.
Vitro Labs.
Webcor, Inc., Government Div.
Westinghouse Electric Corp.
Young Development Div., Hercules Powder Co.

RAM JET FLAMEHOLOERS
See FLAMEHOLOERS, RAM JET

RANGE FINDERS
See FINDERS, RANGE

RARE GASES
See GASES, RARE

RAW CRYSTALS
See CRYSTALS, RAW

REACTORS, SATURABLE

American Research & Mfg. Corp.
Audio Development Co.
Bollostran Corp.
Brach Mfg. Corp., Div.-General Bronze
CGS Labs., Inc.
Chicago Electronic Engrg. Co., Inc.
Coil Co. of Americo
Dresser Industries, Inc.
Electro Engrg. Works
Electronic Transformer Co., Inc.
Ferranti Electric Inc.
Foster Transformer Co.
Generol Electric Co., Apparotus Soles Div.
Green Rectifier Co.
Guided Missile Div.-De Havilland Aircraft of Canada, Ltd.
Hevi-Duty Electric Co.
Industrial Transformer Corp.
Keystone Products Co.
Lear, Inc.
Lindberg Engrg. Co.
Magnetic Controls Co.
Minitran Corp.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
NYT Electronics, Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Dsborne Electronic Sales Corp.
Pacific Magnetic Corp.
Perkin Engrg. Corp.
Qutronic Transformer Corp.
Signal Transformer Co.
Technical Apparotus Builders
Transformer Design, Inc. of Milwaukee
Vari-I Co., Inc.
Varo Mfg. Co., Inc.
Warren Transformer Co., Inc.
Westronics Inc.

READOUT DEVICES, COMPUTER

Advanced Electronics Mfg. Corp.
Alwac Corp.
American Electronics, Inc.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix Aviation Corp., York Div.
Benson-Lehner Corp.
Briggs Associates, Inc.
Bristol Co., The
Burroughs Corp.
Centronix Inc.
DBM Research Corp.
Di-An Controls, Inc.
Digitronics Corp.
Dresser Industries, Inc.
Electro Instruments, Inc.
***ELECTROSNAP CORP.**
***A. W. HAYOON CO., THE**
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Labs.
Libroscope Inc.
Milman Engrg. Co.
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Royal Industries, Inc.
Sanborn Co.
Shepord Loboratories, Inc.
Skyline Electric & Mfg. Co.
Soroban Engrg., Inc.
Topco Group, Thompson-Ramo-Wooldridge Inc.
Telectro Industries Corp.
Union Switch & Signol, Div.-Westinghouse Air Brake Co.
Varian Associates
Vitro Labs.
Wang Labs., Inc.
Westronics Inc.

RECEIVERS

a. AM & FM Communicatian
b. AM Fixed Frequency
c. Communicatian
d. Direction Finding, Navigatian
e. Distance Measuring, Navigatian
f. Oiversity
g. Oiversity Receptian
h. Fixed Frequency
i. FM
j. FM Multiplex
k. Frequency Shift
l. Infra-Red, Navigation
m. Microwave
n. Mobile
o. Partable & Mobile
p. Radar
q. Radiatian
r. Radio Communicatian
s. Radio, Hand Powered Emergency
t. Radia, Navigation
u. Remote Pickup, Fixed
v. Selective Signalling, Navigatian
w. Short Wave, Fixed
x. Short Wave, Partable
y. Single Side Band
z. Transistor Operated
a1. UHF
b1. VHF
c1. WWV

Adler Electronics, Inc., m, a-1.
Aerojet-Generol Corp., l.
Aeronca Mfg. Corp., i, a-1.
Airborne Instruments Lab., Div.-Culter-Hammer, Inc. h, m.
Aircom Inc., m, c-1.
Aircom Inc. of New Jersey, m.
Airtron Inc., Div.-Litton Industries, m.
Allied Internationol Co., a thru d, m, n, o, r, w, x, b-1.
Alto Scientific Co., Inc., a, b, i.
Amelco, Inc., a thru d, g thru k, m, n, o, r thru u, w thru z, a-1, b-1, c-1.
American Aeroparts
American Electronics, Inc., Taller & Cooper Div., a b, j.
Americon Missile Products Co., Inc., p, z.
Automation Dynamics Corp., m.
***AVCO MFG. CORP., CROSLEY DIV.**, a thru e, h, p, r, z, a-1, b-1.
Bobcock Radio Engrg., Inc., a-1, b-1.
Baird-Atomic, Inc., l.
Barker Sales Co., a, b, c, f, g, h, j, k, m, n, o, r, v, a-1, b-1.
Barker & Williamson Inc., g.
Rex Bassett, Inc., b, c, h, n, o, w thru z.
Bell Aircraft Corp., Niagara Frontier Div., m.
Bendix Aviation Corp., York Div., e, m, p.
Bendix Radio Div., Bendix Aviation Corp., a thru i, k m thru p, r, t, v, a-1, b-1.
Bendix-Pacific Div., Bendix Aviation Corp., p.
Blonder-Tongue Labs., Inc., a, i.
Bogen-Presto Co., Div.-Siegler Corp., The, i, j.
Bristol Co., The, h.
Budelman Electronics Corp., a, b, c, h, i, j, m, r, a-1, b-1.
CGS Labs., Inc., b-1.

nnaga Div., Underwood Corp., m, p.
ntronix Inc., o thru k, m thru z, a-1, b-1, c-1.
llins Radio Co., o thru j, l, m, n, r, t, v thru z, a-1, b-1, c-1.
mmunications Co., o, b, c, h, n, r, y, b-1.
mmunications Research Co., o, b, c, e thru h, n, r, y.
ntinental Mfg., Inc., i, j.
osby Laboratories, Inc., f, g, j, y.
ta-Cantrol Systems, Inc., o, h, i, j, z.
ven Co., The, o, d, h, k, o, t, z, a-1, b-1.
ytan Aviatian Radia & Equipment Corp., o thru d, r, t, z, b-1.
vco-Wayne Electronics, Div.-Divco-Wayne Corp., o, c, h, p, a-1, b-1.
stman Kadak Co., l.
mund Scientific Co., l.
ectronic Applications, Inc., i, j.
ectronic Communications, Inc., o, b, c, h thru k, m, p, r, z, a-1, b-1.
ectranic Research Assciates, Inc., z.
gin Micronics, West Coast Div.-Elgin National Watch Co., o, r.
nerson Electric Mfg. Co., The, Electronics & Avionics Div., m, p.
nerson Radio & Phonograph Corp., o thru d, f, g, i, j, k, m thru p, r, s, t, z, a-1, b-1.
pire Products Sales Corp., m, p.
grg. Associates, m, p, a-1, b-1, c-1.
R, Inc., h, m, p, a-1, b-1.
irchild Astrionics Div., Fairchild Engine & Airplane Corp., m, p.
rrotran Electronics Co., Inc., z.
sher Research Lab., Inc., c, d, o, z.
ush Wall Radio Co., a.
neral Communicotion Co., m, p.
neral Precision Lab. Inc., d, e, l.
fillon Bros. Inc., p.
slin Electric & Mfg. Co., a.
ller, Raymond & Brown Inc. Div., Singer Mfg. Co.,
llicrafters, a, b, c, h, i, m thru p, r, w, y, z, a-1.
mmarlund Mfg. Co., Inc., o thru d, f, g, h, k, m, n, p, r, u, v, w, y, a-1, b-1, c-1.
zeltine Electronics Div.-Hazeltine Corp., c, e, i, n, p, r, t, a-1, b-1.
ffman Labs. Div., Hoffman Electronics Corp., o, q, d, e, p, t, y, a-1, b-1.
D. E. A., Inc., o, c, h, n.
f Federal Div., International Telephone & Telegraph Corp., d thru h, k, l, m, p, r, t, y, z, a-1, b-1.
f Labs, a thru z, a-1, b-1, c-1.
ustrial Television Inc., z.
ttruments for Industry, Inc., p, a-1, b-1.
n Electronics Corp., g.
nsky & Bailey, Inc., c, r.
or Engrg. Corp., o thru d, m, n, r, a-1, b-1.
iser Aircraft & Electronics, Div.-Kaiser Industries Corp., y.

EARFOTT CO., INC., d, e, l thru o, t.

EARFOTT CO., INC., MICROWAVE DIV., m.

F L, Inc., b, h, m thru p, z, a-1, b-1.
nd-Air Inc., o, b, e, r, v, z.
ndsverk Electrometer Co., The, q.
he Electronics Mfg. Corp., t, z.
lvoie Laboratories Inc., c-1.
laming Engrg., Inc., f, g, i, m, a-1, b-1.
lar, Inc., o thru e, h, i, j, l, n, o, r, t, a-1, b-1.
lar, Inc., Grand Rapids Div., d, r, t, b-1.
lton Industries, Maryland Div., c, e, j, m, p, y, b-1.
lingston Electronic Corp., b, z, b-1.
ckheed Aircraft Corp., Missiles & Spoce Div., i, j, l, m, p, q, z.
navox Co., The, o, c, d, p, r, t, z, a-1.
nson Labs., Inc., c, a-1.
ncani Instruments, o, b, c, h, i, r, w, x, a-1, b-1.
L. Maxson Corp., The, d, g, k, m, p.
crowave Associates, Inc., m, y.
neapolis-Honeywell Regulator Co., Industrial Product Group, q.
natel, Inc., o, b, c, i, m, n, o, r, w, x, y, a-1, b-1.
nagram Precision Industries, m.
rola Inc., Military Electronics Div., o thru k, m thru p, r thru z, a-1, b-1.
ston Mfg. & Service, Inc., c, r, z.
da Microwove Corp., The, m, a-1.
ional Pneumatic Co., Inc., Holtzer-Cabot Divs., , b, c, i, n, o, r, w thru z.
ns Clarke Co., Div.-Vitro Corp. of America, o, b, , h, i, r, a-1, b-1.

CKARD-BELL ELECTRONICS CORP., o, d, y.

y Plastics, Inc., c, n, o.
co Corp., Government & Industrial Div., o thru p, thru z, a-1, b-1, c-1.
rad Electronics Corp., m, p, t.
chester Instrument Corp., m.
ise Development Corp., b, d, i, j, z.
ects Unlimited Inc., b, z.
D. S. Corp., l.
lectronics Corp., h, m, p, z, a-1.
iation, Inc., i, j, m, p.
iatronics, Inc., m.
io Specialty Mfg., Co., o.
way Communications Inc., n.
theon Mfg. Co., j, m, o, p.
theon Mfg. Co., Government Equipment Div., o thru z.
del Engrg. Corp., a-1, b-1.
on Electronics Inc., c-1.
ur C. Ruge Associates, Inc., k-1.
ntific-Atlanta, Inc., m, q.
H. Scott, Inc., i, j.
Seeburg Carp., The, c.
Seeley Electronics, o, b, h, i, n, r, b-1.
Seiscor Mfg. Co., e, t.
Sequoia Wire & Coble Co.-Div.-Mandrell Industries, Inc., o, h thru k, z.
Serva Carp. of America, o, d, l, a-1, b-1.
Simmands Aerocessories, Inc., h, a-1.
Singer Mfg. Ca., The, Military Praducts Div., l.
Skiatron Electronics & Television Corp., p.
Space Carp., o.
Specialty Engrg. & Electranics Co., o, p, q.
Sperry Gyroscope Co., Morine Div., Div.-Sperry Rand Carp., d, e.
Sperry Microwave Electranics Ca., Div.-Sperry Rand Carp., m.
Sperry Piedmont Co.-Div.-Sperry Rand Carp., d, e, p, r, t.
Stanley Aviation Carp., q.
Stavid Engrg., Inc., m, p.
Stoddart Aircraft Radio Co., Inc., a-1, b-1.
Stromberg-Carlsan Div.-Generol Dynamics Corp., o, c, d, e, i, n, o, r, t, u, y, z, a-1, b-1.
Superex Electronics Corp., z.
Systems Inc., p, q.
Tamar Electronics, Inc., b, h, m, u, z.
Telechrome Mfg. Corp., y, a-1, b-1, c-1.
Telectro Industries Corp., o thru e, j, n thru q.
Tele-Dynamics Inc., h, i, j, a-1.
Telerad Mfg. Corp., m, p.
Thiokol Chemical Corp., o thru e, n, o, r, t, v, w, x, a-1, b-1, c-1.
U. S. Science Corp., Div.-Topp Industries, Inc., c, d, e, r, t, y, a-1, b-1.
Varian Associates, m, p.
Virginia Electronics Co., Inc., c, d, e, h, r, t.
Webcor, Inc., Government Div., o thru z, a-1, b-1, c-1.
Westinghouse Electric Corp., o, c.
Zenith Radio Corp., c, d, i, o, r, x, y, z.

RECEIVERS, OMNIRANGE
See OMNIRANGE RECEIVERS

RECEIVING EQUIPMENT, VHF OMNIRANGE

Allied International Co.
American Missile Products Co., Inc.
Bendix Radio Div., Bendix Aviation Corp.
Centronix Inc.
Collins Radio Co.
Dayton Aviation Radio & Equipment Corp.
Electronic Communications, Inc.
Emerson Radio & Phonograph Corp.
Engrg. Associates
Hoffman Labs. Div., Hoffman Electronics Corp.
Hammorlund Mfg. Co. Inc.
ITT Labs.
Lear, Inc.
Lear, Inc., Grond Rapids Div.
Litton Industries, Inc.
Litton Industries, Maryland Div.
Livingston Electronic Corp.
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Sperry Piedmont Co.-Div.-Sperry Rand Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.

RECORDERS

a. Antenno Pottern
b. Binaurol Tape
c. Code
d. Dato
e. Depth
f. Disc
g. Disc Magnetic
h. Electronic Rotory Stylus
i. Electronic Self-Baloncing Recorders & Indicators
j. Focsimile
k. Film
l. Film Stripe, Magnet
m. Film Thickness
n. Flight
o. Flight Dato
p. Fluid Conductivity, Electronic
q. Frequency
r. Frequency Response
s. Humidity, Electronic
t. Liquid Level, Electronic
u. Magnetic, Mobile Comm.
v. Materiols Thickness, Electronic
w. Mechanicol
x. Millivolt
y. Moisture, Electronic
z. Oscillograph
o1. Oxygen
b1. Polar
c1. Potentiometers
d1. Power Level
e1. Pressure, Electronic
f1. Sound Level
g1. Specific Gravity, Electronic
h1. Stroin
i1 Tape & Wire
j1. Telemetering
k1. Temperature, Electronic
l1. Timing
m1. Torque, Electronic
n1. Transient
o1. Vacuum
p1. Vibration
q1. Weight, Electronic
r1. XY

ACF Industries, h-1.
Actan Labs. Inc., z.
Aeranutronic Systems, Inc., Sub.-Fard Mator Co., g.
Air Logistics Corp., c, m, n.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., o, b-1, r-1.
Airpax Electranics Inc. Seminole Div., q.
Allegany Instrument Ca., Inc., d, z, e-1, h-1, k-1, n-1.
Alwoc Corp., r-1.
Amelco, Inc., d, j-1, l-1.
American Electronics, Inc., Taller & Cooper Div., o, t, j-1, q-1.
American Machine & Foundry Ca., Gavernment Products Graup, o, q, n-1, q-1.
American Missile Praducts Ca., Inc., o, z, j-1.
Amplifier Corp. of America, i-1.
Antlab Inc., o, b-1, d-1.
Applied Science Corp. of Princeton, n, o, j-1.
***ARNOUX CORP.**, d, o, x.
Associated Engrg. & Mfg. Corp., l-1.
Atlos Precision Products Co., w.
Audio-Master Corp., i-1.
B & F Instruments, Inc., h-1, m-1.
B & K Instruments, Inc., r, b-1, f-1, p-1.
Barker Soles Co., j-1.
Beckmon Instruments, Inc., Berkeley Div., d, q, l-1.
Beckman-Systems Div., d, j-1.
Bendix-Pacific Div., Bendix Aviation Corp., j-1.
Benson-Lehner Corp., d, k, n, r-1.
Bogen-Presto Co., Div.-Siegler Corp., The, b, i-1.
Bowser, Inc., Defense Dept., y.
Briggs Associotes, Inc., c, d.
Bristol Co., The, i, p, q, w, x, a-1, c-1, d-1, g-1, h-1, j-1, k-1, l-1, a-1, r-1.
Broadcast Equipment Specialties Corp., i-1.
Brush Instruments, Div.-Clevite Corp., g, h, n, o, p, r, x, z, e-1, h-1, j-1, p-1, q-1.
Bulow Electric Co., t, i-1, j-1.
Burke & James Inc., k.
CDC Control Services, Inc., s, q-1.
California Technical Industries, Div.-Textron Inc., a.
Cambridge Instrument Co., Inc., a-1.
Comera Mart Inc., The, k, l.
Centronix Inc., c, d, e, h, r, u, z, h-1, j-1, l-1, n-1.
Century Electronics & Instruments, Inc., d, o, z.
Chesapeoke Instrument Corp., o.
Chicago Aerial Industries, Inc., d, k.
Consolidated Electrodynamics Corp., d, n, o, u, y, z, a-1, e-1, h-1, i-1, j-1, p-1.
Data-Control Systems, Inc., d, r, j-1.
Datran Electronics, Div.-Mid-Continent Mfg., Inc., i, h-1.
Dresser Industries, Inc., d, r, z, j-1, n-1.
M. Ducommun Co., l-1.
Edgerton, Germeshausen & Grier, Inc., j-1, l-1.
Edin-Div.-Epsco, Inc., z.
Edwards Engrg. Co., b, n, o, i-1.
Electro Instruments, Inc., r-1.
Electronic Applications, Inc., b, q, i-1.
Electronic Engrg. Co. of California, o, h-1, l-1, p-1.
Electro-Tech Equipment Co., x.
Emerson Radio & Phonograph Corp., u, i-1.
Engrg. Associates, q, x.
Epic, Inc., z, p-1.
Esterline-Angus Co., Inc., The, x, l-1.
FXR, Inc., q.
Federol Mfg. & Engrg. Corp., i-1.
Fischer & Porter Co., i, t, e-1, g-1, j-1, k-1.
Fisher Research Lab., Inc., t, x, y, h-1.
Flight Research, Inc., k.
General Electric Co., Apparatus Sales Div., i, q, v, x, z, d-1, l-1.
General Electric Co., Computer Dept., d.
General Electric Co., X-Ray Dept., d, k, o.
General Kinetics, Inc., i-1.
General Precision Lab. Inc., k, a.
General Scientific Equipment Co., c-1.
Gilmore Industries, Inc., h-1, m-1, q-1, r-1.
Gordon Enterprises, d, k, o, z, i-1.
Graflex Inc., i-1.
Green Rectifier Co., a-1.
Gulton Industries, Inc., p-1.
Hagan Chemicals & Controls, Inc., e-1, h-1.
Hallamore Electronics Co., j-1.
Hallicrafters, q.
Hamilton Watch Co.-Industrial Div., z.
Hays Corp., The, a-1.
Heiland Div.-Minneapolis-Honeywell, z.
High Vacuum Equipment Corp., a-1.
Hoffman Labs. Div., Hoffman Electronics Corp., o.
Hogan Laboratories, Inc., d, j, n, o, w, z, b-1, j-1.
Hull Corp., a-1.
ITT Labs., d, j, n, o, q, r.
Industrial Instruments Inc., p, a-1.
Instrumentation Div.-Ampex Corp., c, d, n, o, u, f-1, j-1.
Instruments Corp., The, s, j-1.
Kinevox Div.-Electromation Co., d, k.
Land-Air Inc., d, j-1.
Leach Corp., d, o, i-1, j-1.
Leeds & Northrup Co., o, d, i, p, s, t, x, o-1 thru e-1, h-1, k-1, q-1, r-1.
Librascope Inc., r-1.
Liquidometer Corp., The, t.
Litton Industries, Inc., f, g, j, j-1.
Livingston Electronic Corp., b.

MB Mfg. Co., p-1.
Magnaflux Corp., m, v, h-1.
Magnavox Co., The, e, r-1.
Magnetic Instrument Co. Inc., i, t.
Markite Corp., c-1.
Massa Div.-Cahu Electronics, Inc., d, a, r, z, n-1.
W. L. Maxson Corp., The, k.
Merz Engrg., Inc., v.
Mid-Century Instrumatic Corp., d, z.
Midwestern Instruments, Inc., b, d, k, n, o, z, h-1, i-1, j-1.
Miles Reproducer Co. Inc., k, i-1.
Milgo Electronic Corp., d, r-1.
Minicom Div., Minnesota Mining & Mfg. Co., a, i-1, j-1, n-1, p-1.
Mine Safety Appliances Co., a-1.
Minicord Corp. of America, i-1.
Minneapolis-Honeywell Regulator Co.-Davies Labs. Div., d, n, a, u, i-1, j-1.
Minneapolis-Honeywell Regulator Co., Industrial Div., d, i, p, q, s, t, y, c-1, e-1, g-1, h-1, j-1, k-1, o-1, r-1.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, i, n thru q, s, t, x, y, z, c-1 thru k-1, m-1 thru r-1.
Minnesota Mining & Mfg. Co., b, d, l, u, i-1, j-1.
F. L. Moseley Co., i, x, c-1, r-1.
Motorola Inc., Military Electronics Div., d, k, j-1, r-1.
NRC Equipment Corp., o-1.
National Electronics, d-1.
Notional Research Corp., o-1.
New England Scientific Instruments Co., x, z, n-1.
Northeastern Engrg. Inc., q.
Northrop Corp., o.
Norton Associates, Inc., l.
Norwood Controls Unit Detroit Controls Div., t, e-1, h-1, j-1, k-1.
Nuclear Products-Erco Div.-ACF Industries, Inc., r-1.
Offner Electronics Inc., x, z, h-1.
Orbitran Co., Inc., q-1.
Pacific Scientific Co., p-1.
*PACKARD-BELL ELECTRONICS CORP., i-1.
Peirce Dictation Systems, i-1.
Photron Instrument Co., d, a, r, z, h-1.
Potter Aeronautical Corp., g-1.
Radiaphone Co. Inc., j-1.
Radiation, Inc.
Raymond Engrg. Lab., Inc., i-1, l-1.
Research Appliance Co., d, i, c-1, k-1.
Richardson Scale Co., q-1.
Royal Industries, Inc., a, i.
Sanborn Co., q, r, z, d-1, e-1, f-1, h-1, i-1, q-1, r-1.
Schaevitz Engrg., r-1.
Scientific-Atlanta, Inc., a, b-1.
Seiscor Mfg. Co., z.
Shepard Laboratories, Inc., i-1.
Singer Mfg. Co., The, Military Products Div., w, i-1, j-1.
Somers Brass Co. Inc., i-1.
Soroban Engrg., Inc., c, d, w, i-1.
Southwestern Industrial Electronics Co., d, i-1.
Space Corp., t.
Strand Engrg. Co., k.
Sun Electric Corp., Aeronautical Div., a, z.
Systron Corp., a, q, e-1, h-1, j-1 thru m-1, q-1.
Tapco Group, Thompson-Ramo-Wooldridge Inc., z.
Technology Instrument Corp., q, r, z, c-1, e-1.
Telechrome Mfg. Corp., i, x.
Telectro Industries Corp., a thru d, j, n, o, u, i-1, j-1, r-1.
Thermo Electric Co., Inc., k-1,
Thwing-Albert Instrument Co., k-1, r-1.
Traid Corp., k, n, o.
Universal Dynamics Corp., s.
Varian Associates, i, x, c-1, k-1.
Victor Adding Machine Co., n, w.
Victory Engrg. Corp., k-1.
Vitro Labs., c, d.
Waldorf Electronics., Div.-F. C. Huyck & Sons, r-1.
Wang Labs., Inc., d.
Waste King Corp., Technical Products Div., d, n, a.
Webcor, Inc., Government Div., b, c, d, n, a, u, i-1.
West Instrument Corp., x, c-1, e-1, k-1.
Weston Instruments, Div.-Daystrom, Inc., i, q, s, v, w, x, c-1, e-1, k-1, o-1.
Westranics Inc., o, d, e, i, p, q, s, t, x, y, a-1, c-1 thru h-1, k-1, m-1, p-1, q-1, r-1.
Wright Engrg. Co., a.
Yellow Springs Instrument Co., The, k-1.

RECORDERS, AIRBORNE FILM

Applied Science Corp. of Princeton
Chicago Aerial Industries, Inc.
Consolidated Electrodynamics Corp.
Eastman Kodak Co.
Flight Research, Inc.
Gordon Enterprises
Hallicrafters
Hycon Mfg. Co.
Kinevox Div.-Electromation Co.
Magnasync Mfg. Co., Ltd.
Mognavox Co., The
Midwestern Instruments, Inc.
Specialties, Inc.
Sun Electric Corp., Aeronautical Div.
Traid Corp.

RECORDERS, AIRBORNE MAGNETIC

American Electronics, Inc.
Audio-Master Corp.
B J Electronics, Borg-Warner Corp.
Broadcast Equipment Specialties Corp.
Centronix Inc.
Consolidated Electradynamics Corp.
Edwards Engrg. Co.
Elgin Micronics Div.-Elgin National Watch Co.
Emersan Radio & Phonagroph Corp.
Federal Mfg. & Engrg. Corp.
General Precision Lab. Inc.
Graflex Inc.
Hallicrafters
Instrumentotion Div.-Ampex Corp.
Kinevox Div.-Electromotion Co.
Leach Corp.
Litton Industries, Inc.
Magnasync Mfg. Co., Ltd.
Midwestern Instruments, Inc.
Minicom Div., Minnesota Mining & Mfg. Co.
Minneapolis-Honeywell Regulator Co.-Davies Labs. Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Minnesota Mining & Mfg. Co.
*PACKARD-BELL ELECTRONICS CORP.
Peirce Dictation Systems
Seeburg Corp., The
Space Corp.
Sun Electric Corp., Aeronautical Div.
Telectro Industries Corp.
Victor Adding Machine Co.
Webcor, Inc., Government Div.
Winzen Research Ind.

RECORDING DRIVERS
See DRIVERS, RECORDING

RECORDING PAPER
See PAPER, RECORDING

RECTIFIER POWER UNITS

Applied Radiation Corp.
Consolidated Diesel Electric Corp.
Control Circuits Inc.
Dresser Industries, Inc.
General Electric Co., Apparatus Sales Div.
Green Rectifier Co.
Guided Missile Div.-De Havilland Aircraft of Conada, Ltd.
ITT Federal Div., International Telephone & Telegraph Corp.
Kahn & Co., Inc.
Land-Air Inc.
Meteor Production Engrg., Inc.
Sanford Miller Co.
*MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.
Motoresearch Co.
Perkin Engrg. Corp.
Peschel Electronics, Inc.
Precise Development Corp.
Rapid Electric Co.
Republic Aviation Corp.
Schauer Mfg. Corp.
Sel-Rex Corp.
A. O. Smith Corp.
Syntron Co.
Talley Corp., The
Technical Apparatus Builders
Tel-Instrument Electronics Corp.
Winder Aircraft Corp. of Florido

RECTIFIERS

a. Capper Oxide
b. Electranic Tube
c. Germanium
d. Mercury Arc
e. Metal Sulphide
f. Metallic Oxide
g. Metallic, Power Supplies
h. Metallic Stack
i. Selenium
j. Silicon
k. Titanium
l. Tube
m. Tube Rectifying Units

Aeroject-Generol Corp.
Aerolob Development Co., g.
Allied Research Products, Inc., i, j.
Allis-Chalmers, c, i, j, m.
American Elite, Inc., b, l.
Astronetics, Inc., g.
Audio Devices, Inc., j.
Audio Devices, Inc.-Rectifier Div., j.
Bendix Aviation Corp., Red Bank Div., b, j.
Bendix Aviation Corp.-Semiconductor Products, Red Bank Div., j.
Bogue Electric Mfg. Co., g, j.
Bradley Semiconductor Corp., a, f thru j.
Britton Electronics Corp., i, j.
CBS-Hytron, Div.-Columbia Broadcasting System, Inc., b, l.
Christie Electric Corp., g.
Clark Electronic Labs., c, i, j, l.
Columbus Electronics Corp., j.
Conant Labs., a, i.
Consolidated Diesel Electric Corp., b, g, l, m.
Continental Electronics Mfg. Co., m.
Control Circuits Inc., i.
Davenport Mfg. Co., m.
Dresser Industries, Inc., m.
Edgerton, Germeshausen & Grier, Inc., l.
Eitel-McCullough, Inc., l.
Electronic Communications, Inc., m.
Electro-Tech. Equipment Co., i.
Erie Resistor Corp., c, j.
Finney Co., The, i.
General Electric Co., Apparatus Sales Div., d, g.
Good-All Electric Mfg. Co., c, i, j.
Green Rectifier Co., c, f thru j, m.
Hoffman Electronics Corp., Semiconductor Div., j.
Hughes Aircraft Co., j.
International Rectifier Corp., c, h, i, j.
International Resistance Co., i.
Knopp Inc.
Ling Electronics, Inc., b, l.
P. R. Mallory & Co. Inc., e, j.
Meteor Production Engrg., Inc., i, j, m.
Sanford Miller Co., g thru j.
Model Rectifier Corp., g.
Motorolo Inc., Military Electronics Div., c, j.
Multi-Amp Corp., c, e, g.
North American Electronics Inc., h, j.
Pacific Semiconductors, Inc., j.
Peschel Electronics, Inc., m.
Power Supplies Inc., g, m.
Precise Development Corp., g.
Radio Industries, Inc., i.
Rapid Electric Co., b, i, j.
Raytheon Mfg. Co., j, l.
Rectico, Inc., o, d thru j.
Rex Corp., The, Sub.-Americon Enka, h.
Schauer Mfg. Corp., a, f, g, h.
Sperry Semiconductor Div., Sperry Rand Corp., j.
State Testing Lab. Inc., c, i.
Strong Scott Mfg. Co., The, m.
Sylvania Electric Products Inc., Semiconductor Div., c, j.
Syntron Co., g thru j.
Technical Apparatus Builders, a thru l.
Thermosen Inc., j.
Transmares Corp.
Trans-Sil Corp., f, g, h, j.
Union Switch & Signal, Div.-Westinghouse Air Brake Co., a.
U. S. Semiconductor Products, Inc., j.
United States Dynamics Corp., b, c, g, j.
Wesrep Corp., j.
Westinghouse Electric Corp., a, c, d, i, j.
Weston Instruments, Div.-Daystrom, Inc., a.
Winder Aircraft Corp. of Florida, g.

REDUCERS, SHAFT

Arch Geor Works Inc.
Diversey Engrg. Co.
Lovejoy Flexible Coupling Co.
Lundy Mfg. Corp.
Talley Corp., The
Western Gear Corp.

REFLECTED & TRANSMITTED LIGHT SCANNERS
See SCANNERS, REFLECTED & TRANSMITTED LIGHT

REFLECTORS, RADAR

Ainslie Corp.
Atlas Precision Products Co.
Brooks & Perkins, Inc.
Diomond Antenna & Microwave Corp.
Gilfillan Bros. Inc.
Haller, Raymond & Brown Inc., Div.-Singer Mfg. Co.
I-T-E Circuit Breaker Co.
ITT Federal Div., International Telephone & Telegraph Corp.
*LAVELL AIRCRAFT CORP.
Mc Millan Industrial Corp.
Narmco Mfg. Co.
Plastic Age Sales, Inc.
Precision Sheet Metol, Inc.
Radiation, Inc.
C.W. Torngren Co., Inc.
Turbo Machine Co.
Winder Aircraft Corp. of Florida
Winzen Research Inc.

REFRIGERATION EQUIPMENT, AIRBORNE

*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Alco Valve Co.
American Aeroparts
Bendix Utica Div., Bendix Aviation Corp.
Eastern Industries Inc.
Ellis & Watts Products, Inc.
Hallicrafters
Hamilton Standard, Div.-United Aircraft Corp.
Hydromatics, Inc.
Monrovia Aviation Corp.
Mueller Brass Co.
Northrop Corp.
Reinhold Engrg. & Plastics Co.
Safety Electrical Equipment Corp.
Stratos, Div.-Fairchild Engine & Airplone Corp.
United Aircraft Products, Inc.
Universal Dynamics Corp.
Waste King Corp., Technical Products Div.
Winzen Reseorch Inc.

REFRIGERATION EQUIPMENT, GROUND

*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Alco Valve Co.
American Air Filter Co., Defense Products Div.
*ASSOCIATED TESTING LABS., INC.
Bendix Utica Div., Bendix Aviation Corp.
Bogue Electric Mfg. Co.

rrier Corp.
nsolidated Diesel Electric Corp., Western Div.
oll-Reynolds Co. Inc.
yle & Rath Mfg. Co., Inc.
ayer-Hanson Div., National-U.S. Radiator Corp.
esser Industries, Inc.
stern Industries Inc.
is & Watts Products, Inc.
emco, Inc.
llicrafters
milton Standard, Div.-United Aircraft Corp.
ul Hardeman, Inc.
G. Hakanson Co., Inc.
ghes Tool Co., Aircraft Div.
ll Corp.
dromatics, Inc.
trruments Div.-Philips Electronics, Inc.
ternational Radiant Carp.
hison Cald Storage Door Co.
-Heet, Inc.
gee-Bralla & Associates
hravia Aviatian Corp.
eller Brass Co.
neer Industries Div., Almar-York Co. Inc.
enno Metal Products, Div.-Standard Screw Co.
sty Electricol Equipment Corp.
ling Precision Corp., Instrument Div.
tros, Div.-Foirchild Engine & Airplone Corp.
rmo King Corp.
ver Mfg. Corp.
nter Mfg., Inc.
ted Aircraft Products, Inc.
versal Dynamics Corp.
er Mfg. Co., The
stinghouse Electric Corp.
k Corp.

ILATORS

Air
Air Combustion
Air Pressure
Battery Charging
Cable Tensian
Coolant
Demand Oxygen
Frequency
Fluid Flaw
Fuel Flaw
Fuel Pressure
Generatar
Hydraulic Pressure
Liquid Level
Manifold Pressure
Oil Cooler
Oil Pressure
Oil Pump Flaw
Oil Temperature
Oxygen
Temperature
Vacuum Systems
Voltage Frequency
Voltage Regulatars & Stabilizers
Water Injection
Water Metering

f Industries Inc., b, c, h, j, k, q, w thru z.
essory Products Co., Div.-Textron Inc., a, b, c, i, thru a, s, t.
lc Electric Corp., d, x.
uation Research Corp., a, c, i, j, m.
l Precision Products of Colifornio, Div.-Generol etals Corp., m, q, r.
s Supply Mfg. Inc., i, j, k, m, n, q, r, y, z.
ject-Generol Corp., i, j, k, m, n.
lob Development Co., h, w, x.
tec Corp., The, a, b, c, i, j, k, m, n, q.
Products, Inc., c, g, i.
Reduction Sales Co., Div.-Air Reduction Co., Inc.

RESEARCH MFG. CO. OF ARIZ., a, c, i, s, u.
RESEARCH MFG. CO., DIV.-THE GARRETT ORP., a, c, f thru k, p, q, s, t, u.
ir, Inc., a, c, g, i, m, q, t.
lco, Inc., h.
rican Aeroparts, e, g thru k, a thru u.
ricon Electronics, Inc., Electric Machinery & uipment Div., h, l, w, x.
rican Instruments Co., Inc., u.
rican Research & Mfg. Corp., x.
lifier Corp. of Americo, x.
lied Dynomics Corp., a, c.
Equipment Corp., a, c, g, t.
onautics Engrg. Co., i, j.
mation Products, Inc., n.
er-Colman Co., u.
Ray Products, Inc., u.
ett-Christie Co., a, c, i, u.
ow Mfg. Corp., a, c, i, m.
dix Aviation Corp., Pioneer-Central Div., g, n, t.
dix Aviation Corp., Red Bank Div., d, h, l, w, x.
NDIX PRODUCTS DIV., BENDIX AVIATION ORP., i, k.
Bdix-Pacific Div., Bendix Aviation Corp., i, m.
Bdix Utica Div., Bendix Aviation Corp., a, c, i, j,

Bo Lob., Inc., w, x.
Biederman, Inc., g.
Brick Mfg. Corp., a, c, e, i, m.
Bue Electric Mfg. Co., d, h, l, n, u, w, x.
Brach Mfg. Corp., Div.-Generol Branze, x.
Breeze Corporations, Inc., a.
Brooks Rotameter Co., i, j, n, r, z.
Carletan Aviatian Co., a, b, c, i, j, k, m, a, t, y, z.
Carruthers & Fernandez, Inc., w, x.
J. C. Carter Co., The, i, j, k, n, y, z.
A. W. Cash Valve Mfg. Corp., k, m, q, s, t, u.
Central Electronic Mfrs., Div.-Nuclear Carp. of America, v.
Central Transformer Co., x.
Chandler Evans Corp., a, c, f, i, j, k, m, q, y, z.
Clary Dynamics, a, b, c, g, i, k, m, n, q, t, y, z.
Com-Air Products, Div.- A S R Products Corp., a, i, m, q.
Components Carp., a, c, i, j, k, n, q, r, z.
Conaflow Corp., a, b, c, v.
Consalidated Controls Corp., a, c, i, j, k, m, q, s, u, v.
Consolidated Diesel Electric Corp., a, b, c, i, j, k, m, a thru s, u, v.
Controls Co. of America, i, n.
Cornelius Co., The, Aero Div., a, c, v.
Daven Co., The, h, w, x.
Davenport Mfg. Co., x.
Delca-Remy Div., General Motors Corp., d, l, x.
Denisan Engrg. Div., American Brake Shoe Co., m, q, r.
Donner Scientific Co., x.
Dresser Industries, Inc., i, j, x.
R. C. Dudek & Co., x.
Dumont Aircraft Fitting Co., c, i, m.
Dynamic Controls Corp., i, m, n, u.
Electric Auto-Lite Co., The, l.
Electric Regulotor Corp., d, h, k, l, m, r, w, x.
Electrol Inc., m.
Electro-Mechonical Products Co., d, l, x.
Electronic Research Associotes, Inc., w, x.
Electro-Tech Equipment Co., x.
Engineered Magnetics, Div.-Gulton Industries, Inc., d, x.
Foirfield Engrg. Corp., h, x.
Fidelity I nstrument Corp., h, l, w, x.
Firewel Co., Inc., The, g.
Fischer & Porter Co., c, i, j, k, m, n, a, q, s, t, u, z.
Fisher Governor Co., a, c, i, k, m, t, y.
Generol Electric Co., Apparotus Sales Div., h, l, u, w, x.
General Scientific Equipment Co., g, t.
Gits Brothers Mfg. Co., a.
Goslin Electric & Mfg. Co., w, x.
Gray Co., Inc., a, c, i, k.
Green Rectifier Co., d, v, x.
Grove Volve & Regulator Co., a, c, i, k, m, q, r, y, z.
Guided Missile Div.-De Hovilland Aircraft of Canada, Ltd., d, h, l, w, x.
Hagan Chemicols & Controls, Inc., a, c, i, j, k, m, n, p, s, t, z.
Hallicrafters, x.
Hamilton Standord, Div.-United Aircraft Corp., a, c, h, w, x.
Honnifin Co., Div.-Porker-Hannifin Corp., a, c, m.
High Vacuum Equipment Corp., v.
E. Vernon Hill & Co., u, w.
Hoffmon Electronics Corp., Semiconductor Div., x.
Hoke Inc., a, c, i.
Hughes Tool Co., Aircraft Div.
Hull Corp., v.
Hydra-Power Corp., i, m, q.
***HYDRO-AIRE CO., DIV.-CRANE CO.**, a, c, i, j, l, w, x.
Hydrodyne Corp., Skinner Seol Div., c, i, j, k, m.
Hydromotics, Inc., i, j, k, m, t.
ITT Federol Div., Internationol Telephone & Telegroph Corp., h.
Industriol Engrg. Corp., m.
Integral Corp., a, m.
Interstate Engrg. Corp., c, i, k.
Jack & Heintz, Inc., h, l, w, x.
***JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.**, a, b, c, k, v.
Kemp Aero Products, a, c, g, i, j, k, m, q, t, u.
Wolter Kidde & Co., Inc., Aviation Div., a, c.
Kinney Mfg. Div., The New York Air Brake Co., v.
Kohler Co., k, m.
Korda Industries, i, j, k, o.
Leoch Corp., h, w, x.
Leor, Inc., v.
Leeds & Northrup Co., u.
Lelond Airborne Products, Div.-American Machine & Foundry Co., d, h, l, w, x.
***WALLACE O. LEONARD, INC.**, a, c, g, i, k, m, n, q, t, v.
Leslie Co., a, c, l, j, k, m, n, q, s, u.
Linde Co., Div.-Union Carbide Corp., t.
M. C. Mfg. Co., m.
Magnetic Controls Co., x.
Marotto Valve Corp., a, c, i, k, m, t.
Jos. P. Marsh Corp., u.
Moson-Neilon, b, i, k, m, n, u.
Motheson Co., Inc., The, c, t.
Metols & Controls Corp., Spencer Div., u.
Meteor Production Engrg., Inc., d.
Mine Safety Appliances Co., g.
Minitron Corp., x.
Minneopolis-Honeywell Regulotor Co., Industriol Div., i, k, m, n, s.
Minneapolis-Honeywell Regulotor Co., Industrial Product Group, a, c, h thru k, n, a, u, w, z.
Mucon Corp., d.
National Instrument Loborotories, Inc., i.
National Research Corp., v.
Notionol Spectrogrophic Labs., Inc., w, x.
National Welding Equipment Co., a.
Networks Electronic Carp., x.
Ernest Norrman Laboratories, h.
North American Electronics Inc., x.
Dhmart Carp., The, n.
Dil-Dyne, Inc., m, q, r.
Dxygen Equipment & Service Co., g, t, v.
Dzone Metal Products Corp., i, m.
Pacific Scientific Co., e.
Papesch & Kolstad, Inc., u.
Parker Aircraft Co., a, b, c, i, j, k, m, n, a, u.
Penberthy Mfg. Co., n.
Perkin Engrg. Corp., d, h, l, w, x.
Pneu-Hydro Valve Corp., a, c, g, i, j, k, m, t.
Power Designs Inc., d, x.
Power Sources, Inc., h, w, x.
Power Supplies Inc., d, l, w, x.
Power-Tranic Systems Inc., w, x.
Process & Instruments, v.
Puritan Compressed Gas Corp., Aviation Div., g, t.
Pyles Industries, Inc., a.
Pyrometer Instrument Co., Inc., u.
Racine Hydraulics & Machinery Inc., a, q, r.
Randall Engrg. Corp., a, c, i, m, t.
Raythean Mfg. Co., x.
Reaction Motars Div., Thiokol Chem. Corp., i, j, k.
Republic Mfg. Co., c, m, q.
Reseorch Appliance Co., v.
Research Controls, a, c, i, j.
Ronson Hydraulic Units Corp., c, m.
Sofety Electricol Equipment Corp., d, l, v, w.
Sorgent Engrg. Corp., a, c, i, m, q, r.
Scoico Controls, Inc., s, u.
Scientific Instrument Co., c, u.
Sequoio Wire & Coble Co., Div.-Mandrel Industries, Inc., x.
Simmonds Aerocessories, Inc., i, j, n.
A. O. Smith Corp. · Smith-Erie Div., i.
Sorensen & Co., Inc., h.
South Wind Div., Stewort Worner Corp., p.
Speciol Instruments Div., British Industries Corp., x.
Specialty Engrg. & Electronics Co., w, x.
Spectrol Electronics Corp., h, w.
Standard-Thomson Corp., Clifford Mfg. Co. Div., p, r, s.
Sterling Precision Corp., Instrument Div., x.
A. U. Stone & Co., Inc., i, j, k, m, q, r, z.
Strotos, Div.-Foirchild Engine & Airplone Corp., a, c, i, j, u.
Superior Electric Co., The, x.
Surface Combustion Corp., c.
Tapco Group, Thompson-Ramo-Wooldridge Inc., h thru l, w, y.
Technicol Apparatus Builders, d, w, x.
Tel-Instrument Electronics Corp., x.
Temperature Engrg. Corp., u, v.
Torwico Electronics, Inc., x.
Transitron Electronic Corp., x.
Tronsonic, Inc., w, x.
United Aircroft Products, Inc., a, c, f, i, j, k, m, n, p thru s, u, v, w, y.
United Control Corp., s, u.
United Electric Controls Co., a, c, g, k thru v.
U. S. Science Corp., Div.-Topp Industries, Inc., h.
Vap-Air Aeronautical Products Div., Vapor Heating Corp., c.
Veeco Vocuum Corp., v.
Vickers Inc., Marine & Drdnonce Dept., Machinery Hydroulics Div., m.
Victory Engrg. Corp., t, u.
Vinson Mfg. Co. Inc., c, i, j, k, m, n, q, r, t.
Waldorf Fluid Systems. Div.-F.C. Huyck & Sons, o, c, i, j, k, m, o, r, v.
Walloce & Tiernon Inc., c.
Western Design, Div.-U.S. Industries, Inc., Sonto Borboro Div., x.
Westinghouse Air Brake Co., Industriol Products Div., c.
Westinghouse Electric Corp., w, x.
Weston Hydroulics Ltd.-Sub., Borg-Worner Corp., a, c, i, k, m.
Yellow Springs Instrument Co., The, u.

REINFORCED PLASTICS

Aero Gasket Corp.
Aeroject-General Corp.
Air Logistics Corp.
Allied Plostics Supply Corp.
American Printed Circuits Co., Inc.
Apex Reinforced Plostics, Div.-White Sewing Machine Corp.
Aristocrot Plostics, Inc.
Atkins & Merrill, Inc.
Corl H. Biggs Co.
Bonny Mfg. Corp.
Colfibe Co., Inc.
Chemold Co.
Chemplost, Inc.
Chicogo Gosket Co.
Cincinnoti Milling Mochine Co., The
Collins Engrg. Corp.
Coloniol Aircroft Corp.
Continental Con Co., Inc.
Continentol Diomond Fibre Corp.
Cornell Deep Drawing Co., Div.-Lones Industries Corp.
Crystal-X Corp.
Curtiss-Wright Corp., Santa Borbora Div.
Curtiss-Wright Corp., Utica Div.
DBM Research Corp.
Dayton Aircroft Products, Inc.

Delta Products Div.-Air Accessaries, Inc.
Dixon Carp.
***DOW CORNING CORP.**
Durez Plastics Div.-Hooker Chemical Carp.
Electrical Insulatian Ca., Inc.
Electra Technical Products Div., Sun Chemical Carp.
Eljay Carp.
Emerson & Cuming, Inc.
Emerson Plastics Corp.
Emmco Plastic Fabricators -Div.-E. M. McCarthy Machine Co.
Fischer & Porter Ca.
Fletcher Mfg. Ca., Inc., The
Fluorocarban Co., The
Franklin Fibre-Lamitex Corp.
Fruehauf Trailer Ca., Military Equipment Div.
Gatke Carp.
General Plastics Carp. of New Jersey
Goodyear Aircraft Corp.
Hardman Tool & Engrg. Ca.
Haveg Industries, Inc.
Homalite Corp., The
Hughes Tool Ca., Aircraft Div.
Integrated Mica Carp.
Jarvis Carp.
Jaclin Mfg. Ca.
Jadee Plastics Co.
Johns-Manville
Johns-Manville Sales Carp.
Kerrco Products
Walter Kidde & Ca., Inc., Aviatian Div.
H. Koch & Sons
Lamtex Industries, Inc.
Liss Products, Inc.
Magee-Bralla & Associates
Mc Millan Industrial Corp.
Mica Insulatar Div.-Minnesata Mining & Mfg. Ca.
Minnesata Mining & Mfg. Ca.
National Vulcanized Fibre Ca.
New England Laminates Co., Inc.
Perry Plastics, Inc.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Prewitt Aircraft Co.
Raybestas-Manhattan, Inc., Pa.
Reinhald Engrg. & Plastics Co.
Republic Aviation Corp.
Resistoflex Corp.
Rex Carp., The, Sub.-American Enka
Rogers Carp.
Russell Reinforced Plastics Corp.
Joseph T. Ryersan & Son, Inc.
Scientific-Atlanta, Inc.
Silicane Insulatian, Inc.
Skydyne, Inc.
Spaulding Fibre Ca., Inc.
Specialty Engrg. & Electronics Ca.
Stevens Products, Inc.
Stratas, Div.-Fairchild Engine & Airplane Carp.
Swedlow Inc.
H. I. Thampson Fiber Glass Ca.
Tapper Mfg. Co., Inc.
Trianics Carp.
United States Chemical Milling Corp.
United States Rubber Co.
Veet Industries
Waterbury Companies, Inc.
Wenzlau Engrg. Ca.
Western Tool & Mfg. Ca., The
Zippertubing Co., The

RELAYS

a. Audia Operated
b. Capacitance
c. Coaxial
d. Cantact
e. Crass-Bar
f. D Arsonval
g. Differential
h. Electranic, Resistance Activated
i. Frequency Selective
j. High Valtage
k. Impulse
l. Keying & Break-In
m. Latching
n. Mercury
o. Meter
p. Microwave
q. Overfrequency
r. Overload
s. Overvaltage & Undervaltage
t. Photaelectric
u. Plate Circuit
v. Palarized
w. Pawer
x. Reverse Current
y. RF
z. Ratary
a1. Sensitive
b1. Sequence
c1. Stepping
d1. Subminiature
e1. Synchranizing, Transfer
f1. Telephone
g1. Temperature Compensated
h1. Thermal
i1. Thermostatic Delay
j1. Time Delay
k1. Timing
l1. Under Frequency
m1. Vacuum Contact
n1. Vibrating Reed Type

A-G-A Div., Elastic Stop Nut Corp. af America, j-1.
Acra Div., Robertshaw-Fultan Controls, w.
Acramag Inc., x.
Advance Relays, Electronics Div., Elgin National Watch Ca., c, d, e, i, k, l, q, t, v, y, z, b-1, c-1, e-1, g-1, h-1, i-1.
Advanced Electronics, Inc., a.
Advanced Products Co., The, j-1, k-1.
Ad-Yu Electronics Lab., Inc., a-1.
Aeralite Electronics Corp., a-1.
Aircom Inc., p.
All American Engrg. Co., j-1.
Allied Control Co., Inc., c, g, j thru n, r, s, u thru x, z, a-1, d-1, f-1, g-1, j-1, k-1, m-1.
Alta Scientific Co., Inc., j-1, k-1.
American Aeraparts, x, i-1, j-1, k-1.
American Instrument Co., Inc., a-1, j-1.
American Machine & Faundry Co., Gavernment Products Group
American Machine & Foundry Co., Greenwich
Arrow-Hart & Hegeman Electric Co., The, d, m, r, s, w, a-1, h-1, i-1, j-1.
Artisan Electronics Carp., a, d, g, j thru m, r thru x, z, a-1, b-1, c-1, g-1, j-1.
Assembly Products, Inc., f, a, s, a-1.
Automatic Electric Sales Carp., d, k, m, n, v, b-1, c-1, f-1, j-1, k-1.
Automatic Switch Ca., g, j, m, p, r, w, x, a-1, j-1.
Autotron, Inc., t.
Babcock Radio Engrg., Inc., a-1, d-1.
Babcock Relays, Inc., b, d, g, m, n, r, s, u thru x, z, a-1, d-1, e-1, f-1.
Barber-Calman Co., i, m, v, a-1.
Barker Sales Co., e, k thru p, a-1 thru d-1, f-1, g-1, j-1.
Basa Inc., a-1, d-1, g-1, j-1.
James G. Biddle Ca., i, n-1.
Branson Corp., r, s, u, v, w, z, d-1, g-1 thru k-1.
Bristal Ca., The, g, v, a-1, d-1, g-1, m-1, n-1.
Central Electranic Mfrs., Div.-Nuclear Corp. of America, m-1.
C. P. Clare & Ca., k thru n, u, v, a-1 thru d-1, f-1, j-1.
Clark Electranic Labs., d-1.
Cails-Electronics, b.
Camar Electric Co., k, l, m, t, w, a-1, d-1, f-1, j-1.
Contral Engrg. Ca., Div.-Jervis B. Webb Co., j-1.
Couch Ordnance, Inc., u, z, a-1, d-1.
Cramer Cantrals Corp., j-1, k-1.
James Cunningham San & Co., Inc., e.
Curtiss-Wright Corp., Electronics Div., h-1, i-1, j-1, k-1.
Curtiss-Wright Electranics Div., IMI Branch, k, m, w, d-1, j-1, k-1.
Cutler-Hammer Inc., d, g, h, r, w, a-1, b-1, j-1, k-1.
Datascan Inc., h.
Delca-Remy Div., General Matars Corp., m, w, z, d-1.
Destron Ca., j-1, k-1.
Douglas Micrawave Co., Inc., p.
Durakool, Inc., n, j-1, k-1.
Durant Mfg. Co., t.
Ebert Electronics Corp., h, m, n, q, w, a-1, j-1, m-1.
Electra Tec Carp., d, w, z, z-1.
Electro-Mechanical Products Ca., g, r, x.
Electra-Mechanical Specialties Ca., Inc., d, e, g, h, i, k, m, q, s, u, v, w, z, b-1, c-1, d-1, g-1, j-1.
Electronic Cantrol Corp., h, r, t, j-1.
Electranic Research Assaciates, Inc., s.
Electranic Specialty Ca., c, q, s, x, d-1, j-1, k-1, l-1.
Electron-Radar Products, n.
Electra-Switch & Cantrols, Inc., s, v, w, a-1, d-1, f-1, g-1, j-1.
Electra-Tech Equipment Co., f, k, m, n, a, t, w, a-1, thru d-1, f-1, i-1, j-1, k-1.
Elgin Micranics Div.-Elgin National Watch Ca., i-1, k-1.
Engrg. Assaciates, v, f-1, i-1, j-1.
Essex Wire Corp., b, d, e, h, j, k, r, x, a-1, f-1, h-1.
Farmer Electric Products Ca., Inc., h.
***FILTORS, INC.**, m, r, w, z, d-1.
Fisher Scientific Ca., h.
G-V Controls Inc., i, q, r, s, g-1 thru l-1.
General Automatic Corp., d, g, k, l, m, r, s, u, w, a-1, f-1, g-1, j-1.
General Cammunication Co., c, p, y.
General Electric Ca., Apparatus Sales Div., k, q thru t, w, x, b-1, d-1, g-1, h-1, j-1, k-1, l-1.
Glabe Electrical Mfg. Co., d, l, m, u, w, z, a-1, f-1, g-1, j-1.
Gordas Corp., n.
Green Rectifier Co., s.
Guardian Electric Mfg. Ca., d, h thru m, q, z, a-1 thru d-1, f-1, h-1, j-1, k-1, l-1.
Gulton Industries, Inc., i.
Gyrex Carp., The, i.
Haledy Electronics Co., d, n, t, w.
Hamiltan Watch Co.-Industrial Div., j-1, k-1.
Hamlin, Inc., n, n-1.
Hart Mfg., Co., The, d, h, k, m, v, w, a-1, b-1, d-1.
Hartman Electrical Mfg. Co., The, g, i, k, m, q, r, s, v, w, x, a-1, b-1, d-1, e-1, j-1, k-1, l-1.
***A. W. HAYDON CO., THE**, b-1, j-1, k-1.
Heinemann Electric Ca., r, j-1.
Hi-G Inc., z, a-1, d-1, g-1.
Hillburn Electronic Products Ca., d, e, j thru m, r, t thru w, a-1 thru d-1, f-1.
Hi-Spec Electronics Corp., j, u, w, a-1.
Hughes Aircraft Co., h-1.
***HYDRO-AIRE CO., DIV.-CRANE CO.**, j-1.
Imtra Corp., m, c-1, f-1.

Industrial Timer Carp., h-1, j-1, k-1.
Iran Fireman Mfg. Co., Electranics Div., k, m, z, a-d-1.
ITT-Kellagg, f-1.
Jack & Heintz, Inc., q, r, s, w, x, j-1, l-1.
Jaidinger Mfg. Ca., Inc., g, k, m, u, a-1, d-1, j-1, n-1.
Jennings Radio Mfg. Corp., c, r, m-1.
Jardan Electranics, Div.-Victareen Instrument Co., s, j-1, k-1.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., b, h, w.
Kurman Electric Ca., Div.-Norbute Corp., a, d, e, g, h, j, k, l, p, r thru w, y, a-1, d-1, f-1, j-1.
Land-Air Inc., k, z, b-1, c-1.
Leach Carp., d, g, i thru m, q, r, s, u, v, w, y, z, b-d-1, f-1, i-1 thru l-1.
Leaming Engrg., Inc., a.
G. H. Leland, Inc., z, c-1.
Liquidometer Corp., The, a-1.
Luther Mfg. Ca., v, d-1.
Magnecraft Electric Co., c, d, e, g, j thru m, r, s, u, w, z, a-1, d-1, f-1, j-1.
Magnetic Devices, Inc., c, m, v, z, a-1.
P. R. Mallary & Co., Inc., a-1, b-1, d-1, k-1.
Marion Instrument Div., c, f, a-1.
Master Specialties Co., b-1, j-1.
Metals & Cantrals Corp., Spencer Div., q, r, s, h-1, i-1.
Miratel, Inc., a.
Managram Precision Industries, p.
Matarola Inc., Military Electronics Div., p, y, n-1.
Narda Micrawave Carp., The, p.
E. V. Naybar Labs., Inc., r, s, u, w, j-1.
Networks Electronic Corp., i, q, r, s, x, h-1, i-1, l-1
North Electric Ca., e, h, k, l, m, r, s, v, w, z, a-1 thru f-1, j-1, n-1.
Pacific Scientific Co., d-1.
Paragon Electric Co., j-1, k-1.
Penn Keystone Corp., v, a-1, d-1, m-1.
Penta Labs., Inc., m-1.
Peschel Electronics, Inc., h, j.
Phaastron Instrument & Electronic Co., a-1.
Philca Carp., Gavernment & Industrial Div., h thru l p, y, d-1, f-1, j-1.
Photobell Ca., Inc., a, b, h, j, t, j-1, k-1.
Phata-Crystals, Inc., n.
Photamatian, Inc., t.
Joseph Pollak Carp., c, d, g, j, p, s, w, a-1, f-1, g-1
Potter & Brumfield Inc., c, j, l, t thru w, a-1, c-1, d-1, f-1.
Precise Development Corp., h.
Precision Thermameter & Instrument Co., a-1.
Price Electric Carp., c, d, j, l, q, s, u, w, y, z, c-1, d-1, f-1, j-1.
Projects Unlimited Inc., a.
Q. V. S. Inc., a.
Radar Relay, Inc., a-1, d-1.
Raymand Engrg. Lab., Inc., j-1.
Relay Sales Inc., c, d, e, g, j thru n, u thru x, z, a-1 thru d-1, f-1, h-1, j-1, k-1.
Relays, Inc., k, l, s, u, w, x, a-1, d-1, f-1.
Research Appliance Co., h, m-1.
Revere Corp. af America, n-1.
M. H. Rhodes, Inc., j-1.
Rixan Electronics Inc., h.
Safety Electrical Equipment Corp., x.
St. Regis Paper Co., Panelyte Div.
Sealectric Switch & Relay Carp., e, h, w, c-1, f-1.
Sequaia Wire & Cable Ca., Div.-Mandrel Industries, Inc., j-1, k-1.
Sigma Instruments, Inc., g, l, m, s thru w, a-1, d-1, g-1.
Simpson Electric Co., f, a.
Standard Electramagnetics, Inc., k, l, m, r, t, u, w, x, z, a-1 thru d-1, f-1, k-1.
Stanley Aviation Carp., c-1.
Stramberg-Carlsan Div.-General Dynamics Corp., f-1.
Struthers-Dunn, Inc., j thru n, r, s, u, w, x, y, a-1 thru d-1, h-1 thru k-1, m-1.
Technique Assaciates Div., Duncan Electric Ca., Inc., h-1.
Telectra Industries Corp., a, b, c, u, z.
Telerad Mfg. Corp., p.
Tempo Instrument Inc., s, j-1, k-1.
Terada Co., d, r, a-1.
Textran Carp., j-1.
Thiakal Chemical Carp., y.
Tarwico Electranics, Inc., g, i, m, q, s, v, x, a-1, j-1, l-1.
Transca Products, Inc., c, p, y.
Triplett Electrical Instrument Co., f.
George Ulanet Ca., h-1, i-1, j-1.
Union Switch & Signal, Div.-Westinghause Air Brake Ca., k, z, d-1.
United Aircraft Products, Inc., g-1 thru j-1.
U. S. Relay Ca., d, e, g thru j, m, q, r, t, u, v, y, a-1, b-1, d-1, f-1, g-1, h-*, j-1, k-1, l-1.
United Supply Co.
Vap-Air Aeronautical Products Div., Vapar Heating Carp., d, w.
Varo Mfg. Co., Inc., i, l-1.
Vemaline Products Ca., j-1, k-1.
Victory Engrg. Carp., b, h, l, a-1, d-1, g-1, h-1, j-1.
Video Instruments Co., Inc., n.
Wallace & Tiernan Inc., i.
Waltham Engrg. Carp., j-1.
Webcor, Inc., Gavernment Div., a-1, b-1, c-1, j-1.
Westan Instruments, Div.-Daystram, Inc., f, g, i, m, a, s, t, v, w, a-1, d-1, g-1.
Wheeler Electronic Corp., Sub.-Speery Rand Corp., n.

eelock Signals Inc., c, l, m, r, v, w, a-1, d-1, f-1.
C. Wilson & Co., j-1.
notic Corp., The, d, m, w, f-1, k-1.
rner Electronic Devices, t.
nith Electric Co., j-1, k-1.

EASE MECHANISMS

erican Machine & Foundry Co., Government Products Group
plied Design Co.
ckman & Whitley, Inc., Missile Products Div.
rklyn Co.
pewell Mfg. Co.
mponents Corp.
nsolidated Diesel Electric Corp.
oper Development Corp., Sub.-Marquardt Aircraft Co.
rnell Deep Drawing Co., Div.-Lones Industries Corp.
mont Aircraft Fitting Co.
ectro-Mechanical Products Co.
rdmon Tool & Engrg. Co.
ks Corp., The
ex, Inc.
W. Kellogg Co., The
Koch & Sons
C CORMICK SELPH ASSOCIATES
I. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc.
brook Machine Corp.
ific Scientific Co.
secki Aircraft Corp.
mond Engrg. Lab., Inc.
nhold Engrg. & Plastics Co.
ublic Aviation Corp.
H. Rhodes, Inc.
ot Industries Inc.
hley Aviation Corp.
ley Corp., The
ectro Industries Corp.
d Inc.
iety Aircraft Corp.
shington Technological Associates Inc.
ks Precision Instrument Co., Inc.
zen Research Inc.

TE CONTROL SYSTEMS
S SYSTEMS, REMOTE CONTROL

TE PICKUP, AUDIO

sser Industries, Inc.
ctronic Applications, Inc.
flex Inc.
ry Plastics, Inc.
lco Corp., Government & Industrial Div.
ectro Industries Corp.

TE SOUND CONTROLLERS
S CONTROLLERS, REMOTE SOUND

ATERS, MICROWAVE

elmon Electronics Corp.
tronix Inc.
M Research Corp.
T Labs.
truments for Industry, Inc.
ser Aircraft & Electronics, Div.-Kaiser Industries Corp.
torola Inc., Military Electronics Div.
lco Corp., Government & Industrial Div.
erad Mfg. Corp.

EATERS, PASSIVE, MICROWAVE

tronix Inc.
M Research Corp.
dra-Power Corp.
T Labs.
ton Industries, Maryland Div.
torola Inc., Military Electronics Div.
lco Corp., Government & Industrial Div.
ver Construction Co.

ERVOIRS, HYDRAULIC
S HYDRAULIC RESERVOIRS

ERVOIRS, HYDRAULIC SYSTEMS

***RESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
erican Bosch Arma Corp.
erican Machine & Foundry Co., Government Products Group
ronautics Engrg. Co.
dix-Pacific Div., Bendix Aviation Corp.
onial Aircraft Corp.
per Development Corp., Sub.-Marquardt Aircraft Co.
mont Aircraft Fitting Co.
ern Industries Inc.
er Hydroulics, Inc.
nifin Co., Div.-Parker-Hannifin Corp.
kel Engrg. & Supply Co.
rodyne Corp., Skinner Seal Div.
n & Co., Inc.
ser Aircraft & Electronics, Div.-Kaiser Industries Corp.
cury Tool & Mfg. Corp.
. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc.
is-Thermador Corp.
land Copper & Tank Works Inc.
Precision Sheet Metal, Inc.
Pressed Steel Tank Co.
Racine Hydraulics & Machinery Inc.
Red Lion Cabinet Co., Redco Tool Div.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Ronson Hydraulic Units Corp.
Rucker Co., The
Santa Anita Engrg. Co.
Sargent Engrg. Corp.
Stoiniess Steel Products, Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
United Aircraft Products, Inc.
Universal Metal Products Inc.
Vickers Inc., Div.-Sperry Rand
Vickers Inc., Marine & Ordnonce Dept., Machinery Hydraulics Div.
Watertown Div., The New York Air Brake Co.
Wise Aerodraulics, Inc.

RESERVOIRS, PNEUMATIC

American Machine & Foundry Co., Government Products Group
Associated Engineers, Inc.
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Utico Div., Bendix Aviation Corp.
Components Corp.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Cornelius Co., The, Aero Div.
Dumont Aircraft Fitting Co.
Haskel Engrg. & Supply Co.
Hydrodyne Corp., Skinner Seal Div.
Kohn & Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Walter Kidde & Co., Inc., Aviation Div.
Natl. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc.
Pressed Steel Tank Co.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Ronson Hydraulic Units Corp.
Rucker Co., The
Santa Anita Engrg. Co.
Stratos, Div.-Foirchild Engine & Airplane Corp.
United Aircraft Products, Inc.

RESISTANCE PYROMETERS
See PYROMETERS, RESISTANCE

RESISTANCE THERMOMETERS
See THERMOMETERS, RESISTANCE

RESISTANCE THERMOMETER BULBS

***ARNOUX CORP.**
Avnet Corp.
Bristol Co., The
Fisher Scientific Co.
Hallikainen Instruments
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
***LEWIS ENGRG. CO., THE**
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Rosemount Engrg. Co.
Arthur C. Ruge Associates, Inc.
Thermo Electric Co., Inc.
Trons-Sonics, Inc.
United Control Corp.

RESISTORS

a. Borancarbon
b. Composition, Variable
c. Carbon Film
d. Decode
e. Deposited Carbon
f. Encapsulated
g. Film
h. Fixed Composition
i. Fixed Wire-Waund
j. Fuse
k. Glass
l. High Frequency
m. High Temperature
n. High Valtage
o. Industrial, Fixed
p. Miniature Variable
q. Negative Temperature Coefficient
r. Photo Sensitive
s. Plug-in-Tube
t. Precisian
u. Printed Circuit
v. Printed Strip
w. Rectilinear
x. Silicane
y. Subminiature
z. Tape
a1. Temperature Sensitive
b1. Variable Composition
c1. Variable, Miniature
d1. Variable Wire Waund
e1. Wire Waund

Ace Coil & Electronics Co., i, e-1.
Adept Industries Inc., u, v.
Aero Electronics Corp., c-1, d-1.
Aerovox Corp., c thru f, t, e-1.
Allies Products Corp., e, f, q, t.
Analogue Controls, Inc., c-1, d-1.
***ARNOUX CORP.**, a-1.
Avnet Corp., i.
Axel Electronics, f, i, m, q, t, u, a-1, e-1.
Axler Associates Inc., g.
Bourns Labs., Inc., b, c, f, b-1, c-1, d-1.
Bradford Components, Inc., f, i, j, l thrau a, q, t, y, d-1, e-1.
Carborundum Co., Refractories Div., f, h, m, y.
Centralab, Div.-Globe-Union, b, e, f, h, m, p, t, u, w, y, b-1 thru e-1.
Cinema Engrg., f, t, y, e-1.
Clark Electronic Labs.
Clarostat Mfg. Co., Inc., b thru g, i, j, m thru p, t, u, b-1 thru e-1.
Computer Instruments Corp., b, w, b-1.
Continental Carbon, Div.-Wirt Co., e thru i, a, p, q, t, d-1, e-1.
Corning Glass Works, f, g, k thru a, t, u.
Dale Products, Inc., a, c, e, f, g, i, m, n, a, t, x, y, e-1.
Daven Co., The, f, g, i, k, m, t, x, y, a-1, e-1.
Eastman Kodak Co., r.
Electra Mfg. Co., c, e, f, g, l, m, q, t, u, y.
Electro Instruments, Inc., d, f, i, t.
Electromath Corp., c-1, d-1.
Electro-Measurements Inc., d, i, t, e-1.
Electro-Mec Lab. Inc., i, d-1.
Electronic Applications, Inc., c, e, m, n.
Erie Resistor Corp., c, e thru h, n, t, y.
Ferroxcube Corp. of America, q, a-1.
Fidelity Amplifier Co., d.
Filmohm Corp., g, k, l, m, u, v, z.
Ford Instrument Co., Div.-Sperry Rand Corp., e-1.
Fugle-Miller Labs. Inc., i, t, e-1.
GAR Mfg. Corp., e-1.
General Cement Mfg. Co., Div.-Textron, Inc., c, e.
General Electric Co., Apparatus Sales Div., i, a, d-1, e-1.
General Electric Co., Metallurgical Products Dept., a-1.
General Transistor Corp., i, t, u, e-1.
Globar Plant, Refractories Div.-The Carborundum Co., h, l thru a, q, y, a-1.
Gray Instrument Co., d, i, e-1.
Gunnar Laboratories, e-1.
Haveg Industries, Inc., m, x.
Helipot Div.-Beckman Instruments Inc., i, t, e-1.
Humphrey, Inc., w, c-1, d-1, e-1.
Huntington Rubber Mills, x.
Industrial Instruments Inc., d.
Instrument Resistors Co., d, i, l, m, a, t, y, a-1, e-1.
International Resistance Co., a, b, c, e thru q, t, u, x, b-1, d-1, e-1.
Joclin Mfg. Co., z.
Julie Research Labs., Inc., f, t, e-1.
Key Resistor Corp., c, e, f, g, l, m, t, u, y.
Keystone Carbon Co., q.
Lectrohm, Inc., i, j, l, n, u, x, a-1, d-1, e-1.
Leeds & Northrup Co., d, t.
Legris Co., a thru z, a-1 thru e-1.
Liss Products, Inc.
P. R. Mallory & Co. Inc., c, h, i, l, m, a, p, u, w, y, c-1, d-1, e-1.
Mepco, Inc., c thru g, i, a, q, t, u, x, y, e-1.
Miller Electro-Research Labs., d, t.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, i, l, n, a, t, a-1, e-1.
Minnesota Mining & Mfg. Co., a-1.
Mullenbach Div.-Electric Machinery Mfg. Co., i, a, e-1.
National Beryllia Corp., m.
National Coil Co., e-1.
Networks Electronic Corp., k, a-1.
Non-Linear Systems, Inc., f, i, t.
Ohio Carbon Co., The, h, i, j.
Phaostron Instrument & Electronic Co., c.
Precision, Inc., f, i, t, u, y, a-1, e-1.
Precision Resistor Co. Inc., d, f, i, j, n, a, t, u, x, y, a-1, e-1.
Pyrofilm Resistor Co., Inc., c, e, f, g, k thru n, t, y.
R. C. L. Mfg. Co., f, i, t, e-1.
Reon Resistor Corp., d, f, i, l, m, q, s thru v, a-1, b-1, c-1, e-1.
Resistors, Inc., i, d-1, e-1.
Rinco, Inc., i, d-1, e-1.
Rogers Corp., u.
Rosemount Engrg. Co., a-1.
Arthur C. Ruge Associates, Inc., a-1.
Sage Electronics Corp., e-1.
Shallcross Mfg. Co., d, f, i, n, a, t, u, e-1.
Shallite, Inc., f, i, t, u, y.
Spectrol Electronics Corp., c-1, d-1, e-1.
Stackpole Carbon Co., b.
States Co., The, q.
H. W. Sullivan Ltd., d, t.
Sun Electric Corp., Aeronautical Div., a.
Technology Instrument Corp., a thru g, i, m, n, p, q, s, t, u, w, y, c-1, d-1, e-1.
Tel-Labs, Inc., d, f, i, a, q, t, u, x, a-1, e-1.
Tepro Electric Corp., i, t, x, y, e-1.
Topper Mfg. Co., Inc., m.
Trionics Corp., y.
Tucson Instrument Corp., i, p, t, c-1, d-1, e-1.
United Mineral & Chemicol Corp., c, e, d-1, e-1.
U. S. Science Corp., Div.-Topp Industries, Inc., p, w, d-1.
Victory Engrg. Corp., q, a-1.
Welwyn International Inc., c thru g, i, l thru a, q, t, y, d-1, e-1.
Weston Instruments, Div.-Daystrom, Inc., g, i, n, t.

RESOLVERS

Accessory Products Co., Div.-Textron Inc.
Airdome Parts Co.
American Basch Arma Corp.
American Electronics, Inc.
American Electronics, Incarparated
American Electronics, Inc.-Instrument Div.
Arma Div., American Basch Arma Corp.
Beckman Instruments, Inc., Berkeley Div.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Chalco Engrg. Corp.
Clifton Precision Products Co., Inc.
Computer Instruments Corp.
Control Data Corp.
Dalmatar Div., Yuba Consolidated Industries, Inc.
Daystram Tronsicoil Div., Daystram Inc.
Diehl Mfg. Co.
Electro Precision Corp.
Hamilton Watch Co.-Industrial Div.
Inductian Motars Corp.
***KEARFOTT CO., INC.**
Ketay Dept., Norden Div., United Aircraft Carp.
Lond-Air Inc.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Luther Mfg. Co.
Milga Electronic Corp.
Networks Electronic Corp.
Power-Tranic Systems Inc.
Reeves Instrument Corp.
Scientific-Atlanta, Inc.
Singer Mfg. Co., The, Military Products Div.
United Mineral & Chemical Carp.
Western Gear Carp.
Westan Instruments, Div.-Daystram, Inc.

RESTRICTORS, HYDRAULIC SYSTEMS

Astranautics Engrg. Co.
Benbaw Mfg. Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Corruthers & Fernandez, Inc.
Clary Dynamics
Haskel Engrg. & Supply Co.
Walter J. Hyatt Co., The
Integral Corp.
Interstate Engrg. Carp.
Kaiser Aircraft & Electranics, Div.-Kaiser Industries Carp.
Kemp Aero Praducts
Newbrook Machine Corp.
Ozone Metal Products Carp.
Pneu-Hydro Valve Corp.
Ranson Hydraulic Units Corp.
Sargent Engrg. Corp.
A. U. Stone & Co., Inc.
Tactair Valve Div.-Aircroft Products Co.
United Aircraft Products, Inc.
Vickers Inc., Marine & Ordnance Dept., Machinery Hydraulics Div.
Vinsan Mfg. Co. Inc.

RETRACTING, MECHANISM UNITS

Actuatar Products Div., Geartranics Carp.
American Machine & Foundry Co., Government Products Group
Bendix Utica Div., Bendix Aviation Corp.
Clary Dynamics
Colonial Aircraft Corp.
Electra-Mechanical Products Co.
Haskel Engrg. & Supply Co.
Haaver Electric Co.
Kaiser Aircraft & Electranics, Div.-Kaiser Industries Carp.
Kemp Aera Products
Lear, Inc.
***McCORMICK SELPH ASSOCIATES**
Menasco Mfg. Co.
Natl. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc.
Newbraak Machine Corp.
Piasecki Aircraft Carp.
Sargent Engrg. Carp.
Smith-Morris Corp.
Wise Aerodraulics, Inc.

RETRACTORS, LANDING GEAR

Bendix Utica Div., Bendix Aviation Corp.
Clary Dynamics
Colonial Aircraft Corp.
Haskel Engrg. & Supply Co.
Haaver Electric Co.
Kanarr Carp.
Kemp Aera Products
Lear, Inc.
Menasco Mfg. Co.
Natl. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc.
Ronsan Hydraulic Units Carp.
Sargent Engrg. Corp.
Smith-Morris Corp.
United Mfg. Co., The
Weston Hydraulics Ltd.-Sub., Barg-Worner Carp.
Wise Aeradraulics, Inc.

REVERBERATION UNITS

Ling Electranics, Inc.

RF INTERFERENCE EQUIPMENT
See INTERFERENCE EQUIPMENT, RF

RF PERMEATERS
See PERMEATERS, RF

RHEOSTATS

James G. Biddle Co.
Clark Electronic Labs.
Clarostat Mfg. Co., Inc.
Components Corp.
Cutler-Hammer Inc.
Dejur-Amsco Corp., Electronic Sales Div.
Electro-Tech Equipment Co.
Faredam Electric Co., Inc.
General Electric Co., Apparatus Sales Div.
Gunnar Labaratories
P. R. Mallory & Co. Inc.
National Spectrographic Labs., Inc.
Riverbank Labs., Dept.-Engrg.
Superiar Electric Co., The
Technology Instrument Corp.

RIGID SHAFTS
See SHAFTS, RIGID

RIGID WAVEGUIDES
See WAVEGUIDES, RIGID

RINGS

a. Carbon Packing
b. Clamping
c. Collectar
d. Expansian
e. Hydraulic Back-Up
f. Oil Sealing
g. Retainer
h. Scraper
i. Sealing
j. Shock Absorber
k. Slip
l. Slip & Brush Assemblies
m. Special

Ace Products Co., g, h.
Advance Carban & Electric Mfg. Co., a, k, l.
Advanced Products Co., The, f, i.
Aera Ball & Screw Co., Inc., e, f, h, i.
Airflyte Electronics Co., k, l.
All Specs Carp., e thru i.
Allied Plastics Supply Carp., a thru g, i thru m.
Alloys Unlimited Inc., m.
Alpitec, Inc.
American Aeroparts, j.
American Standard Products, Inc., m.
American Welding & Mfg. Co., The, m.
Atlantic Instrument Carp., Sub.-American Electronics, Inc., k, l, m.
Auburn Mfg. Co., The, e, f, i, j.
Augat Brathers, Inc., b.
Bacon Industries, Inc., m.
Ball Machine Products Co., The, g.
California Aircraft Products
Californio Spring Co., Inc., m.
Capewell Mfg. Co., m.
Capital City Mfg. Co., f, g, m.
Carbone Carp., The, a, l.
Carmac Aviation
Cartriseal Corp., i.
Century Fasteners Carp., e thru h.
Chemplast, Inc., h.
Chicago Gasket Co., m.
Chicago Rawhide Mfg. Co., e, f, i.
Christie Machine Warks, m.
Clevelond Welding Div.-American Machine & Foundry Co., m.
Campanents Carp., f, i.
Computer Instruments Carp., b, k.
Cantinental Rubber Works, f.
C. Lee Cook Co., Airtamic Products Div., a, d, e, f, h, i, m.
Carbin Products Div., f thru i, m.
Crystal-X Carp., g, i, m.
Curtiss-Wright Corp.-Wright Aeronautical Div., c, d, f thru i, m.
Dackendarff & Co. Inc., b, m.
Dresser Mfg. Div., Dresser Industries, Inc., a, b, g, i, m.
Eaton Mfg. Co., Reliance Div., b, g.
Edgewater Steel Co., m.
Electric Heater Co., The, m.
Electricol Insulation Co., Inc., m.
Electra Development Co., k, l.
Electro Tec Carp., c, k, l, m.
Electra-Mechanical Products Co., c, k, l.
Emerson Plastics Corp., e, f, i.
Engelhard Industries Inc., D. E. Makepeace Div., c, k, l.
Federal Machine Co. Inc., m.
Fletcher Mfg. Co., Inc., The, c.
Flexrock Co., e.
Fluaracarbon Co., The, e, h, i, k.
General Gasket Inc., e, f, i, m.
Gibsan Electric Co., c, k.
Gashen Rubber Co., Inc., f, i.
Graphite Metallizing Corp., a, c, f, i, k, l.
Halagen Insulatar & Seal Corp., e, g, i.
Haskel Engrg. & Supply Co., e, f, h, i.
Helwig Carbon Products, Inc., a.
E. F. Haughtan & Co., e, h, i.
Huntington Rubber Mills, g.
Hydradyne Corp., Skinner Seal Div., a, f, i, j.
Industrial Retaining Ring Co., g.
Johns-Manville, a, e thru i, m.
Kanarr Corp., m.
King Fifth Wheel Co., m.
Ladish Co., m.
Lucas Aircraft Supply Co., g, i.
Machine Products Div., New Haven Trap Rock Co., b, f, g, i, m.
Magnetic Seal Carp., f, i.
Mercury Tool & Mfg. Corp., b, c, e, g.
Metals & Controls Carp., General Plate Div., c, k, l.
Minnesota Rubber Co., f, h, i, m.
Maran Co., i, m.
Morganite, Inc., a, f, i, k, l.
National Utilities Carp., b.
Nippert Electric Products Co., The, k.
Ohio Carbon Co., The, a, f, i.
Oil-Dyne, Inc., e, f.
Pacific Cut Washer Co., f, i, m.
Pacific Scientific Co., k, l, m.
Parker Seal Co., Div.-Parker-Hannifin Corp., i.
Penn Fibre & Specialty Co., Inc., e, f, g, i, j, l.
Penn-Michigan Mfg. Corp., c.
Research Development Mfg. Inc., g, m.
Roberts Toledo Rubber Co., The, f, g, i.
Robinson Technical Products, Inc., j.
Rogers Carp., e.
Miltan Ross Metals Co., The, k, l, m.
Rubbercraft Carp. of California, f, i, m.
Ryan Aeranautical Co., c.
St. Marys Carbon Co., a, f, i, l.
Schaevitz Engrg., j, k.
Seamless Products Co., Inc., g.
Simonds Saw & Steel Co., g, h, k, m.
Skycraft Taal Engrg. Co., e, h, m.
Slip Ring Co. of Americo, c, k, l.
Smith-Morris Carp., b, c, g, i.
Sparta Mfg. Co., Div.-U.S. Ceramic Tile Co., e, f, i, m.
Stackpole Carbon Co., a, i, k, l.
Standard Metals Corp., c.
Stanley-Judd Div.-The Stanley Works, b, c, d, g thru k, m.
Staver Co., Inc., The, b, e, i, m.
Stein Seal Co., a, f, i.
Teiner Engrg. Corp., b, i.
Thermech Engrg. Carp., e thru i.
Turbo Products, Inc., e, f, g, i, m.
United Aircraft Products, Inc., e, f, i, m.
U. S. Hammered Piston Ring Co., Inc., d thru i, m.
U. S. Science Corp., Div.-Topp Industries, Inc., k.
Veet Industries, m.
Walbar Machine Products Inc., f, i.
Waldes Kohinoor, Inc., g, m.

RIVETS, BLIND

Adam Metal Supply Inc.
American Aeroparts
Auto-Valve Inc.
Best Aircraft Carp.
Century Fasteners Carp.
Callins Engrg. Corp.
Deutsch Fastener Carp.
B. F. Goodrich Aviation Products
Hi-Shear Rivet Tool Co.
Huck Mfg. Co.
Gea. E. Kaercher Co.
Lucas Aircraft Supply Co.
National Screw & Mfg. Co., The
Southco Div., South Chester Corp.
Star Expansian
***TOWNSEND CO., CHERRY RIVET DIV.**
United Shae Machinery Corp., Ordnance Dept.

RIVETS, EXPLOSIVE

American Aeraparts
Atlantic Research Carp.

ROCKET ENGINE HIGH TEMPERATURE MATERIALS

***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**

ROCKET FUELS, SOLID
See SOLID ROCKET FUELS

ROCKET LAUNCHING DEVICES

ACF Industries Inc.
Accessory Products Co., Div.-Textran Inc.
Aerajet-General Corp.
Aeralab Development Co.
Aeronca Mfg. Corp.
Aerascience, Inc.
Aircraft Armaments, Inc.
Alca Products, Inc.
American Car & Foundry, Div.-ACF Industries, Inc.
American Machine & Foundry Co., Government Products Group
Apex Reinforced Plastics, Div.-White Sewing Machine Carp.
Astradyne, Inc.
Astranautics Engrg. Co.
Atlantic Research Corp.
Bell Aircraft Carp., Niagara Frantier Div.
E. W. Bliss Co.
Bridgepart Brass Co.
Champian Co., The
Cleveland Pneumatic Industries, Inc.
Cooper Development Carp., Sub.-Marquardt Aircraft Co.
Curtiss-Wright Corp., Santa Barbara Div.
Diversey Engrg. Co.
Dynamic Devices, Inc.
Emersan Electric Mfg. Co., The, Electranics & Avionics Div.

Federal Machine Co. Inc.
Gabriel Co., The—Talca Engrg. Co. Div.
G. W. Gallaway Co.
General Electric Co., Missile & Space Vehicle Dept.
Goodyear Aircraft Corp.
Hardman Tool & Engrg. Co.
Helex, Inc.
Hughes Tool Co., Aircraft Div.
Jack & Heintz, Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
M. W. Kellogg Co., The
Walter Kidde & Co., Inc., Aviation Div.
Land-Air Inc.
Langren Aircraft Co., Inc.
Lundy Mfg. Corp.
W. L. Maxson Corp., The
***MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.**
Monagram Precision Industries
Newbraak Machine Corp.
Northrop Corp., The, Nortronics Div.
Ordnance Div.-Faad Machinery & Chemical Corp.
Piasecki Aircraft Corp.
Edw. Renneburg & Sons Co.
Republic Aviation Corp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Rohm & Haas Co., Redstone Arsenal Research Div.
Stanley Aviation Corp.
Tapco Group, Thompson-Rama-Wooldridge Inc.
Thiakal Chemical Corp.
Trailmobile Inc.
Universal Moulded Products Corp.
Vard Inc.
Washington Technological Associates Inc.
Waste King Corp., Technical Products Div.
Welded Construction Inc.
Western Gear Corp.
Wheland Co., The

ICKETS

Aerojet-General Corp.
Aeralab Development Co.
Alco Products, Inc.
American Machine & Foundry Co., Government Products Group
American Rocket Co.
Arde-Portland, Inc.
Astradyne, Inc.
Atlantic Research Corp.
***AVCO MFG. CORP., CROSLEY DIV.**
Bell Aircraft Corp., Niagara Frontier Div.
Brooks & Perkins, Inc.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dynamic Devices, Inc.
Gabriel Co., The—Talca Engrg. Co. Div.
General Electric Co., Missile & Space Vehicle Dept.
Hercules Powder Co.
Hughes Tool Co., Aircraft Div.
M. W. Kellogg Co., The
***McCORMICK SELPH ASSOCIATES**
Norris-Thermador Corp.
Northrop Corp., The, Nortronics Div.
Olin Mathiesan Chemical Corp., Energy Div.
Reaction Motors Div., Thiakal Chem. Corp.
Red Lion Cabinet Co., Redco Tool Div.
***REDEL INC.**
Republic Aviation Corp.
Special Projects Lab., Faad Machinery & Chemical Corp.
Stanley Aviation Corp.
Thiakol Chemical Corp.
Universal Moulded Products Corp.
Veet Industries

D END BEARINGS

American Aeroparts
Bearing Inspection, Inc.
Century Fasteners Corp.
Collins Engrg. Corp.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dackendarff & Co. Inc.
Freeman Co., The
Mercury Tool & Mfg. Corp.
Raway Bearing Co., Inc.
Southwest Products Co.

LLED PRINTED CIRCUIT COPPER STRIPS

REDEL INC.

TATORS

All Products Co.
Antlab Inc.
Atlas Precision Products Co.
Barnell-Dubilier Electric Corp.
Brawn Controls Co., Inc.
General Devices, Inc.
Hoover Electric Co.
I. F. Johnsan Co.
Land-Air Inc.
RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Labot Industries Inc.
Talley Corp., The
Theta Instrument Corp.
Western Gear Corp.
Wind Turbine Co.

ROTOR ASSEMBLIES, GAS TURBINE ENGINE

American Machine & Faundry Co., Government Products Group
Christie Machine Works
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Dresser Industries, Inc.
M. W. Kellagg Co., The
Kelsey-Hayes Co.
Merz Engrg., Inc.
Solar Aircraft Co.
Talley Corp., The
Tapco Group, Thompsan-Rama-Waoldridge Inc.
Turba Products, Inc.
Veet Industries

ROTOR CASTINGS

American Aeroparts
American Brake Shae Co.
Astranautics Engrg. Ca.
Celca, Canstantine Engrg. Labs. Ca.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dresser Industries, Inc.
Kalcast Industries, Div.-Thampson Rama Waaldridge Inc.

ROTORS

Astranautics Engrg. Ca.
Celco, Constantine Engrg. Labs. Co.
Christie Machine Works
Crown Cantrals Co., Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dresser Industries, Inc.
Hoover Electric Co.
Merz Engrg., Inc.
Heinz Mueller Eng. Co. Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Div.
Parker-Hartford Corp., The
Piasecki Aircraft Corp.
Talley Corp., The
Tapco Group, Thompsan-Ramo-Wooldridge Inc.
Veet Industries

RUDDERS

Brooks & Perkins, Inc.
Colonial Aircraft Corp.
Continental Can Co., Inc.
Haveg Industries, Inc.
Intercantinental Mfg. Co., Inc.
Jarvis Corp.
Javelin Aircraft Co. Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
***LAVELLE AIRCRAFT CORP.**
Langren Aircraft Co., Inc.
Monagram Precision Industries
Narmco Mfg. Co.
Piasecki Aircraft Corp.
Precision Sheet Metal, Inc.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Ryan Aeranautical Co.
Santa Anita Engrg. Co.
Twin Coach Co., Aircraft-Missiles
Wheland Co., The
Winder Aircraft,Corp. af Florida

RUNNING GEAR SYSTEMS
a. Air-Borne Trailers
b. Missile Launchers
c. Missile Refuelers

***NEWAY EQUIPMENT CO.**

SAFETY EQUIPMENT

Air Reduction Sales Co., Div.-Air Reductian Co., Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Ampco Metal, Inc.
Apex Reinfarced Plastics, Div.-White Sewing Machine Carp.
Aro Equipment Carp.
***AVCO MFG. CORP., CROSLEY DIV.**
Aviation Textile Associates
Capewell Mfg. Co.
David Clark Co., Inc.
Cooper Industries, Inc.
Davis Instruments
Electranic Cantrol Corp.
Ericson Mfg. Co., The
Fisher Scientific Co.
General Scientific Equipment Co.
Gentex Carp.
Hardman Tool & Engrg. Co.
***HAWS DRINKING FAUCET CO.**
Hamalite Carp., The
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Johns-Manville
Julian A. McDermatt Carp.
Medical Supply Co.
Micro Switch, Div.-Minneapalis-Haneywell Reg. Co.
Mine Safety Appliances Co.
Pacific Scientific Co.
Reinhald Engrg. & Plastics Co.
Roavers-Lotsch Corp.
Rose Mfg. Co.
Scott Aviatian Carp.
Sperry Piedmant Co., Div.-Sperry Rand Carp.
Stanley Aviation Corp.
Washington Technalogical Associates Inc.
Wintronics

SALT BATHS

American Gas Furnace Co.
***ASSOCIATED TESTING LABS., INC.**
Gardner Labaratary, Inc.
General Electric Co., Apparatus Sales Div.
Hallikainen Instruments
Hevi-Duty Electric Co.
A. F. Halden Co., The
Lindberg Engrg. Co.
Papesch & Kalstad, Inc.
Sargeant & Wilbur Heat Treating Corp.
Temperature Engrg. Carp.

SAPPHIRE CRYSTALS
See **CRYSTALS, SAPPHIRE**

SATURABLE REACTORS
See **REACTORS, SATURABLE**

SAWS

Aircraft Tools, Inc.
Bergen Carbide Co.
Black & Decker Mfg. Co., The
Capewell Mfg. Co.
Covel Mfg. Co.
De Walt Div., American Machine & Foundry Co.
Hunter Tool Co.
Norwalk Cutter Sharpening Co.
Radial Cutter Mfg. Carp.
Simands Saw & Steel Co.
Snap-on-Tools Corp.
W. Whitney Stueck, Inc.
Syntron Co.
Transmares Corp.

SCALES, OSCILLOSCOPE

Adept Industries Inc.
Duralith Carp.

SCANNERS, REFLECTED & TRANSMITTED LIGHT

E. W. Bliss Co.
Gordan Enterprises
Perkin-Elmer Corp.
Philco Carp., Government & Industrial Div.
Photobell Co., Inc.
Plastic Age Sales, Inc.
Singer Mfg. Co., The, Military Products Div.
Telechrome Mfg. Carp.

SCOOPS

American Agile Corp.
Barrett-Christie Co.
Benson Mfg. Co., The
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**

SCREW DRIVERS

Barrett-Christie Co.
Billings & Spencer Co., The
Burklyn Co.
Chicago Pneumatic Tool Co.
Farsberg Mfg. Co., The
Gardner-Denver Co.
Handicraft Tools, Inc., Div.-X-Acta, Inc.
Hunter Tool Co.
Ja-Line Tools, Inc.
Kelsey-Hayes Co.
J. E. Menaugh Co.
Moady Machine Products Co., Inc.
Overlaad Cantrol Co.
Owatanna Tool Co.
Snap-an-Tools Corp.
Stanley-Judd Div.-The Stanley Works
J. H. Williams & Co.

SCREW, MACHINE PRODUCTS

ACF Industries Inc.
Abalon Precisian Mfg. Carp.
Abbatt Screw & Mfg. Co.
Actuatar Products Div., Geartronics Carp.
Adam Metal Supply Inc.
Aero Bolt & Screw Co., Inc.
Airdome Parts Co.
All Specs Corp.
Allied Plastics Supply Carp.
Allmetal Screw Products Co., Inc.
Alpine Electranic Campanents, Inc.
Aluminum Co. of America
Amatam Electronic Hardware Co. Inc.
American Hinge Carp.
American Screw Co.
American Standard Products, Inc.
Anti-Corrasive Metal Products Co., Inc.
Arnav Aircraft Associates, Inc.
Atlas Screw & Specialty Co.
Auburn Spark Plug Co., Inc.
Baldwin Mfg. Co. Inc., The
Ball Machine Products Co., The
Bar-Wark Mfg. Co., Inc.
Bergen Carbide Co.
Best Aircraft Carp.
Bland Burner Co., The
Bristal Co., The
Capital City Mfg. Co.

Carmac Aviation
Century Fasteners Corp.
Chemplast, Inc.
Chicago Screw Co., The, Div.-Standard Screw Co.
Coaxial Connector Co. Inc.
Columbia Nut & Bolt Co., Inc.
Corbin Products Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dockendarff & Co. Inc.
Eastern Specialty Co., The
Electrical Insulation Co., Inc.
Electronic Parts Mfg. Co., Inc.
Federal Screw Products Inc.
Forsberg Mfg. Co., The
GAR Mfg. Corp.
Gae Engrg. Co.
Gardon Enterprises
Hamilton Watch Co.-Industrial Div.
***HARTFORD MACHINE SCREW CO., DIV.-STANDARD SCREW CO.**
Harvey Aluminum
Hi-Lo Manufacturing Corp.
L S M Mfg. Co.
Lamson & Sessions Co., The
Litton Industries, U.S. Engrg. Co., Div.
Lucas Aircraft Supply Co.
Lux Clock Mfg. Co., Inc.
J. E. Menaugh Co.
Mercury Air Parts Co., Inc.
Mercury Tool & Mfg. Corp.
Moran Co.
J. I. Morris Co.
Napolean Products Co., The
National Lock Co.
National Screw & Mfg. Co., The
Precision Shapes, Inc.
Prospect Screw Machine Products
Ravenna Metal Products, Div.-Standard Screw Co.
Red Devil Mfg. Co.
Research Development Mfg. Inc.
C. F. Roark Welding & Engrg. Co., Inc.
Scovill Mfg. Co.
Seamless Products Co., Inc.
Sinclair Mfg. Co.
Skinner Precision Products
Sphinx-American Co.
Standard Goge Co., Inc.
Stondord Pressed Steel Co.
Stonley-Judd Div.-The Stanley Works
Stor Stoinless Screw Co.
Swiss Jewel Co.
Tricroft Products Corp.
United Mfg. Co., The
U. S. Industries, Inc.
Vemoline Products Co.
Western Automotic Mochine Screw Co., Div.-Stondord Screw Co.
Westfield Metol Products Co., Inc.
J. H. Winn Inc.

SCREWS, SELF-TAPPING

Abbott Screw & Mfg. Co.
Adom Metol Supply Inc.
All Specs Corp.
Allmetal Screw Products Co., Inc.
Americon Screw Co.
Anti-Corrosive Metol Products Co., Inc.
Atlos Screw & Specialty Co.
Barrett-Christie Co.
Best Aircroft Corp.
Colinoy-Div.-Illinois Tool Works
Comcor Screw & Mfg. Co., Div.-Textron Industries, Inc.
Century Fasteners Corp.
Continental Screw Co.
Corbin Products Div.
Eaton Mfg. Co., Reliance Div.
Federol Screw Products Inc.
Generol American Transportation Corp.
H. M. Harper Co.
Holub Industries, Inc.
Lomson & Sessions Co., The
Lucas Aircraft Supply Co.
J. I. Morris Co.
Notionol Lead Co.
Notionol Lock Co.
Nationol Screw & Mfg. Co., The
Stor Stoinless Screw Co.
Thompson-Bremer & Co.
Torrington Co., The
Woldom Electronics Inc.

SCREWS, SET

Abbott Screw & Mfg. Co.
Aero Bolt & Screw Co., Inc.
All Specs Corp.
Allen Mfg. Co.
Allmetal Screw Products Co., Inc.
Aluminum Co. of Americo
Americon Screw Co.
Anti-Corrosive Metal Products Co., Inc.
Atlos Screw & Specialty Co.
Borrett-Christie Co.
Best Aircroft Corp.
Bristol Co., The
Colinoy-Div.-Illinois Tool Works
Century Fasteners Corp.
Chase Brass & Copper Co., Inc.
Chicago Screw Co., The, Div.-Standard Screw Co.
Corbin Products Div.
Federol Screw Products Inc.
H. M. Harper Co.
***HARTFORD MACHINE SCREW CO., DIV.-STANDARD SCREW CO.**
Lamson & Sessions Co., The
Lucas Aircraft Supply Co.
Mercury Air Parts Co., Inc.
J. I. Morris Co.
National Lead Co.
National Lock Co.
National Screw & Mfg. Co., The
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Sphinx-American Co.
Standard Pressed Steel Co.
Star Stainless Screw Co.
Waldom Electronics Inc.
Western Automatic Machine Screw Co., Div.-Standard Screw Co.

SCREWS, STANDARD

Abbott Screw & Mfg. Co.
Aero Bolt & Screw Co., Inc.
Alden Products Co.
All Specs Corp.
Allen Mfg. Co.
Allmetol Screw Products Co., Inc.
Aluminum Co. of America
American Screw Co.
Anti-Corrosive Metal Products Co., Inc.
Atlas Screw & Specialty Co.
Best Aircraft Corp.
Calinay-Div.-Illinois Tool Works
Camcar Screw & Mfg. Co., Div.-Textron Industries, Inc.
Century Fasteners Corp.
Chandler Products Corp.
Chicago Screw Co., The, Div.-Standard Screw Co.
Continental Screw Co.
Corbin Products Div.
Eaton Mfg. Co., Reliance Div.
Federal Screw Products Inc.
General American Transportation Corp.
Hamilton Watch Co.-Industrial Div.
H. M. Harper Co.
***HARTFORD MACHINE SCREW CO., DIV.-STANDARD SCREW CO.**
Hydro Molding Co., Inc.
Lamson & Sessions Co., The
Lucas Aircraft Supply Co.
Notionol Leod Co.
Notionol Lock Co.
Notionol Screw & Mfg. Co., The
PIC Design Corp., Sub.-Benrus Wotch Co., Inc.
Screw Corp.
Star Stoinless Screw Co.
Torrington Co., The
Woldom Electronics Inc.
Western Automatic Machine Screw Co., Div.-Stondard Screw Co.

SEALERS, FUEL & OIL TANK

Armstrong Cork Co.
Carl H. Biggs Co.
Borden Chemicol Co.
Curtiss-Wright Corp., Reseorch Div.
Delto Chemicol Works, Inc.
Dennis Chemicol Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Gront Chemicol Co., Inc.
Hydrodyne Corp., Skinner Seol Div.
Johns-Monville
Minnesota Mining & Mfg. Co.
Minnesota Mining & Mfg. Co.-Adhesives, Coating & Sealers Div.
Monogram Precision Industries
Presstite Div., Americon-Morietta
Products Research Co.
***REDEL INC.**
Thiokol Chemicol Corp.
United Aircroft Products, Inc.
United Stotes Rubber Co.

SEALERS, NUCLEAR

Borden Chemicol Co.
Components Corp.
Hydrodyne Corp., Skinner Seol Div.
Parker Seol Co., Div.-Porker-Honnifin Corp.
United Aircroft Products, Inc.

SEALERS, PROTECTIVE

Armstrong Cork Co.
Corl H. Biggs Co.
Borden Chemicol Co.
Clover Industries, Inc.
Devcon Corp.
Dresser Mfg. Div., Dresser Industries, Inc.
Finnell System, Inc.
Grant Chemical Co., Inc.
Johns-Monville
Kelsey-Hoyes Co.
Morblette Corp., The
Minnesoto Mining & Mfg. Co.
Minnesota Mining & Mfg. Co.-Adhesives, Cooting & Sealers Div.
New Englond Tope Co., Div.-United-Corr Fastener Corp.
Presstite Div., American-Marietto
Products Reseorch Co.
Seol-Peel, Inc.
Silicones Div.-Union Corbide Corp.
Western Cooting Co.

SEALING, SERVICE, HERMETIC

Electro-Seal Corp.
Graflex Inc.
Johns-Manville
Mitronics Inc.
Milton Ross Metals Co., The
Sealectric Switch & Relay Carp.
Seal-Peel, Inc.
Strat-o-Seal Mfg. Co.

SEALS

a. Carbon
b. Ceramic-to-Metol
c. Dust Excluder
d. Grease & Oil
e. Hermetic & Pressurized
f. Hydraulic
g. Insulating
h. Metal-to-Glass
i. Missile
j. Oil
k. Pipe Joint
l. Pump
m. Pump-Mechanical
n. Shoft
o. Special Purpose

Advance Carban & Electric Mfg. Co., **a.**
Advanced Products Co., The, **b, d, e, f, h thru k, o.**
Aero Gasket Corp., **f, g, j.**
Aircraft Precision Products, Inc., **i, n, a.**
Allegheny Ludlum Steel Corp., **h.**
Allied Plastics Supply Carp., **d, f, g, j thru a.**
Alloy Bellows Inc., **l, n.**
Alloys Unlimited Inc., **h.**
Amatom Electronic Hardware Co. Inc., **c.**
American Aeroparts, **c, d, f, h, m.**
American Felt Co., **c, d.**
American Lava Corp., **b.**
American Optical Co., Instrument Div., **h.**
Amphenol Connector Div., Amphenol-Borg Electronics Corp., **h.**
Anchar Packing Co., The, **j, n.**
Armite Labs.
Associated Engrg. & Mfg. Carp., **h.**
Astronautics Engrg. Co., **a.**
Atmo Seol Co., **h.**
Auburn Mfg. Co., The, **c, f thru i, k, l, a.**
B G Corp., The, **b.**
Bacon Industries, Inc., **g.**
Borrett-Christie Co., **k, l, m.**
Bellofrom Corp., **e, f, i, j, a.**
Corl H. Biggs Co., **b, h, i, j, n, a.**
J. Bishop & Co., Platinum Works, **h.**
Bonny Mfg. Corp., **g, o.**
Borden Chemicol Co., **h.**
Byron-Jockson Pumps Inc., **f, l thru a.**
Copitol City Mfg. Co., **b, f, i, j, n, o.**
Corbone Corp., The, **a, m, n.**
Corborundum Co., Lotrobe Plont, Refroctories Div., **b, e, g, h, o.**
Corborundum Co., Refroctories Div., **b, e, h.**
Cartriseol Corp., **a thru f, i, j, l thru a.**
Centrolob, Div.-Globe-Union, **b, l, m.**
Ceromoseol, Inc., **b, h.**
Chemplost, Inc., **f, g, l thru a.**
Chicago Gosket Co., **g, m, a.**
Chicago Rowhide Mfg. Co., **a thru d, f, i, j, l thru a.**
Chicago-Allis Mfg. Corp., **c, d, j, n.**
Cleveland Grophite Bronze, Div.-Clevite Corp., **a, j, m, n**
Clover Industries, Inc., **c.**
Components Corp., **d, e, f, i thru m.**
C. Lee Cook Co., Airtomic Products Div., **a, d, f, i, j, l thru o.**
Corning Gloss Works, **b, h.**
Crane Packing Co., **d, f, j thru n.**
Curtiss-Wright Corp., Reseorch Div., **b, g.**
Doge Electric Co., Inc., **b, e, h.**
C. R. Doniels, Inc., **d.**
Delto Chemical Works, Inc., **a, b, f, h, k, a.**
Demornoy-Bonordi, **h.**
Devcon Corp., **b, g, h, k, a.**
Diomonite Products Mfg. Co., **b.**
***DIVERSEY ENGRG. CO., i, a.**
Dixon Corp., **a.**
Dresser Mfg. Div., Dresser Industries, Inc., **f.**
Durometallic Corp., **a, b, m, n.**
Firestone Tire & Rubber Co., The, Guided Missile Div., **f.**
Fischer & Porter Co., **h.**
Fluorocorbon Co., The, **c thru g, i thru n.**
Frenchtown Porcelain Co., **b.**
Furone Plostics, Inc., **b, e thru h, j, k.**
Fusite Corp., **g, h.**
Gorde Mfg. Co., **e.**
Gits Brothers Mfg. Co., **a thru d, j, l thru a.**
Glodding, McBeon & Co., **b.**
Gloss Engrg. Div. Broun-Knecht-Heimann Co., **h.**
Glosseol Products Co., Inc., **b, h.**
B. F. Goodrich Aviotion Products, **e.**
Gront Chemical Co., Inc., **g, h, k, a.**
Grophite Metallizing Corp., **a, d, j, l thru a.**
Greene, Tweed & Co., **a thru a.**
B. H. Hodley, Inc., **i.**
Hologen Insulotor & Seol Corp., **f.**
Hoskel Engrg. & Supply Co., **f, j.**
Helwig Corbon Products, Inc., **a.**
High Vocuum Equipment Corp., **a.**
Holex, Inc., **b.**
E. F. Houghton & Co., **f.**
Houghton Laborotories, Inc., **h.**
Huntington Rubber Mills, **c.**

ydrodyne Corp., Skinner Seal Div., o, b, d, e, f, h, i, j, l thru o.
ntegral Corp., f.
oclin Mfg. Co., d, e, f, i, j, l thru o.
ohns-Manville, b thru h, j thru o.
ennametal Inc., o.
entucky Metal Products Co., o.
oppers Co., Inc., Metol Products Div., n.
ear, Inc., Lear-Romec Div., l, m, n.
inear, Inc., c thru f, i thru o.
ittan Engrg. Labs., b.
ivingston Electronic Corp., e, h.
achine Products Div., New Haven Trap Rock Co., n.
agnetic Seal Corp., o thru d, i, j, l thru o.
McCORMICK SELPH ASSOCIATES, h.
etallizing Co. of Los Angeles Inc., b.
etals & Controls Corp., Generol Plate Div., b, h.
etaplast Co. Inc., b, h.
innesato Mining & Mfg. Co., b, c, h, i.
innesata Rubber Co., c thru f, j, l thru o.
itronics Inc., b.
oran Co., e, o.
organite, Inc., a.
otional Beryllio Corp., b.
otional Utilities Corp., o.
etworks Electronic Corp., e, g, h, i, o.
ortan Co., New Products Dept., b, m.
& S Reseorch, Inc., h.
hia Carbon Co., The, a, d, l, n.
ill-Dyne, Inc., f, l.
rchard Industries, Inc., Actianflex Div., i, n, o.
ocific Universal Products Corp., h.
orker Seal Co., Div.-Porker-Hannifin Corp., c thru f, i thru n.
lastic Age Sales, Inc., b.
olymer Corp., The, g, j, o.
roducts Research Co., h, o.
oberts Toledo Rubber Co., The, d, f, l, o.
iltan Rass Metols Co., The, b, e, g, h.
ubber Teck Inc., d, e, f, k, o.
ubbercraft Corp. of California, c, g.
t. Marys Carbon Co., o, d, f, g, j, l thru o.
chlegel Mfg. Co., c, h, o.
ealectric Switch & Relay Corp., e.
ealol Corp., o, d, e, f, i thru o.
ilicone Seals, Inc., e.
parta Mfg. Co., Div.-U.S. Ceramic Tile Co., o.
pecial Projects Lob., Food Machinery & Chemical Corp., i.
pecialty Plug & Cap. Co., c, o.
tackpale Carban Co., a.
tein Seal Co., o, d, j, m, n, o.
yntron Co., j, m, n, o.
hermal Refractories Corp., b.
hermech Engrg. Corp., c thru g, i thru o.
rionics Corp., b, o.
nited Aircroft Products, Inc., d, e, f, i thru m, o.
. S. Hammered Piston Ring Co., Inc., d, f, j, l, o.
nited States Rubber Co., c, d, j, k.
ocuum Reseorch Co., o.
ickers Inc., Marine & Drdnonce Dept., Mochinery Hydroulics Div., f.
ictor Mfg. & Gasket Co., o thru d, j, l thru o.
orren Components, Div.-El-Tronics, Inc., h.
inzen Reseorch Inc., e.
-Pando Corp., b, c, f, k.
ophor Mills Inc., g, k, o.

S.ECTIVE CALLING APPARATUS

arker Soles Co.
endix Radio Div., Bendix Aviotion Corp.
ollins Rodio Co.
u Kone Corp.
D.E.A., Inc.
EM Electronics Corp.
onsky & Boiley, Inc.
otorolo Inc., Military Electronics Div.
otionol Pneumotic Co., Inc., Holtzer-Cobot Divs.
hilco Corp., Government & Industriol Div.
inger Mfg. Co., The, Military Products Div.
electro Industries Corp.

S.F-LOCKING NUTS
ee NUTS, SELF-LOCKING

S.F-TAPPING SCREWS
ee SCREWS, SELF-TAPPING

SISING DEVICES

AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
mericon Instrument Co., Inc.
mericon Mochine & Foundry Co., Government Products Group
mericon Machine & Foundry Co., Greenwich
ro Equipment Corp.
rlontic Instrument Corp., Sub.-Americon Electronics, Inc.
oird-Atomic, Inc.
endix Aviotion Corp., Friez Instrument Div.
ristol Co., The
handler Evans Corp.
hicago Aeriol Industries, Inc.
. L. Collins Corp.
onsolidated Diesel Electric Corp.
onner Scientific Co.
ostman Kodok Co.
dgerton, Germeshousen & Grier, Inc.
lectro Products Loborotories, Inc.
enerol Precision Lob. Inc.
. M. Gionnini & Co., Inc.
B. F. Goodrich Aviotion Products
Hoffman Electronics Corp., Semiconductor Div.
Hughes Tool Co., Aircraft Div.
ITT Lobs.
Inertia Switch, Inc.
***KEARFOTT CO., INC.**
Land-Air Inc.
Leor, Inc., Grond Ropids Div.
Libroscope Inc.
Mossa Div.-Cohu Electronics, Inc.
Mergenthaler Linatype Co.
Minco Products, Inc.
Mine Safety Appliances Co.
Minneapolis-Honeywell Regulotor Co., Industrial Product Group
Motorolo Inc., Military Electronics Div.
Ohio Semiconductors, Inc.
Pacific Scientific Co.
Peschel Electronics, Inc.
Philco Corp., Government & Industriol Div.
Photobell Co., Inc.
Power-Tronic Systems Inc.
Radiation, Inc.
Revere Corp. of America
Arthur C. Ruge Associates, Inc.
Sargent Engrg. Corp.
Servomechanisms, Inc.
Shannon Luminous Moteriols Co.
Sheffield Corp., The, Sub.-Bendix Aviation Corp.
Specialties, Inc.
Standard-Thomson Corp., Cliffard Mfg. Co. Div.
Stanley Aviation Corp.
Topco Group, Thampson-Ramo-Wooldridge Inc.
Trans-sonics, Inc.
U.S. Science Corp., Div.-Tapp Industries, Inc.
Victary Engrg. Corp.
Washington Technalogical Associates Inc.
Waste King Corp., Technicol Products Div.
Webcar, Inc., Government Div.
Westronics Inc.

SEPARATION DEVICES

Aircraft Armaments, Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
American Machine & Foundry Co., Government Products Group
Atlontic Research Corp.
Beckman & Whitley, Inc., Missile Products Div.
Bendix Filter Div., Bendix Aviotion Corp.
Cooper Development Corp., Sub.-Marquardt Aircroft Co.
***ELECTROSNAP CORP.**
Essex Mfg. Co., Inc.
Genisco, Inc.
Holex, Inc.
Worner Lewis Co., Div.-From Corp.
Newbrook Mochine Corp.
Precision Sheet Metol, Inc.
Roymond Engrg. Lob., Inc.
Reinhold Engrg. & Plostics Co.
M. H. Rhodes, Inc.
Selos Corp. of Americo
Sheffield Corp., The, Sub.-Bendix Aviotion Corp.
Stonley Aviotion Corp.
Thiokol Chemicol Corp., Hunter-Bristol Div.

SEPARATORS, OIL

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Aro Equipment Corp.
Bendix Utico Div., Bendix Aviotion Corp.
Briggs Filtration Co., The
Hormon Equipment Co.
Leor Inc., Lear-Romec Div.
Newbrook Mochine Corp.
Purolotor Products Inc.
Selos Corp. of Americo
Shorples Corp., The
Sterling Precision Corp., Instrument Div.
United Aircroft Products, Inc.

SERVICING EQUIPMENT, BATTERY
See BATTERY SERVICING EQUIPMENT

SERVD MECHANISM CONTROL SYSTEMS

ACF Industries Inc.
Aero Supply Mfg. Inc.
Aeroflex Corp., The, Aeroflex Lobs. Div.
Aeronco Mfg. Corp., Boltimore Focility
Air Logistics Corp.
Airborne Accessories Corp.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Amelco, Inc.
Americon Bosch Armo Corp.
Americon Electronics, Incorporoted
Americon Mochine & Foundry Co., Government Products Group
Americon Machine & Foundry Co., Greenwich
Americon Meosurement & Control, Inc.
Armo Div., Americon Bosch Armo Corp.
Astronoutics Engrg. Co.
Atlontic Instrument Corp., Sub.-Americon Electronics, Inc.
Atlos Precision Products, Co.
Avien, Inc.
Borber-Colmon Co.
Beover Precision Products Inc.
Bell Aircroft Corp., Niogoro Frontier Div.
Belock Instrument Corp.
Bendix Aviation Corp., Eclipse-Pioneer Div.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Bendix-Pacific Div., Bendix Aviotion Corp.
Bendix Radio Div., Bendix Aviotion Corp.
Bogue Electric Mfg. Co.
Bristol Co., The
Bulow Electric Co.
CDC Control Services, Inc.
Cadilloc Gage Co.
Carmody Corp.
Cedar Engrg. Div.-Control Data Corp.
Centronix Inc.
Chalco Engrg. Carp.
Chandler Evans Corp.
Clifton Precisian Products Co., Inc.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Crescent Engrg. & Research Co.
Curtiss-Wright Corp., Propeller Div.
Curtiss-Wright Corp., Research Div.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Doystrom Pacific Div.-Doystrom, Inc.
Doystram Transicoil Div., Doystram Inc.
Delco-Remy Div., Generol Motors Corp.
Donner Scientific Co.
Dresser Industries, Inc.
Dumont Aircraft Fitting Co.
Eastern Industries Inc.
Electro Precision Corp.
Electronic Communications, Inc.
Emersan Electric Mfg. Co., The, Electronics & Avionics Div.
Exoct Engrg. & Mfg. Inc.
FAE Instrument Corp.
Foirchild Astrionics Div., Foirchild Engine & Airplane Corp.
J. W. Fecker, Inc.
Feedback Controls, Inc.
Ford Instrument Co., Div.-Sperry Rond Corp.
Generol Electric Co., Apparatus Soles Div.
General Electric Co., Missile & Space Vehicle Dept.
G. M. Gionnini & Co., Inc.
Graflex Inc.
Greer Hydraulics, Inc.
Guided Missile Div.-DeHovilland Aircraft of Canada, Ltd.
Gulton Industries, Inc.
Hallomare Electronics Co.
Hamiltan Standard, Div.-United Aircraft Corp.
Haskel Engrg. & Supply Co.
Helipot Div.-Beckman Instruments Inc.
Hoffman Labs. Div., Hoffman Electronics Corp.
Hoover Electric Co.
Wolter J. Hyott Co., The
Hydra-Power Corp.
Inertia Switch, Inc.
Integral Corp.
Intercontinentol Dynomics Corp.
Interstate Engrg. Corp.
Jordon Co., Inc., The
***KEARFOTT CO., INC.**
Kelsey-Hoyes Co.
Kemp Aero Products
Wolter Kidde & Co., Inc., Aviotion Div.
Lond-Air Inc.
Leor, Inc.
Leor, Inc., Grand Ropids Div.
Leor, Inc., Lear-Romec Div.
Libroscope Inc.
Ling Electronics, Inc.
Litton Industries, Marylond Div.
Mergentholer Linotype Co.
Micro Gee Products, Inc.
Minneopolis-Honeywell Regulotor Co., Aeronouticol Div.
Minneapolis-Honeywell Regulotor Co., Industriol Div.
Minneopolis-Honeywell Regulotor Co., Industriol Product Group
Minneopolis-Honeywell Regulotor Co., Ordnonce Div.
Moog Volve Co., Inc.
Moron Instrument Corp.
Notl. Woter Lift Co., Div.-Clevelond Pneumatic Industries, Inc.
Networks Electronic Corp.
Northrop Corp.
Otis Elevotor Co., Electronic Div.
Dzone Metal Products Corp.
PIC Design Corp., Sub.-Benrus Wotch Co., Inc.
Philco Corp., Government & Industriol Div.
Power-Tronic Systems Inc.
Rodiotion, Inc.
Reeves Instrument Corp.
Reflectone Corp., The
Reinhold Engrg. & Plostics Co.
Republic Aviotion Corp.
Royol Industries, Inc.
Sanders Associates, Inc.
Sorgent Engrg. Corp.
Servo Corp. of Americo
Servomechonisms, Inc.
Singer Mfg. Co., The, Military Products Div.
Specialties, Inc.
Spectrol Electronics Corp.
Sperry Forrogut Co., Div.-Sperry Rond Corp.
Stonley Aviotion Corp.
Sterling Precision Corp., Instrument Div.
Strotos, Div.-Foirchild Engine & Airplone Corp.
Suffolk Products Corp.
Summers Gyroscope Co.
Sun Electric Corp., Aeronouticol Div.
Systems Inc.
Tolley Corp., The
United Shoe Mochinery Corp., Ordnance Dept.

U. S. Science Corp., Div.-Topp Industries, Inc.
Vard Inc.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Marine & Ordnance Dept., Machinery Hydraulics Div.
Waldorf Electronics Div.-F.C. Huyck & Sons
Webcar, Inc., Government Div.
Western Gear Corp.
Westinghouse Electric Carp.
Weston Hydraulics Ltd.-Sub., Borg-Warner Carp.
Westranics Inc.
Wintranics

SERVOS, MEASUREMENT

Air Logistics Carp.
American Electronics, Incarporated
American Machine & Faundry Co., Gavernment Products Graup
American Measurement & Cantral, Inc.
Atlas Precision Praducts, Co.
Avien, Inc.
B & H Instrument Ca., Inc.
Bristal Ca., The
Bulow Electric Co.
Chandler Evans Carp.
Datran Electronics, Div.-Mid-Continent Mfg., Inc.
Daystram Pacific Div.-Daystram, Inc.
Daystram Transicail Div., Doystram Inc.
Electra Precision Corp.
Exact Engrg. & Mfg. Inc.
FAE Instrument Corp.
Feedback Cantrals, Inc.
General Electric Ca., Apparatus Sales Div.
G. M. Giannini & Co., Inc.
Graflex Inc.
Hamilton Standard, Div.-United Aircraft Carp.
Helipat Div.-Beckman Instruments Inc.
Haaver Electric Ca.
***KEARFOTT CO., INC.**
***WALLACE O. LEONARD, INC.**
Minneapalis-Honeywell Regulator Co., Industrial Div.
Minneapalis-Haneywell Regulatar Co., Industrial Product Graup
Moran Instrument Carp.
F. L. Maseley Ca.
New England Scientific Instruments Ca.
Narwood Cantrols Unit Detrait Controls Div.
Philca Corp., Government & Industrial Div.
Power-Tranic Systems Inc.
Reeves Instrument Carp.
Royal Industries, Inc.
Serva Carp. of Americo
Servomechanisms, Inc.
Stratas, Div.-Fairchild Engine & Airplane Carp.
Sun Electric Carp., Aeranautical Div.
Telechrome Mfg. Carp.
Western Gear Corp.
Weston Hydraulics Ltd.-Sub., Borg-Warner Carp.
Westranics Inc.

SET SCREWS
See SCREWS, SET

SEXTANTS, PERISCOPE TYPE

Baird-Atamic, Inc.
A. Biederman, Inc.
Gardan Enterprises

SHAFT EXTENSIONS
See EXTENSIONS, SHAFT

SHAFT REDUCERS
See REDUCERS, SHAFT

SHAFTS, FLEXIBLE

Actuatar Products Div., Geartranics Corp.
Americon Aeraparts
Barrett-Christie Ca.
Bendix Utica Div., Bendix Aviatian Carp.
Birnbach Radio Ca., Inc.
Bud Radia Inc.
Carmac Aviotion
B. W. Elliott Mfg. Ca., Inc.
E. F. Johnsan Ca.
Lear, Inc.
Lear, Inc., Grand Rapdis Div.
Parts Engrg. Co., Inc.
Standard-Thamsan Corp., Clifford Mfg. Ca. Div.
F. W. Stewart Carp.
Strong Scatt Mfg. Co., The

SHAFTS, RIGID

Amatam Electronic Hardware Co. Inc.
American Aeraparts
Atlas Precisian Products, Ca.
Baldwin Mfg. Ca. Inc., The
Birnbach Radia Co., Inc.
Bruce Engrg. Ca.
Butler Mfg. Co.
Capital City Mfg. Ca.
Carmac Aviation
Curtiss-Wright Carp.-Wright Aeronautical Div.
Finn Aeronauticol Div., T. R. Finn & Co., Inc.
Highland Rim Machine Warks Inc.
International-Nickel Ca., The
E. F. Johnsan Ca.
Konarr Corp.
Kelsey-Hayes Co.
Kling Metal Spinning & Stamping Ca.
Ladish Co.
***LAVELLE AIRCRAFT CORP.**
***LAVEZZI MACHINE WORKS**
Mercury Air Parts Ca., Inc.
Mercury Taol & Mfg. Carp.
PIC Design Corp., Sub.-Benrus Watch Ca., Inc.
Piasecki Aircraft Corp.
Research Development Mfg. Inc.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Joseph T. Ryersan & San, Inc.
St. Regis Paper Ca., Panelyte Div.
Strong Scatt Mfg. Ca., The
C. W. Tarngren Ca., Inc.
Tube-Turns Div., Chemetran Carp.
United Mfg. Ca., The
Western Gear Corp.
Western Iran & Foundry Ca., Inc.

SHAFTS, TURBINES
See Turbine Shafts

SHEET METAL PARTS

ACF Industries Inc.
A & P Metal Products Mfg. Corp.
Abalon Precisian Mfg. Carp.
Aeradex, Inc.
Aeranca Mfg. Carp.
Ainslie Carp.
Braaks & Perkins, Inc.
Canco Engrg. Warks
Carnell Deep Drawing Co., Div.-Lones Industries Corp.
Curtiss-Wright Carp., Santa Barbora Div.
Dahlstrom Metallic Door Co.
Detranic Industries
Daw Chemical Ca., The
Droyer-Hanson Div., Natianal-U. S. Radiator Carp.
Dresser Industries, Inc.
Aircraft Tools, Inc.
Alpitec, Inc.
Aluminum Co. af America
Amatom Electronic Hardwore Co. Inc.
American Aeroparts
Americon Aluminum Ca.
American Machine & Faundry Co., Gavernment Products Group
Anchor Metol Spinning Co., The
Arnalt Carp.
B. H. Aircraft Ca., Inc.
Bensan Mfg. Ca., The
Bergen Corbide Co.
Braaks & Perkins, Inc.
Bruce Engrg. Co.
Bud Radia Inc.
Byrne Doors Inc.
Califarnia Aircraft Products
Carmac Aviation
Centronix Inc.
Colonial Aircroft Corp.
Electric Heater Ca., The
Electra-Mechanical Products Ca.
Eljay Carp.
Elzee Metal Products Ca., Inc.
Essex Mfg. Ca., Inc.
Farwell Metal Fabricating
Ferris-Mfg. Co., The
Fletcher Mfg. Ca., Inc., The
***FLEXONICS CORP., AERONAUTICAL DIV.**
Gardner Laboratory, Inc.
Gasket Mfg. Ca. Inc.
Gordon Enterprises
Green Rectifier Co.
Hardman Taal & Engrg. Ca.
Highland Rim Machine Warks Inc.
Houston Feorless Corp.
Hufford Carp., The
Hughes Taal Ca., Aircraft Div.
Philip A. Hunt Ca.
Hupp Aviotian Ca.
Intercantinental Mfg. Ca., Inc.
***JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.**
Kaiser Aircraft & Electranics, Div.-Kaiser Industries Carp.
C. B. Kaupp & Sons, Inc.
Kelsey-Hayes Ca.
Kirk & Blum Mfg. Co., The
***LAVEZZI MACHINE WORKS**
Leitch-Huard Carp.
Lofstrand Co., The
Langren Aircraft Ca., Inc.
R. H. Lynch Mfg. Ca.
Lyncaach & Truck Ca. Inc.
Mercury Taal & Mfg. Carp.
Metal-Glass Products Ca.
Mid-West Metal Products, Inc.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Managram Precision Industries
Manravia Aviation Corp.
Muckle Mfg. Ca.
Mueller Brass Co.
Newbraak Machine Corp.
Nuclear Products-Erca Div.-ACF Industries, Inc.
Opelika Welding, Machine & Supply Inc.
Peerless Products Industries
Penn-Michigan Mfg. Carp.
Piasecki Aircraft Carp.
Portland Capper & Tank Warks Inc.
Precision Sheet Metal, Inc.
R & R Engrg. Co.
Radiatranics, Inc.
Red Lion Cabinet Co., Redca Tool Div.
Edw. Renneburg & Sons Ca.
Rimak, Inc.
C. F. Roark Welding & Engrg. Ca., Inc.
Rahr Aircraft Corp.
Roll Formed Products Ca.
Ryan Aeronautical Co.
Santa Anita Engrg. Ca.
Shaw Metal Products Corp.
Skyline Electric & Mfg. Ca.
Skyline Products, Inc.
Specialties Mfg. Ca., Inc.
Stainless Steel Products, Inc.
Sylvania Electric Products Inc., Ports Div.
Raland Teiner Ca., Inc.
Teiner Engrg. Carp.
Transue & Williams Steel Forging Carp.
Turbo Products, Inc.
Twigg Industries
United Aircraft Products, Inc.
United States Chemicol Milling Carp.
Universal Metal Products Inc.
Variety Aircraft Corp.
Wayne Foundry & Stamping Co.
Westbury Electranics Inc.
Western ARC Welding, Inc.
Woalf Aircroft Products, Inc.

SHEETS, METAL CLAD
See METAL CLAD SHEETS

SHEETS, METAL CLAD, PRINTED CIRCUIT

American Printed Circuits Ca., Inc.
Electrical Insulatian Co., Inc.
Etched Products Corp.
Ferris-Mfg. Ca., The
Formica Carp.
Franklin Fibre-Lamitex Corp.
General Plastics Corp. af New Jersey
Glodding, McBean & Ca.
Lo Painte Industries Inc.
Mica Insulator Div.-Minnesota Mining & Mfg., Co.
Miller Dial & Nameplate Ca.
Minnesata Mining & Mfg. Co.
Notional Vulcanized Fibre Ca.
New England Laminotes Ca., Inc.
Northern Plastics Carp.
Pilgrim Products Inc.
Rogers Carp.
Taylar Fibre Co.
United States Chemical Milling Carp.

SHEETS, MOLYBDENUM

Bram Metallurgical & Chemical Co.
Delta Chemical Warks, Inc.
Elmet Div.-North American Philips Ca., Inc.
Finn Aeronautical Div., T. R. Finn & Ca., Inc.
General Electric Co., Lamp Metals & Campanents Dept.
Metals & Contrals Carp., General Plate Div.
Universal-Cyclaps Steel Carp.
Westinghause Electric Carp., Metals Plant

SHELTERS, TRAILERS, VANS

Ace Engrg. & Machine Co., Inc.
Aeranca Mfg. Carp.
American Car & Faundry, Div.-ACF Industries, Inc.
Applied Design Co.
Berger Brathers Ca., The
Birdair Structures, Inc.
Braaks & Perkins, Inc.
Butler Mfg. Co.
Cormady Carp.
Calanial Aircraft Carp.
Cooper Development Corp., Sub.-Marquardt Aircroft Ca.
Craig Systems, Inc.
Dresser Industries, Inc.
Fruehauf Trailer Co., Military Equipment Div.
Goodyear Aircraft Carp.
Gramm Trailer Carp.
Ludwig Hanald Mfg. Co.
Lyncoach & Truck Ca. Inc.
Magline Inc.
Metal-Glass Products Ca.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Managram Precision Industries
Manravia Aviation Corp.
Nuclear Products-Erca Div.-ACF Industries, Inc.
Opelika Welding, Machine & Supply Inc.
Perfection Industries, Div.-Hupp Corp.
Piosecki Aircroft Carp.
Red Lian Cabinet Ca., Redco Tool Div.
Trailmabile Inc.
Turba Products, Inc.
United Aircraft Products, Inc.
Welded Construction Inc.
Winzen Reseorch Inc.

SHIELDING
- **a. Cathode Ray Tube**
- **b. Coil**
- **c. Electrastatic**
- **d. Heat**
- **e. Ignitian**
- **f. Lead**
- **g. Lead, Nuclear**
- **h. Magnetic**
- **i. Radiation**
- **j. Radiation, Nuclear**
- **k. Rubber**
- **l. Sheet or Screen**

m. Solid
n. Transformer
o. Tube

Ace Engrg. & Machine Co., Inc., b, k, l.
ACF Industries Inc., i, j.
Aerojet-General Corp., d.
Allays Unlimited Inc., g.
Alpha Metals, Inc., f.
Alpitec, Inc., h, i, j.
American Brass Co., The, c.
American Smelting & Refining Co., f, g, i, j.
Atlas E–E Corp., o.
Auburn Mfg. Ca., The, c, k.
Auburn Spark Plug Co., Inc., e.
Augat Brothers, Inc., o.
Bar-Ray Products, Inc., f, g, i, j.
Belmont Smelting & Refining Works, Inc., f, g, i, j.
Birnbach Radio Co., Inc., e.
Birtcher Corp., The, o.
Borden Chemical Co., e.
Breeze Corporations, Inc.
Braaks & Perkins, Inc., i, j.
Brush Beryllium Ca., The, i, j.
Connecticut Hard Rubber Co., The, k.
Ca-Dperative Industries, Inc., e.
Corning Glass Works, i, j.
Crystal-X Corp., j, l.
Curtiss-Wright Corp., Research Div., i, j.
Dean Products, Inc., d, i.
Devcan Corp., f, g, k.
Division Lead Ca., f, g, i, j, l, m.
Dynocar, Inc., h.
Edgerton, Germeshausen & Grier, Inc., o, j.
Elco Corp., o.
Electrical & Mechanicol Design Ca., e.
Electronic Tube Carp., o.
Emersan & Cuming, Inc., i, j.
Farrel Birminghom Ca. Inc., f, g, i, j.
Flexible Metal Hase Mfg. Co.
Furane Plastics, Inc., i, j, k, m, n.
Gladding, McBean & Ca., i, j.
Goodyear Tire & Rubber Ca., The, Aviotion Products Div., j, k.
Hallett Mfg., Co., b thru j.
Hayword Scientific Glass Carp., i.
Huntington Rubber Mills, k.
Internationol Electronic Reseorch Carp., o.
Jon Hardware Mfg. Co., Inc., o, h, n, o.
Jansky & Bailey, Inc., i.
Johns-Manville, d, l, o.
Johns-Manville Sales Corp., d, i, j.
E. F. Johnsan Co., o.
Kling Metal Spinning & Stamping Co., n, o.
Lithium Carp. af Americo, Inc., j, l, m.
Magnetic Shield Div. Perfection Mica Co., o, b, g, m, n.
Magnetics Inc., o, b, h, o.
P. R. Mallory & Ca. Inc., i, j, m.
McMillan Industrial Carp., i, l, m.
J. E. Menaugh Co., e.
Metal Textile Carp., Electranics Div., a thru e, h, n, o.
Metaplast Ca. Inc., c.
Methode Mfg. Corp., o.
Minnesota Mining & Mfg. Co., d, l.
National Beryllia Corp., d, i, j, o.
Notianal Lead Co., f, g, i, j.
New York Rubber Corp., k.
Newark Wire Cloth Ca., c, l.
Norton Ca., d, i, j.
Nuclear-Chicaga Carp., g, i, j.
Omega Electranic Carp., o, h, n, o.
R & R Engrg. Co., j.
Radiation Instrument Development Lab., Inc., j.
Ray Proof Carp., o, c, g, i, j, l.
Rimak, Inc., o, b, h, n, o.
Rubbercraft Corp. of California, k.
Ryan Aeranautical Co., d, j.
St. Regis Paper Co., Panelyte Div., i.
Shielding Inc., c, h, l, m.
Staver Ca., Inc., The, b, f, g, k, o.
Swedlaw Inc., d.
Teiner Engrg. Carp., o, o.
Telectra Industries Corp., i, j.
Topotron, Inc., c, h, l, m.
Tronter Mfg., Inc., d.
Universol Unlimited, Inc., o, i.
Warren Wire Co., e.
Waterman Products Co., Inc., o.
Western Tool & Mfg. Co., The, i, j.
Westinghouse Electric Corp., Metals Plant, h.
Zippertubing Co., The, c thru j, l, o.

IELOS, LEAO

Alloys Unlimited Inc.
Alpha Metals, Inc.
American Smelting & Refining Ca.
Anchor Metal Ca. Inc.
Belmant Smelting & Refining Works, Inc.
Devcan Corp.
Division Lead Ca.
Elco Carp.
Emersan & Cuming, Inc.
Farrel Birmingham Co. Inc.
Hallett Mfg., Co.
Hayward Scientific Glass Carp.
National Lead Ca.
Nuclear-Chicago Carp.
Ray Praof Carp.
Star Expansian
Stover Co., Inc., The
Zippertubing Ca., The

SHIMS, AOJUSTING

Acme Mfg. & Gasket Co.
Aero Gasket Corp.
American Silver Ca.
Auburn Mfg. Ca., The
Gasket Mfg. Ca. Inc.
General Gasket Inc.
***LAMINATEO SHIM CO.**
PIC Design Carp., Sub.-Benrus Watch Ca., Inc.
Staver Ca., Inc., The
TA Mfg. Carp.
Wilmingtan Fibre Speciolty Co.
Wraught Washer Mfg., Ca.

SHIMS, LAMINATEO

Aera Gasket Corp.
Allied Plastics Supply Carp.
Allays Unlimited Inc.
American Aeraparts
American Aluminum Ca.
Auburn Mfg. Ca., The
Electrical Insulatian Co., Inc.
Emersan Plastics Carp.
Gasket Mfg. Co. Inc.
General Box Ca.
Jadee Plastics Ca.
***LAMINATEO SHIM CO.**
Metals & Cantrals Carp., General Plate Div.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Pacific Cut Washer Co.
Silicane Insulatian, Inc.
Staver Co., Inc., The
TA Mfg. Carp.

SHIPPING CONTAINERS

Alca Products, Inc.
Allison Steel Mfg. Co.
American Car & Faundry, Div.-ACF Industries, Inc.
American Machine & Faundry Ca., Government Products Group
American Machine & Faundry Co., Greenwich
Applied Design Ca.
Arnolt Carp.
Basca Metal Praducts, Inc.
Carmady Carp.
Champian Ca., The
Clark Equipment Co.
Clover Industries, Inc.
Continental Technical Service, Inc.
Crystal-X Carp.
Curtiss-Wright Carp., Santa Barbara Div.
Dresser Mfg. Div., Dresser Industries, Inc.
FWD Corp.
Federal Shack Maunt Corp.-Div. The Korfund Ca., Inc.
Fruehouf Trailer Ca., Military Equipment Div.
General Box Ca.
Gaodyear Aircraft Carp.
Hardman Taol & Engrg. Ca.
Ludwig Hanold Mfg. Co.
Intercantinental Mfg. Co., Inc.
Jeta, Inc.
Jet-Heet, Inc.
M. W. Kellogg Co., The
Kirk & Blum Mfg. Ca., The
H. Koch & Sons
Lofstrand Ca., The
Lyan Van & Storage Ca., Aircraft Div.
***MIRAX CHEMICAL PROOUCTS CORP., METAL CONTAINER DIV.**
Monogram Precision Industries
Piasecki Aircraft Corp.
Partland Copper & Tank Works Inc.
Precision Sheet Metal, Inc.
Pressed Steel Tank Co.
Pry Welding & Mfg., Inc.
***RHEEM MFG. CO., OEFENSE & TECHNICAL PRODUCTS OIV.**
Roberts Industries Inc.
Thiokal Chemical Corp.
Vendorlotor Mfg. Co.
Washington Technalagical Assaciates Inc.
Weber Aircraft Corp.
Zippertubing Co., The

SHOCK ABSORBER CORO & RINGS

American Aeroparts
J. W. Johnson & Ca., Inc.

SHOCK ABSORBER LANOING GEAR

American Aeroports
***BENOIX PROOUCTS OIV., BENOIX AVIATION CORP.**
Cleveland Pneumatic Industries, Inc.
Colonial Aircroft Corp.
Electral Inc.
Garrett Carp., The, Air Cruisers Div.
Hydra-Pawer Carp.
J. W. Jahnson & Ca., Inc.
Menasca Mfg. Co.
Ranson Hydraulic Units Corp.
Taylor Devices, Inc.
U. S. Industries, Inc.
Washingtan Technalagical Associates Inc.

SHOCK MOUNTS

American Aeraparts
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Anchor Metal Spinning Co., The
Applied Design Ca.
***AVCO MFG. CORP., CROSLEY OIV.**
Barry Controls Inc.
Bushings, Inc.
Capital City Mfg. Ca.
Champian Co., The
Cleveland Pneumatic Industries, Inc.
Collins Engrg. Corp.
Caaper Industries, Inc.
Crown Cantrals Co., Inc.
Daw-Elco, Inc.
Federal Shack Maunt Carp.-Div. The Karfund Ca., Inc.
Finn Aeranautical Div., T. R. Finn & Co., Inc.
B. F. Gaadrich Industriol Praducts Ca.
Johns-Manville
J. W. Jahnsan & Co., Inc.
Lord Mfg. Co.
MB Mfg. Co.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER OIV.**
Orchard Industries, Inc., Actianflex Div.
Pacific Scientific Co.
Robinson Technical Praducts, Inc.
Rubbercraft Corp. of Califarnia
Taylar Devices, Inc.
Western Felt Works & Acadio Synthetic Products Div.

SHOCK TUBES

American Instrument Ca., Inc.
Anchar Metal Spinning Ca., The
Astravac Carp.
Cleveland Pneumatic Industries, Inc.
Dresser Industries, Inc.
Electric Steel Foundry Ca.
Generol Electric Co., Apparatus Sales Div.
Orchord Industries, Inc., Actianflex Div.
Rubbercraft Carp. af Califarnia
U. S. Industries, Inc.
Zippertubing Co., The

SHOCK TUNNELS

Astrovac Carp.
General Electric Ca., Apparatus Sales Div.
Partlond Capper & Tank Warks Inc.
Edw. Renneburg & Sans Ca.
Zippertubing Ca., The

SHOCK & VIBRATION MOUNTINGS
See MOUNTINGS, VIBRATION & SHOCK

SHOWERS, DRENCH & PORTABLE ORENCH

***HAWS DRINKING FAUCET CO.**

SHUNTS, METER

American Aeroports
Avo Ltd.
Beede Electrical Instrument Ca. Inc.
General Electric Co., Apparatus Sales Div.
Janca Carp.
Minneapolis-Honeywell Regulatar Co., Industrial Praduct Group
National Electronics
Precise Develapment Carp.
Precision Resistar Co. Inc.
Simpson Electric Co.
H. W. Sullivan Ltd.
Westan Instruments, Div.-Daystrom, Inc.

SHUTTERS, MICROWAVE

Aircam Inc. af New Jersey
Airtran Inc., Div.-Littan Industries
Bogart Mfg. Corp.
Douglas Micrawave Ca., Inc.
FXR, Inc.
J–V–M Microwave Ca.
Manogram Precisian Industries
Motorola Inc., Military Electronics Div.
Omega Labs., Inc.
Radar Design Corp.
Telerad Mfg. Carp.
Waveline, Inc.

SIGNAL TRACERS
See TRACERS, SIGNAL

SIGNALLING OEVICES

American Machine & Faundry Co., Gavernment Products Group
Barker Sales Co.
Bendix Radio Div., Bendix Aviatian Corp.
Bil-Jax Inc.
Centranix Inc.
DBM Research Carp.
Dryamatic Corp.
General Precisian Lab. Inc.
Graflex Inc.
JEM Electronics Carp.
Kemlite Laboratories, Inc.
Karry Mfg. Co.
Leetronics, Inc.
Matorola Inc., Military Electranics Div.
Philco Corp., Government & Industriol Div.
Telectra Industries Corp.
Transistar Electronics Corp.
United Control Corp.
Vitro Labs.
Webcar, Inc., Government Div.

SILVER PASTE

Alloys Unlimited Inc.
All-State Welding Alloys Co., Inc.
American Silver Co.
DBM Research Corp.
B. F. Drakenfeld & Co., Inc.
Eastern Smelting & Refining Corp.
Engelhard Industries, Inc.
Micro-Circuits Co.
Joseph E. Podgor Co., Inc.

SKID & SLED CONNECTORS

See CONNECTORS, SKID & SLED

SIMULATORS, FLIGHT

ACF Industries Inc.
American Machine & Foundry Co., Government Products Group
American Missile Products Co., Inc.
Bell Aircraft Corp., Niagara Frontier Div.
Belock Instrument Corp.
Bendix Computer, Div.-Bendix Aviation Corp.
Burton-Rodgers, Inc.
California Technical Industries, Div.-Textron Inc.
Centronix Inc.
Cholco Engrg. Corp.
Colorado Research Carp.
Curtiss-Wright Corp., Electronics Div.
Donner Scientific Co.
Electro-Mechanical Products Co.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Federal Mfg. & Engrg. Corp.
Federal Scientific Corp.
Gilfillan Bros. Inc.
Goodyear Aircraft Corp.
ITT Federal Div., International Telephone & Telegroph Corp.
ITT Labs.
International Radiant Corp.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Marquardt Aircraft Co.
Micro Gee Products, Inc.
Motorola Inc., Military Electronics Div.
Nuclear Products-Erco Div.-ACF Industries, Inc.
Otis Elevator Co., Electronic Div.
Philco Corp., Government & Industrial Div.
Piasecki Aircraft Corp.
Power-Tronic Systems Inc.
Radiation, Inc.
Ramo-Wooldridge Div., Thompson-Romo-Wooldridge of Calif.
Reflectone Corp., The
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Tapco Group, Thompson-Ramo-Wooldridge, Inc.
Task Corp.
Telectro Industries Corp.
Transdyne Corp.
Woldorf Electronics, Div.-F. C. Huyck & Sons
Westgate Lab., Inc.

SLEEVES, METALLIC

Airdome Parts Co.
American Aluminum Co.
American Brake Shoe Co.
American Standard Products, Inc.
Ampco Metal, Inc.
Anchor Metal Spinning Co., The
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
B. H. Aircroft Co., Inc.
Baldwin Mfg. Co. Inc., The
Copital City Mfg. Co.
Carmac Aviation
Century Fosteners Corp.
Diversey Engrg. Co.
Division Lead Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Electric Steel Foundry Co.
Haynes Stellite Co., Div.-Union Carbide Corp.
Kirk & Blum Mfg. Co., The
Kolcast Industries-Div. Thompson Romo Wooldridge Inc.
Mercury Tool & Mfg. Corp.
Metol Textile Corp., Electronics Div.
Mitronics Inc.
Edw. Renneburg & Sons Co.
Rimak, Inc.
St. Marys Carbon Co.
Sinclair Mfg. Co.
Smith-Morris Corp.
Specialty Engrg. & Electronics Co.
Stanley-Judd Div.-The Stanley Works
Tube-Turns Div., Chemetron Corp.
United Mfg. Co., The
Wilmington Fibre Specialty Co.
Zippertubing Co., The

SLEEVES, NON-METALLIC

Aeroquip Corp., Jackson Div.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Brake Shoe Co.
Auburn Mfg. Co., The
Auburn Spark Plug Co., Inc.
Birnbach Radio Co., Inc.
William Brand & Co., Inc.
Cormac Aviation
Centrolab, Div.-Globe-Union
Chemplost, Inc.
Chicago Gosket Co.
Continental Diamond Fibre Corp.
Continental Rubber Works
Crystol-X Corp.
Diamonite Products Mfg. Co.
Duramic Products Inc.
Electrical Insulation Co., Inc.
Emerson Plastics Corp.
Emmco Plastic Fabricators — Div.-E. M. McCorthy Machine Co.
Franklin Fibre-Lamitex Corp.
General Gosket Inc.
General Plostics Corp. of New Jersey
Gering Products, Inc.
Gladding, McBean & Co.
Graphite Metallizing Corp.
Isolontite Mfg. Corp.
Jessall Plostics
Jodee Plostics Co.
Johns-Monville
Lomtex Industries, Inc.
M & Q Plostic Products
J. E. Menaugh Co.
Metal Textile Corp., Electronics Div.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Minnesota Mining & Mfg. Co.
National Beryllia Corp.
National Utilities Corp.
New England Tope Co., Div.-United-Corr Fostener Corp.
Orchard Industries, Inc., Actionflex Div.
Penn Fibre & Specialty Co., Inc.
Pilgrim Products Inc.
Polymer Corp., The
Resistoflex Corp.
Rubbercraft Corp. of California
St. Marys Corbon Co.
Sanford Plastics Corp.
Silicone Insulation, Inc.
Sinclair Mfg. Co.
Sparta Mfg. Co., Div.-U.S. Ceramic Tile Co.
United Mfg. Co., The
United States Rubber Co.
Vorflex Corp.
Wilmington Fibre Specialty Co.
Wire Co. of America, Inc.
Zippertubing Co., The

SLEEVES, TUBE

Airdome Ports Co.
All Specs Corp.
Allied Plastics Supply Corp.
Ampco Metal, Inc.
Anchor Metal Spinning Co., The
Arnov Aircraft Associotes, Inc.
B. H. Aircraft Co., Inc.
***BEATON & CORBIN MFG. CO., THE**
William Brand & Co., Inc.
Bridgeport Brass Co.
Copital City Mfg. Co.
Carmac Aviation
Centralab, Div.-Globe-Union
Century Fasteners Carp.
Continentol Diamond Fibre Corp.
Crown Controls Co., Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Electric Steel Foundry Co.
General Cement Mfg. Co., Div.-Textron, Inc.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Lamtex Industries, Inc.
M & Q Plastic Products
Metal Textile Corp., Electronics Div.
Minnesoto Mining & Mfg. Co.
Monogram Precision Industries
Orchard Industries, Inc., Actionflex Div.
Penn Fibre & Specialty Co., Inc.
Raybestos-Manhattan, Inc., Pa.
Sanford Plastics Corp.
Silicone Insulation, Inc.
Stanley-Judd Div.-The Stanley Works
Sylvania Electric Products Inc., Ports Div.
Varflex Corp.
Zippertubing Co., The

SLEEVING

Aeroquip Corp., Jackson Div.
Allied Plastics Supply Corp.
Ampco Metal, Inc.
Anchor Metal Spinning Co., The
Birnbach Radio Co., Inc.
William Brand & Co., Inc.
Capital City Mfg. Co.
Cormoc Aviation
Centralab, Div.-Globe-Union
Chemplast, Inc.
Division Lead Co.
Federal Mochine Co. Inc.
General Cement Mfg. Co., Div.-Textron, Inc.
General Plastics Corp. of New Jersey
Johns-Manville
Lamtex Industries, Inc.
Minnesota Mining & Mfg. Co.
Natvar Corp.
New England Tape Co., Div.-United-Carr Fastener Corp.
Permacel
Polymer Corp., The
Raybestos-Manhattan, Inc., Pa.
Sanford Plostics Corp.
Sporta Mfg. Co., Div.-U.S. Ceromic Tile Co.
Spectra-Strip Wire & Coble Corp.
Vorflex Corp.
Zippertubing Co., The

SLIDES

Copital City Mfg. Co.
Chassis-Trak, Inc.
Grant Pulley & Hardware Corp.
Monogram Precision Industries
Precision Shapes, Inc.
Stanley-Judd Div.-The Stanley Works
Universol Metal Products Inc.
Watson Mfg. Co., Inc.

SLIDES, INDUSTRIAL

American Machine & Foundry Co., Greenwich
Grant Pulley & Hardware Corp.
Precision Shopes, Inc.
Universal Metal Products Inc.
Watson Mfg. Co., Inc.

SLIDING LOADS, MICROWAVE

Aircom Inc. of New Jersey
Bogart Mfg. Corp.
Demornay-Bonardi
Douglas Microwave Co., Inc.
FXR, Inc.
ITT Labs.
Lieco, Inc.
Meridian Metalcraft, Inc.
Microlab
Monogram Precision Industries
N.R.K. Mfg. & Engrg. Co.
Narda Microwave Corp., The
Omega Labs., Inc.
Soge Labs., Inc.
Telerod Mfg. Corp.
Waveline, Inc.

SLIP RING ASSEMBLIES

Advance Carbon & Electric Mfg. Co.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Anderson Machine & Tool Co.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Breeze Corporations, Inc.
Collectron Corp.
Electro Development Co.
Electro Tec Corp.
Electro-Mechanicol Products Co.
Electro-Miniatures Corp.
Engelhord Industries, Inc.
Engelhard Industries Inc., D. E. Makepeace Div.
Graphite Metallizing Corp.
Iron Fireman Mfg. Co., Electronics Div.
Kelsey-Hayes Co.
Magnetic Controls Co.
Metals & Controls Corp., General Plate Div.
Motorola Inc., Military Electronics Div.
J. M. Ney Co., The
Northrop Corp.
Pacific Scientific Co.
Piasecki Aircraft Corp.
Milton Ross Metals Co., The
Schaevitz Engrg.
Slip Ring Co. of Americo
Superior Carbon Products, Inc.
Unison Products, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.

SLOTTED LINES

See LINES, SLOTTED

SMALL BLOWERS

See BLOWERS, SMALL

SNIPS

Hunter Tool Co.
H. K. Porter Co., Inc.
Snap-on-Tools Corp.

SOLDER

a. Aluminum
b. Indium
c. Lead-Tin
d. Platinum
e. Printed Circuit
f. Rings & Preforms
g. Silver

Curtiss-Wright Corp., Research Div.
DBM Research Corp., **g.**
Dalweld Co. Inc., **a, f, g.**
Delta Chemical Works, Inc., **a thru g.**
Division Lead Co., **b, c, e, f.**
M. W. Dunton Co. Inc., The, **c, e, f.**
Eastern Smelting & Refining Corp., **d, g.**
Accurate Specialties Co. Inc., **a thru g.**
Adam Metal Supply Inc., **a.**
Alloys Unlimited Inc., **a thru d, f, g.**
All-State Welding Alloys Co., Inc., **a, f, g.**
Alpha Metals, Inc., **a, b, c, e, f.**
Aluminum Co. of America, **a.**
American Brazing Alloys Co., **a, f, g.**
American Silver Co., **d, f, g.**
American Smelting & Refining Co., **a, b, c, e.**
American Solder & Flux Co., **a.**

Anchor Metal Co. Inc., a thru g.
Borker Sales Co., a.
Barrett-Christie Co., a, c.
Belmont Smelting & Refining Works, Inc., a, b, c, f, g.
Bow Solder Products Co., Inc., a, b, c, e, f.
Chase Brass & Copper Co., Inc., c, g.
Chemalloy Electronics Corp., a.
Engelhard Industries, Inc., g.
General Cement Mfg. Co., Div.-Textron, Inc., e.
Glabe Automatic Sprinkler Div., The Fyr-Fyter Co., c.
Indium Corp. of America, The, b, f.
Johnson Mfg. Co., Inc., a, c, f.
London Chemical Co., Inc., c, e, g.
Metallizing Co. of Los Angeles Inc., a.
Metals & Controls Corp., Generol Plate Div., d, g.
Mica Instrument Co., c.
Mueller Brass Co., c, g.
Multicare Sales Corp., c, g.
National Lead Co., c.
New York Solder Co., Inc., c.
Savage-Rawe Ploting Co., Inc., c.
Standard Metals Corp., f, g.
Staver Co., Inc., The, f.
Teiner Engrg. Corp., a, b, c.
United Wire & Supply Corp., f, g.
Wildberg Bros. Smelting & Refining Co., d, g.

)LDER POTS

Americon Gas Furnoce Co.
Barrett-Christie Co.
Dee Electric Co.
Delto Chemical Works, Inc.
Eisler Engrg. Co., Inc.
Electro-Tech Equipment Co.
General Electric Co., Apparatus Soles Div.
Speciol Instruments Div., British Industries Corp.
Temperature Engrg. Carp.
Waage Electric, Inc.

)LDERING EQUIPMENT, PRINTED CIRCUIT

Dee Electric Co.
Division Leod Co.
Ideol Industries, Inc.
Ransahoff, Co.
Edward Segol
Ungar Electric Tools, Inc.

)LDERING EQUIPMENT, ULTRASONIC

Gulton Industries, Inc.
Massa Div.-Cohu Electronics, Inc.
Wye Industries

)LDERING GUNS

Barrett-Christie Co.
Bow Solder Products Co., Inc.
Electro-Tech Equipment Co.
Fisher Scientific Co.
Ideal Industries, Inc.
Metallizing Co. of Los Angeles Inc.
Snap-on-Tools Corp.
Ungar Electric Tools, Inc.

)LDERING IRONS

Americon Electricol Heater Co.
Barrett-Christie Co.
Bow Solder Products Co., Inc.
Electro-Tech Equipment Co.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Ideal Industries, Inc.
Linde Co., Div.-Union Carbide Corp.
National Specialties Co., Inc.
M. M. Newman Corp.
Selas Corp. of America
Snap-on-Tools Corp.
Ungar Electric Tools, Inc.

)LDERING IRDN STANDS

Americon Electricol Heater Co.
Barrett-Christie Co.
Ungar Electric Tools, Inc.

)LDERING IRDN TIPS

Americon Electrical Heater Co.
Barrett-Christie Co.
Chase Brass & Copper Co., Inc.
Electro-Tech Equipment Co.
National Specialties Co., Inc.
M. M. Newman Corp.
Snap-on-Tools Corp.
Ungar Electric Tools, Inc.

)LENDIDS

a. Control
b. Linear
c. Rotary
d. Sub-Miniature

A.P.W. Co., o, b, d.
Amelca, Inc., a.
American Aeroparts, b, c.
American Measurement & Control, Inc., a thru d.
Applied Dynamics Carp., a, b.
Artisan Electronics Corp., a, b.
Automatic Electric Sales Corp., b.
Automatic Switch Co., a.
Automation Instruments Inc., a.

***BENDIX PRDDUCTS DIV., BENDIX AVIATION CORP., a.**
Bendix-Pacific Div., Bendix Aviation Carp., b.
Caltron Products Ca., a.
***CANNDN ELECTRIC CO., b, d.**
Carruthers & Fernandez, Inc., a thru d.
Coils-Electronics, b.
Cole-Hersee Co.
Comar Electric Co., b, d.
Control Circuits Inc.
Controls Co. of Americo, b.
Cutler-Hammer Inc., a.
Dolmotor Div., Yuba Consolidoted Industries, Inc., b.
Dynomic Controls Corp., a, b, d.
Electric Auto-Lite Co., The, a.
Electro-Mechanicol Products Co., a.
Electro-Mechanicol Specialties Co., Inc., a, c, d.
Electro-Tech Equipment Co., a, b.
Forbes & Wagner, Inc.
General Electric Co., Apparatus Sales Div., a.
Gordon Enterprises, a, b, c.
Guordian Electric Mfg. Co., a thru d.
Hamilton Standard, Div.-United Aircraft Corp., a, b.
Hoover Electric Co., a thru d.
Induction Motors Corp., a, b, d.
Integrol Corp., a.
Jack & Heintz, Inc., b.
Johnson Electronics Inc., b.
***KOONTZ-WAGNER ELECTRIC CO., INC., a, b, d.**
Lond-Air Inc., c.
Lear, Inc., Grond Rapids Div., d.
Leetronics, Inc., a thru d.
G. H. Lelond, Inc., c.
G. W. Lisk Co. Inc., a, b, d.
Meletron Corp., b.
Modelectric Products Corp., d.
Nationol Pneumotic Co., Inc., Holtzer-Cobot Divs., a, b.
E. V. Naybor Labs., Inc., b, d.
P. S. P. Engrg. Co., Div.-Inductian Motors Corp., b, d.
Penn Keystone Corp., d.
Pickering & Co., Inc., a thru d.
Douglas Randoll Inc., o, b.
Tolley Corp., The, a, b, c.
Telectro Industries Corp., b.
Transco Products, Inc., b.
Trombetta Solenoid Corp., a, b.
United Aircraft Products, Inc., a, b, c, d.
U. S. Reloy Co., a, b.
Webcor, Inc., Government Div., a thru d.
Wheeler Electronic Carp., Sub.-Sperry Rand Corp., a.
Winatic Corp., The, a, b, d.
Z & W Mfg. Corp., b.

SOLID FUELED MISSILE BOOSTERS
See BOOSTERS, MISSILE, SOLID FUELED

SOLID FUELS
See FUELS, SOLID

SOLID RDCKET FUELS

Aerojet-General Corp.
***AMERICAN POTASH & CHEMICAL CORP.**
Astrodyne, Inc.
Atlantic Research Corp.
Callery Chemical Co.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Dynomic Devices, Inc.
Foote Minerol Co.
Fulton-Irgon Corp., The
B. F. Goodrich Aviotion Products
Kennedy Van Soun Mfg. & Engrg. Corp.
Oerlikon Tool & Arms Corp. of Americo
Olin Mathieson Chemical Corp., Energy Div.
Pennsalt Chemicols Corp.
***REDEL INC.**
Thiokol Chemicol Corp.
Topper Mfg. Co., Inc.

SOLID ROCKET IGNITION ASSEMBLIES
See IGNITION ASSEMBLIES, SOLID ROCKET

SOLID ROCKET PROPELLANT CASES
See PRDPELLANT CASES, SOLID ROCKET

SOLID ROCKET PROPELLANTS
See PRDPELLANTS, SDLID ROCKET

SONAR

Americon Machine & Foundry Co., Government Products Group
Americon Machine & Foundry Co., Greenwich
Atlantic Research Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Daven Co., The
Dresser Industries, Inc.
General Communication Co.
B. F. Goodrich Industrial Products Co.
Haffman Labs. Div., Hoffman Electranics Corp.
ITT Federal Div., International Telephone & Telegraph Carp.
ITT Labs.
Ling Electronics, Inc.
Lockheed Aircraft Corp., Missiles & Spoce Div.
Magnavox Co., The
Minneopolis-Honeywell Regulatar Co., Ordnonce Div.
Motorola Inc., Military Electronics Div.
Nuclear Products-Erco Div.-ACF Industries, Inc.
Philco Corp., Government & Industrial Div.
Roythean Mfg. Co., Government Equipment Div.
Rohm & Haas Co., Redstone Arsenal Research Div.
Sangamo Electric Co.
Stramberg-Carlson Div.-General Dynamics Corp.
Thiokol Chemical Carp.
Westinghouse Electric Corp.

SOUND EQUIPMENT TURNTABLES
See TURNTABLES, SOUND EQUIPMENT

SOUND REPRODUCTION EQUIPMENT BRUSHES
See BRUSHES, SOUND REPRDDUCTIDN EQUIPMENT

SOUND SYSTEMS, COMPLETE

Centronix Inc.
Du Kane Corp.
Executone, Inc.
ITT Labs.
ITT-Kellogg
Lane Electronics Mfg. Corp.
Ling Electronics, Inc.
Midwestern Instruments, Inc.
Philco Corp., Government & Industriol Div.
Teiner Engrg. Corp.
Telectro Industries Corp.
University Loudspeakers, Inc.
Webcor, Inc., Government Div.

SOUNDING GRENADES

***AMERICAN PDTASH & CHEMICAL CORP.**

SPACERS

Aero Bolt & Screw Co., Inc.
Allied Plastics Supply Corp.
Americon Aeroparts
Auburn Mfg. Co., The
Copital City Mfg. Co.
Century Fasteners Corp.
Crystal-X Corp.
Diversey Engrg. Co.
Electro-Mechonical Products Co.
Garde Mfg. Co.
Generol Gasket Inc.
Hupp Aviotian Co.
Lodish Co.
Litton Industries, U.S. Engrg. Co., Div.
Mercury Tool & Mfg. Corp.
Mid-West Metal Products, Inc.
Stover Co., Inc., The

SPADE BOLTS
See BDLTS, SPADE

SPEAKER COILS
See COILS, SPEAKER

SPEAKER CONES
See CONES, SPEAKER

SPEAKER GRILLE CLDTHS
See CLDTHS, SPEAKER GRILLE

SPEAKER GRILLS
See GRILLS, SPEAKER

SPEAKER PRDJECTDR HORNS
See HORNS, SPEAKER PROJECTDR

SPEAKERS

Barker Sales Co.
Duotone Co., Inc.
Electronic Applicatians, Inc.
General Coil Products Corp.
Jensen Mfg. Co.
Ling Electronics, Inc.
Oxford Components, Inc.
Perkin-Elmer Corp.
Perry Plastics, Inc.
Philco Carp., Government & Industriol Div.
University Laudspeakers, Inc.
Zenith Radio Corp.

SPECIAL DEVICES

***McCDRMICK SELPH ASSOCIATES**

SPECIAL PURPDSE COLDRIMETERS
See COLDRIMETERS, SPECIAL PURPDSE

SPECTROMETERS

American Electronic Labs., Inc.
Applied Research Labs., Inc.
***BAUSCH & LOMB OPTICAL CD.**
Beckman-Scientific & Process Instruments Div.
Central Scientific Co.
Consolidated Electrodynomics Corp.
Davidson Mfg., Co., Inc.
***ENGIS EQUIPMENT CD.**
Epic, Inc.
Fisher Scientific Co.
General Electric Co., X-Ray Dept.
General Electrodynamics Corp.
Giannini Plasmadyne Corp.
Jarrell-Ash Co.
Nuclear-Chicago Corp.
Perkin-Elmer Corp.
Process & Instruments
Radiation Instrument Development Lab., Inc.
Varian Associates

SPECTROGRAPHIC INSTRUMENTS, PHOTOGRAPHIC MATERIALS
See PHOTOGRAPHIC MATERIALS, SPECTROGRAPHIC INSTRUMENTS

SPECTROPHOTOMETERS
American Electronic Labs., Inc.
Applied Physics Corp.
*BAUSCH & LOMB OPTICAL CO.
Beckman-Scientific & Process Instruments Div.
Bristol Co., The
Central Scientific Co.
*ENGIS EQUIPMENT CO.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Giannini Plasmadyne Corp.
Jarrell-Ash Co.
Perkin-Elmer Corp.
Process & Instruments

SPECTROSCOPIC EQUIPMENT
*BAUSCH & LOMB OPTICAL CO.
Consolidated Electrodynamics Corp.
*ENGIS EQUIPMENT CO.
Fisher Scientific Co.
General Electric Co., X-Ray Dept.
Giannini Plasmadyne Corp.
Gardon Enterprises
Jarrell-Ash Co.
Land-Air Inc.
New England Scientific Instruments Co.
Perkin-Elmer Corp.

SPLICING EQUIPMENT
Kinevox Div.-Electromation Co.
Minnesota Mining & Mfg. Co.
Robins Industries Corp.
Shepard Laboratories, Inc.

SPOT WELDERS
See WELDERS, SPOT

SPOTTING CHARGES
*AMERICAN POTASH & CHEMICAL CORP.

SPRING SUSPENSION SYSTEMS
*NEWAY EQUIPMENT CO.

SPRINGS
a. Antenna Tensian
b. Grounding Antenna
c. Hardware
d. Instrument Hairsprings
e. Knab
f. Precision

Ace Spring Mfg. Co., Inc., a, b, c, e, f.
Amatom Electronic Hardware Co. Inc., c.
American Aeroparts, a thru f.
American Steel Foundries, Hammond Div.
W. L. Barrett Co., The, a thru f.
Birnbach Radio Co., Inc., a.
California Spring Co., Inc., a thru e.
John Chatillon & Sons, d, f.
Consolidated Controls Corp., f.
Consolidated Diesel Electric Corp., f.
General Cement Mfg. Co., Div.-Textron, Inc., e.
Gerbet Hairspring Co., d.
Gordon Enterprises, d, f.
Hunter Spring Co., Div.-American Machine & Metals, Inc., f.
Leetronics, Inc., a, b, e, f.
J. E. Menaugh Co., f.
Mid-West Spring Mfg. Co., f.
Minnesota Mining & Mfg. Co.
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
J. M. Ney Co., The, f.
PIC Design Corp., Sub.-Benrus Watch Co., Inc., d, e, f.
Piasecki Aircraft Corp.
Reliable Spring & Wire Forms Co., a, b, c, e, f.
Rockwell-Standard Corp., c, f.
Skinner Precision Products
Sphinx-American Co., d, f.
Stanley-Judd Div.-The Stanley Works, a thru f.
Swiss Jewel Co., d.
Wind Turbine Co., a.

SPROCKETS, FILM
*LAVEZZI MACHINE WORKS

SQUIBS
Aerojet-General Corp.
Atlantic Research Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Components Corp.
Dynamic Devices, Inc.
Holex, Inc.
Land-Air Inc.
Librascope Inc.
*McCORMICK SELPH ASSOCIATES
Olin Mathieson Chemical Corp., Energy Div.
*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.
Raymond Engrg. Lab., Inc.
*REDEL INC.
Space Corp.
Taylor Devices, Inc.
Winzen Research Inc.

STABILIZERS
Aeronca Mfg. Corp.
Cantinential Can Co., Inc.
Intercontinental Mfg. Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Karmca Mfg. Co.
Power-Tronic Systems Inc.
Precision Sheet Metal, Inc.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Ryan Aeronautical Co.
Santa Anita Engrg. Co.
Sperry Gyroscope Co., Marine Div., Div.-Sperry Rand Corp.
Sperry Piedmont Co. — Div.-Sperry Rand Corp.
Technical Apparatus Builders

STACKS
Benson Mfg., Co., The
Colonial Aircraft Corp.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Newbrook Machine Corp.
Penn-Michigan Mfg. Corp.
Pittsburgh-Des Maines Steel Co.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Ryan Aeronautical Co.
Stainless Steel Products, Inc.
Western Iron & Foundry Co., Inc.

STAMPED PARTS
*LAMINATED SHIM CO.

STAMPED PARTS, TUBE
Acramark Co., The
Allied Plastics Supply Corp.
American Aeroparts
Anchor Metal Spinning Co., The
B. H. Aircraft Co., Inc.
Bergen Carbide Co.
California Spring Co., Inc.
Emmco Plastic Fabricators — Div.-E. M. McCarthy Machine Co.
Franklin Fibre-Lamitex Corp.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kelsey-Hayes Co.
Kling Metal Spinning & Stamping Co.
E. Konigslow Stamping & Tool Co.
Monogram Precision Industries
Newbrook Machine Corp.
Pacific Cut Washer Co.
Peerless Products Industries
Penn-Michigan Mfg. Corp.
Precision Sheet Metal, Inc.
Rimak, Inc.
Rockwell-Standard Corp.
Stainless Steel Products, Inc.
Stanley-Judd Div.-The Stanley Works
Sylvania Electric Products Inc., Parts Div.
Teiner Engrg. Corp.
Universal Metal Products Inc.
Winder Aircraft Corp. of Florido
Woodworth Specialties Corp.
Woolf Aircraft Products, Inc.

STAMPS
Acromark Co., The
Adept Industries Inc.
American Aeroparts
Jas. H. Matthews & Co.
Monogram Precision Industries
Noble & Westbrook Mfg., Co., The
Parker-Hartford Corp., The
Pryor Marking Products
Stanley-Judd Div.-The Stanley Works

STANDARD SCREWS
See SCREWS, STANDARD

STANDARDS
a. Capacitance
b. Equipment, Calibration
c. Frequency
d. Inductance
e. Laboratory Time
f. Phase
g. Resistance
h. Temperature
i. Time
j. Voltage

Accurate Instrument Co., c, e, i.
Acton Labs. Inc., f.
Airtronics International Corp., b.
Avien, Inc., i.
Avtron Mfg., Inc., b.
Rex Bassett, Inc., c.
Beckman Instruments, Inc., Berkeley Div., c.
A. Biederman, Inc., b, g, j.
Boonton Radio Corp.
Borg Equipment Div., Amphenol-Borg Electronics Corp., c, e, i.
Bristol Co., The, b.
Bulova Watch Co., Electronics Div., b, c, e, i, j.
Consolidated Controls Corp., j.
Daven Co., The, g.
Davenport Mfg. Co., b, j.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp., c.
Donner Scientific Co., j.
Dytronics Co., b, f.
Electra-Measurements Inc., a, g.
Electronic Applications, Inc., c.
Electronic Engrg. Co. of California, e, i.
Engrg. Associates, c, e, i.
Erie Resistor Corp., c.
FXR, Inc., b, c.
Federal Mfg. & Engrg. Corp., b.
General Communication Co., b.
Gaod Electronic Corp., a thru d, g, h, j.
Good-All Electric Mfg. Co., a.
Gyrex Corp., The, c, e, i.
Hewlett-Packard Co., c, e, i.
Hoffman Electronics Corp., Semiconductor Div., j.
I-L-S Instrument Div., The Meriam Instrument Co., c.
Industrial Test Equipment Co., b, c, f.
Kin Tel Div.-Cahu Electronics, Inc., j.
Knopp Inc., b, j.
Land-Air Inc., b, f.
Lavaie Laboratories Inc., c.
Leeds & Northrup Co., a, d, g, h, j.
Mac Leod & Hanopol, Inc., a.
Mansan Labs., Inc., c.
Minneapalis-Haneywell Regulator Co., Industrial Product Group, a, b, d, g, j.
Gearge L. Nonkervis Co., b.
National Instrument Laboratories, Inc., b.
Networks Electronic Corp., j.
New England Scientific Instruments Co., a, d, g.
Ernest Norrman Laborataries, c, e, i.
Northeastern Engrg. Inc., c.
Physics Research Laboratories, Inc., g.
Polytechnic Research & Development Co., Inc., c.
Portchester Instrument Corp., c.
Precise Development Corp., a, d, g, j.
Riverbank Labs., Dept.-Engrg., c.
Rasemount Engrg. Co., h.
Arthur C. Ruge Associates, Inc., h.
Shallcross Mfg. Co., g.
Simpson Electric Co., j.
H. W. Sullivan Ltd., a thru e, g, i.
Technical Apparatus Builders, j.
Technalogy Instrument Corp., a, f.
Telectra Industries Corp., a.
Textron Corp., c, e, i.
Theta Instrument Corp., f.
Trans-Sanics, Inc., h.
United Aircraft Products, Inc., h.
United States Radium Corp., b.
Varo Mfg. Co., Inc., c.
Wallace & Tiernan Inc., b.
Weinschel Engrg., b.
Weston Instruments, Div.-Daystrom, Inc., b, j.

STANDS, IRON, SOLDERING
See SOLDERING IRON STANDS

STANDS, MICROPHONE
B & K Instruments, Inc.
Bil-Jox, Inc.
General Cement Mfg. Co., Div.-Textron, Inc.
Gordon Enterprises
Mercury Tool & Mfg. Corp.
Specialty Engrg. & Electronics Co.

STANDS, TEST
ACCO Equipment Div., American Chain & Cable Co Inc.
Aerodex, Inc.
Aerojet-General Corp.
Air Logistics Corp.
Alden Products Co.
American Instrument Co., Inc.
Anchor Specialty Mfg. Co. Inc.
Associated Engineers, Inc.
*ASSOCIATED TESTING LABS., INC.
Astronautics Engrg. Co.
Avtron Mfg., Inc.
Bil-Jax, Inc.
Centronix Inc.
Champion Co., The
C. B. Christiansen Co.
Colonial Aircraft Corp.
Colson Corp., The
Columbia Research & Development Corp.
Consolidated Diesel Electric Corp.
Continental Technical Service, Inc.
Control Engrg. Co., Div. Jervis B. Webb Co.
Cornelius Co., The, Aero Div.
Curtiss-Wright Corp., Research Div.
Diversey Engrg. Co.
Douglas Microwave Co., Inc.
Dresser Industries, Inc.
Electro-Mechanical Products Co.
Engrg. Associates
Erdco Engrg. Corp.
FXR, Inc.
Forwell Metal Fabricating
General Electric Co., Apparatus Sales Div.
Greer Hydraulics, Inc.
Gremco, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Paul Hardeman, Inc.
Hardman Tool & Engrg. Co.
Haskel Engrg. & Supply Co.
Hufford Corp., The
Hughes Tool Co., Aircraft Div.
Hycon Mfg. Co.
Industrial Engrg. Corp.

Intercontinentol Dynomics Corp.
Jamison Cold Storage Door Co.
Jeto, Inc.
Kahn & Co., Inc.
Kirk & Blum Mfg. Co., The
Korda Industries
Lond-Air Inc.
Lear, Inc.
Machine Products Div., New Haven Trap Rock Co.
Mercury Tool & Mfg. Corp.
Merz Engrg., Inc.
Metol Fabricators Corp.
Mid-West Metal Products, Inc.
*MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.
Monogram Precision Industries
George L. Nonkervis Co.
Newbrook Machine Corp.
Opeliko Welding, Machine & Supply Inc.
Peschel Electronics, Inc.
Philco Corp., Government & Industriol Div.
Precision Sheet Metal, Inc.
Regent Jack Mfg. Co., Inc.
Robot Industries Inc.
Rucker Co., The
Soncor Corp.
Sorgent Engrg. Corp.
Schoffer Air Industries, Inc.
Scientific Engrg. Co.
Smith-Morris Corp.
Stainless Inc.
State Testing Lab. Inc.
Sterns-Roger Mfg. Co.
Sun Electric Corp., Aeronautical Div.
Technicol Apporatus Builders
Thiokol Chemicol Corp.
United Aircraft Products, Inc.
United Mfg. Co., Div., The W. L. Moxson Corp.
Woshington Technologicol Associates Inc.
Welded Construction Inc.
*R. D. WERNER CO., INC.
Western Gear Corp.

BANDS, TEST, STATIC
See TEST STANDS, STATIC

BANDS, WAVEGUIDE

Aircom Inc.
Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
Demornoy-Bonordi
Douglas Microwove Co., Inc.
FXR, Inc.
J-V-M Microwove Co.
Metol Fabricators Corp.
Microwove Associotes, Inc.
Monogram Precision Industries
Narda Microwove Corp., The
Omego Lobs., Inc.
Polytechnic Research & Development Co., Inc.
Rodor Design Corp.
Radiotronics, Inc.
Stainless Inc.
Victor R. F. & Microwove Co.
Woveline, Inc.

CARTER CARTRIDGES
See CARTRIDGES, STARTER

CARTERS

*AIRESEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Americon Aeroports
Americon Bosch Armo Corp.
Bendix Utico Div., Bendix Aviotion Corp.
Consolidated Diesel Electric Corp.
Curtiss-Wright Corp., Sonto Borboro Div.
Electric Auto-Lite Co., The
General Electric Co., Apporatus Soles Div.
Hamilton Standord, Div.-United Aircroft Corp.
Hoover Electric Co.
Jack & Heintz, Inc.
Technicol Apporotus Builders
Tower Mfg. Corp.
Vickers Inc., Div.-Sperry Rond
Watertown Div., The New York Air Broke Co.

CARTERS, GAS TURBINE ENGINE

Accessory Products Co., Div.-Textron Inc.
Aerojet-General Corp.
*AIRESEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Americon Bosch Armo Corp.
Bendix Utico Div., Bendix Aviotion Corp.
Breeze Corporotions, Inc.
Consolidoted Diesel Electric Corp.
Curtiss-Wright Corp., Sonto Borboro Div.
General Electric Co., Apporatus Soles Div.
Hamilton Standord, Div.-United Aircroft Corp.
Hoover Electric Co.
Jack & Heintz, Inc.
*McCORMICK SELPH ASSOCIATES
George L. Nonkervis Co.
Dlin Mathieson Chemicol Corp., Energy Div.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Solor Aircroft Co.
Spoce Corp.
Speciol Projects Lab., Food Mochinery & Chemicol Corp.
Thiokol Chemicol Corp.
Vickers Inc., Div.-Sperry Rond
Watertown Div., The New York Air Broke Co.
Western Geor Corp.
Westinghouse Electric Corp.

STARTERS, PNEUMATIC

Accessory Products Co., Div.-Textron Inc.
*AIRESEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
American Aeroparts
Apex Reinforced Plastics, Div.-White Sewing Machine Corp.
Bendix-Pacific Div., Bendix Aviotion Corp.
Bendix Utico Div., Bendix Aviotion Corp.
Consolidoted Diesel Electric Corp.
Generol Electric Co., Apporatus Soles Div.
Gremco, Inc.
Homilton Stondord, Div.-United Aircroft Corp.
Kohn & Co., Inc.
Wolter Kidde & Co., Inc., Aviotion Div.
Solor Aircroft Co.

STARTERS, ROCKET ENGINE

Accessory Products Co., Div.-Textron Inc.
Aerojet-Generol Corp.
Astrodyne, Inc.
Atlontic Reseorch Corp.
Bendix Utico Div., Bendix Aviotion Corp.
Consolidoted Diesel Electric Corp.
Cooper Development Corp., Sub.-Morquordt Aircroft Co.
Diversey Engrg. Co.
Dynomic Devices, Inc.
Jack & Heintz, Inc.
*McCORMICK SELPH ASSOCIATES
Dlin Mathieson Chemicol Corp., Energy Div.
*PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.
Reoction Motors Div., Thiokol Chem. Corp.
Rocketdyne Div.-North Americon Aviotion, Inc.
Solor Aircroft Co.
Thiokol Chemicol Corp.
Thiokol Chemicol Corp., Hunter-Bristol Div.

STARTING SYSTEMS & CONTROLS

*AIRESEARCH MFG. CO. OF ARIZ.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Americon Bosch Arma Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bendix Utico Div., Bendix Aviotion Corp.
Consolidoted Diesel Electric Corp.
Cornelius Co., The, Aero Div.
Generol Electric Co., Apporotus Soles Div.
Homilton Stondord, Div.-United Aircroft Corp.
Hoover Electric Co.
Jack & Heintz, Inc.
Kahn & Co., Inc.
Kordo Industries
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Robot Industries Inc.
Spoce Corp.
Stoinless Steel Products, Inc.
Topco Group, Thompson-Romo-Wooldridge Inc.
Technicol Apporotus Builders
Vickers Inc., Div.-Sperry Rond
Wotertown Div., The New York Air Broke Co.

STATIC DISCHARGERS
See DISCHARGERS, STATIC

STATIC ELIMINATORS

Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Goodyeor Tire & Rubber Co., The, Aviotion Products Div.
Merix Chemicol Co.
Philco Corp., Government & Industriol Div.
Thiokol Chemicol Corp.
United Stotes Rodium Corp.

STATORS, MOTOR & GENERATOR

Bogue Electric Mfg., Co.
Consolidoted Diesel Electric Corp.
Dresser Mfg. Div., Dresser Industries, Inc.
Generol Electric Co., Apporotus Soles Div.
Hoover Electric Co.
Jack & Heintz, Inc.
Leland Airborne Products, Div.-American Mochine & Foundry Co.
Notionol Pneumotic Co., Inc., Holtzer-Cobot Divs.
Precision, Inc.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Tolley Corp., The
Westinghouse Electric Corp.
Winchorger Corp., Sub.-Zenith Rodio Corp.

STEEL NEEDLES
See NEEDLES, STEEL

STILLS & DEMINERALIZERS

Bornstead Still & Sterilizer Co.
Butler Mfg. Co.
Fisher Scientific Co.
Dpeliko Welding, Machine & Supply Inc.
Spoce Corp.
Winzen Reseorch Inc.

STIMULATORS

Electro-Medicol Lob., Inc.
Ensco, Inc.
Mast Development Co., Inc.
Northrop Corp., The, Norironics Div.
Singer Mfg. Co., The, Military Products Div.
Woldorf Electronics, Div.-F.C. Huyck & Sons

STOOLS & BENCHES

Borrett-Christie Co.
Albert H. Coyne Equipment Corp.
Cooper Industries, Inc.
Snop-on-Tools Corp.
Standord Pressed Steel Co.

STORAGE BOXES
See BOXES, STORAGE

STORAGE CONTAINERS

Americon Mochine & Foundry Co., Government Products Group
Anchor Metol Spinning Co., The
Applied Design Co.
Arde-Portland, Inc.
Bosco Metal Products, Inc.
Bosic Tool Industries, Inc.
Brooks & Perkins, Inc.
Butler Mfg. Co.
Combridge Co.-Div.-Corrier Corp.
Albert H. Coyne Equipment Corp.
Champion Co., The
Electric Heater Co., The
Elzee Metol Products Co., Inc.
Farwell Metol Fobricoting
Fletcher Mfg. Co., Inc., The
General Box Co.
Gremco, Inc.
Ludwig Honold Mfg. Co.
Jeto, Inc.
Kirk & Blum Mfg. Co., The
H. Koch & Sons
Linde Co., Div.-Union Corbide Corp.
Lyon Von & Storage Co., Aircroft Div.
Mercury Tool & Mfg. Corp.
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
Monogram Precision Industries
Opeliko Welding, Machine & Supply Inc.
Ordnonce Div.-Food Mochinery & Chemicol Corp.
Precision Sheet Metol, Inc.
Pressed Steel Tonk Co.
Pry Welding & Mfg., Inc.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Royol Industries, Inc.
Texos Metol & Mfg. Co., Inc.
United Aircroft Products, Inc.
United Stotes Chemicol Milling Corp.
Vendorlotor Mfg. Co.
Woshington Technologicol Associates Inc.

STORAGE UNITS

Anchor Metol Spinning Co., The
Borrett-Christie Co.
Deluxe Metal Products Co.
*MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.
Snop-on-Tools Corp.
Speciol Projects Lob., Food Mochinery & Chemicol Corp.
Standord Pressed Steel Co.

STRAIN RELIEFS

Accessory Products Co., Div.-Textron Inc.
Heymon Mfg. Co.
Penn Fibre & Specialty Co., Inc.
Milton Ross Metals Co., The

STRAINERS

Aero Supply Mfg. Inc.
Bendix Filter Div., Bendix Aviotion Corp.
A. W. Cosh Volve Mfg. Corp.
Commercial Filters Corp.
Cuno Engrg. Corp., The
Dumont Aircroft Fitting Co.
Lodish Co.
Leslie Co.
Jos. P. Morsh Corp.
Michigon Wire Cloth Co.
Mueller Brass Co.
Newark Wire Cloth Co.
DPW-Jordon
Purolator Products Inc.
Republic Mfg. Co.
Sproying Systems Co.
Teiner Engrg. Corp.
Yornoll-Woring Co.

STRIPPERS, WIRE
See WIRE STRIPPERS

STRIPS, GROUNDING

Accurate Electronics Corp., Dept. D
American Silver Co.
Double E Products Co.
Kulka Electric Corp.
Smith-Morris Corp.
Teiner Engrg. Corp.

STRIPS, MOUNTING

Accurate Electronics Corp., Dept. D
Celco, Constantine Engrg. Labs. Co.
Double E Products Co.
Keystone Electronics Corp.
Kulka Electric Corp.
Mitronics Inc.
Rimak, Inc.
Sangamo Electric Co.
Smith-Morris Corp.
Teiner Engrg. Corp.
Tri-Dex Co.

STRIPS, TERMINAL
See TERMINAL STRIPS

STROBOSCOPE, SYNCHRONIZER

Chadwick-Helmuth Co.
Graflex Inc.
Kemlite Laboratories, Inc.
Technical Apparatus Builders
Winkler Labs.

STROBOSCOPES

Astronetics, Inc.
Boulin Instrument Corp.
Chadwick-Helmuth Co.
Edgerton, Germeshausen & Grier, Inc.
Electronic Brazing Co.
Epic, Inc.
Graflex Inc.
Kemlite Laboratories, Inc.
Slaughter Co., Inc.
Sun Electric Corp., Aeronautical Div.
Technical Apparatus Builders
Western Gear Corp.

STRUCTURES

a. **Aircraft**
b. **Aluminum & Stainless Steel Honeycomb**
c. **Missile**

***AVCO MFG. CORP., NASHVILLE DIV.**

STUDIO PATCH CORDS
See PATCH CORDS, STUDIO

SUBMINIATURIZATION SERVICES

Aerolab Development Co.
Alloys Unlimited Inc.
Cleveland Metal Specialties Co., Electronics Div.
Consolidated Diesel Electric Corp.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Curtiss-Wright Corp., Electronics Div.
Dockendorff & Co. Inc.
Electro Development Co.
Elgin Micronics Div.-Elgin National Watch Co.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Erie Resistor Corp.
Ferrotran Electronics Co., Inc.
Instruments For Industry, Inc.
***KEARFOTT CO., INC.**
Land-Air Inc.
Lear, Inc.
Livingston Electronic Corp.
Motorola Inc., Military Electronics Div.
Northrop Corp.
Philco Corp., Government & Industrial Div.
Sperry Farragut Co., Div.-Sperry Rand Corp.
Technology Instrument Corp.
Telechrome Mfg. Corp.
Topper Mfg. Co., Inc.
United Aircraft Products, Inc.
Walkirt Co.

SUPERSONIC EQUIPMENT

Aeronca Mfg. Corp.
Aeroscience, Inc.
Bendix Radio Div., Bendix Aviation Corp.
Consolidated Diesel Electric Corp.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Maico Electronics, Inc.
Marquardt Aircraft Co.
Massa Div.-Cohu Electronics, Inc.
Philco Corp., Government & Industrial Div.
Woste King Corp., Technical Products Div.

SUPPORTS, TUBE

Anchor Metal Spinning Co., The
Best Aircraft Corp.
Capital City Mfg. Co.
Mercury Tool & Mfg. Corp.
National Beryllia Corp.

SUPPRESSORS, NOISE

Air Logistics Corp.
All-Tronics, Inc.
Continental Carbon, Div.-Wirt Co.
Curtiss-Wright Corp., Research Div.
Erie Resistor Corp.
Hallett Mfg., Co.
Philco Corp., Government & Industrial Div.
Precision Sheet Metal, Inc.
Rohr Aircraft Corp.
Space Corp.

SURFACE FINISH CONTROLS
See CONTROLS, SURFACE FINISH

SURVEILLANCE RADAR
See RADAR, SURVEILLANCE

SWITCH, GUARDS

Anchor Metal Spinning Co., The
Cutler-Hammer Inc.
Grimes Mfg. Co.
Vemaline Products Co.

SWITCH INERTIA

Americon Machine & Foundry Co., Government Products Group
Cedar Engrg. Div.-Control Data Corp.
Delco-Remy Div., General Motors Corp.
Diamond Antenna & Microwave Corp.
Donner Scientific Co.
***ELECTROSNAP CORP.**
Elgin Micronics Div.-Elgin National Watch Co.
Elgin Micronics, West Coast Div.-Elgin National Watch Co.
Era Engrg. Inc.
Haydon Switch, Inc.
Hoffman Labs. Div., Hoffman Electronics Corp.
Instrument Development Labs., Inc.
Walter Kidde & Co., Inc., Aviation Div.
Pacific Scientific Co.
Raymond Engrg. Lab., Inc.

SWITCHES

a. **Acceleration**
b. **Air Ram**
c. **Anerald**
d. **Alarm**
e. **Automatic**
f. **Automatic Transfer**
g. **Circuit Breaker**
h. **Commutation, for Telemetering**
i. **Contact**
j. **Control**
k. **Crossbar**
l. **Decade**
m. **Duplex**
n. **Electronic**
o. **Float**
p. **Foot**
q. **Hermetically Sealed**
r. **Hydroulic**
s. **Ignition**
t. **Impact**
u. **Indicating**
v. **Jack**
w. **Key**
x. **Knife**
y. **Limit**
z. **Liquid Oxygen Control**
a1. **Mach Limit**
b1. **Mechanical Control**
c1. **Mercury**
d1. **Micraphane**
e1. **Microwave**
f1. **Miniature**
g1. **Oil Immersed**
h1. **Plunger**
i1. **Pressure**
j1. **Printed Circuit**
k1. **Pulse**
l1. **Pushbuttan**
m1. **Radia**
n1. **Remote Control**
o1. **Reset**
p1. **Rotary**
q1. **Rotary Chopper**
r1. **Rotary Sampling**
s1. **Rotary Selector**
t1. **Safety**
u1. **Slide**
v1. **Snap Action**
w1. **Specialty**
x1. **Step Type**
y1. **Sub-Miniature**
z1. **Tap**
a2. **Telemetering**
b2. **Temperature Control**
c2. **Thermal**
d2. **Timing**
e2. **Toggle**
f2. **Transformer**
g2. **Transistor**
h2. **Vacuum**
i2. **Wavechange Receiver**
j2. **Wavechange Transmitter**
k2. **Waveguide**
l2. **Waveguide Microwave**

ACF Industries Inc., a, r, g-1, i-1, y-1, h-2.
A–G–A Div., Elastic Stop Nut Corp. of America, d-2.
Acro Div., Robertshaw-Fulton Controls, x, h-1, l-1, v-1, x-1, y-1.
Actuation Research Corp., a thru f, b-1, e-1, t-1, k-2, l-2.
Adept Industries Inc., j-1.
Advanced Products Co., The, d-2.
Aero Instrument Co., b, r, i-1, h-2.
Aero Supply Mfg. Inc., a.
Aerolab Development Co., h, n, d-2, g-2.
Aerolite Electronics Corp., y.
Aerotec Corp., The, b, c, d, a, r, u, z, a-1, g-1, i-1, t-1.
Aircom Inc., e-1, i-2.
Aircom Inc. of New Jersey, e-1, k-2, l-2.
Aircraft Controls Co., Div., Garn Electric Co., Inc., b, c, j, a, r, z, a-1, i-1, b-2.
Airflyte Electronics Co., h, j-1, p-1, q-1, r-1, y-1, a-2.
Airtron Inc., Div.-Litton Industries, e-1, k-2, l-2.
Alden Products Co., u.
Alford Mfg. Co., e-1.
Allied Control Co., Inc., l-1, y-1, e-2, h-2.
Allied International Co., q, e-1, v-1, w-1, x-1.
Alloy Bellows Inc., j, f-1, i-1.
Alto Scientific Co., Inc., h, n, d-2.
Amelco, Inc., j-1.
American Aeroparts, a, b, g.
Americon Machine & Foundry Co., Government Products Group, a.
Americon Missile Products Co., Inc., a-2.
Analogue Controls, Inc., y.
Andrew Corp., k-2, l-2.
Applied Science Corp. of Princeton, h, n, a-2.
Arch Gear Works Inc., y, a-1, b-1.
***ARNOUX CORP.**, e, h, n, a-2, b-2.
Arrow-Hart & Hegeman Electric Co., The, e, f, i, j, n, a, p, t, u, w, x, y, b-1, c-1, f-1, h-1, i-1, l-1 thru p-1, s-1 thru w-1, z-1, c-2, d-2, e-2.
Associated Engineers, Inc., d.
Astronautics Engrg. Co., r.
Atlas Precision Products, Co., b-1, d-2.
Automatic Electric Sales Corp., e, f, i, j, q, u, v, g-1, j-1, k-1, n-1, p-1, x-1.
Automatic Switch Co., e, f, j, n, b-1, e-1, n-1.
Avnet Corp.
Barber-Colman Co., b-2.
Barker Sales Co., h, k, v, w, p-1, s-1, x-1, a-2.
Barton Instrument Corp., u.
Barwood Electronics Inc., p.
Beckmon & Whitley, Inc., Missile Products Div., a.
Bell & Gossett Co., g-2.
Belock Instrument Corp., a, j, n, u, b-1, i-1, n-1, a-2, e-2.
Benbow Mfg. Corp., i-1.
Bendix Aviation Corp., Friez Instrument Div., c, i-1, d-2.
Bendix Aviation Corp.-Montrose Div., i-1.
Bendix Aviation Corp., Pioneer-Central Div., b, z, a-1.
Bendix Aviation Corp., York Div., n.
Bendix-Pacific Div., Bendix Aviation Corp., a-2.
Bernco Engrg. Corp., c-1, d-2.
A. Biederman, Inc., a.
Birnbach Radio Co., Inc., x, l-1, p-1, u-1, e-2.
Bobrick Mfg. Corp., r, i-1.
Bogart Mfg. Corp., e-1, l-2.
Branson Corp., d, e, f, c-2, d-2.
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., i-1.
Bristol Co., The, d, e, h, j, o, i-1, n-1, p-1, s-1, a-2, b-2, d-2, h-2.
Budd Stanley Co. Inc., e-1.
Cable Electric Products Inc., g, n-1, w-1, e-2.
Cadillac Gage Co., i-1.
***CANNON ELECTRIC CO.**, q, p-1, w-1.
Capitol Machine Co., The, j, w, l-1.
Captive Seal Corp., i-1.
Carleton Aviation Co., i-1.
Carling Electric, Inc., j, a, p, b-1, f-1, h-1, l-1, p-1, u-1, v-1, e-2.
Cedar Engrg. Div.-Control Data Corp., a.
Central Electronic Mfrs., Div.-Nuclear Corp. of America, h-2, k-2, l-2.
Centralab, Div.-Globe-Union, h, i, j, l, n, b-1, f-1, l-1, p-1, s-1, u-1, y-1.
Century Electronics & Instruments, Inc., c, j, q, r, z, i-1.
Cinema Engrg., p-1.
C. P. Clare & Co., q, w, x-1.
Clarostat Mfg. Co., Inc., i, j, f-1, m-1, s-1, v-1, i-2.
Cleveland Metal Specialties Co., Electronics Div., j-1.
Cole Electric Co., f, q, a-1, w-1, x-1.
Cole-Hersee Co., d, p, s, w, i-1, l-1, n-1, p-1, t-1, e-
Colemon Engrg. Co., Inc., i-1.
Collectron Corp., h, f-1, p-1 thru s-1.
Collins Engrg. Corp., g.
Collins Radio Co., l-2.
Colvin Labs., Inc., h-1, m-1.
Com-Air Products, Div.-A S R Products Corp., i-1.
Comar Electric Co., i.
Components Corp., d, y-1.
Computer Instruments Corp., h, j, f-1, p-1, u-1.
Consolidated Controls Corp., b, c, d, r, a-1, i-1, b-2, c-2, h-2.
Consolidated Diesel Electric Corp., b thru f, j, n, q, r, u, z, b-1, i-1, b-2, c-2, g-2, h-2.
Consolidated Electrodynamics Corp., Rochester Div., h-2.
Continental Carbon, Div.-Wirt Co., u-1.
Control Data Corp., c-2.
Controls Co. of America, y, b-1, i-1, j-1, p-1, s-1, v-
Cooper Development Corp., Sub.-Marquardt Aircraft Co., a.
Cornelius Co., The, Aero Div., i-1.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., d, i, j, a, p, q, y, h-1, i-1, l-1, t-1, v-1, e-2.
Cramer Controls Corp., j, k-1, d-2.
Crescent Engrg. & Research Co., a.
Croname Inc., j-1.

rucible Steel Co. of America, h.
ames Cunningham Son & Co., Inc., k, l-1, m-1, n-1, w-1, a-2, b-2.
urtiss-Wright Corp., Electronics Div., c-2.
urtiss-Wright Electranics Div., IMI Branch, i-1, a-2.
ushman Precision Industries, e, h, i, q, f-1, j-1, n-1, p-1, q-1, r-1, w-1, y-1, a-2, g-2.
utler-Hammer Inc., d thru g, i, j, n thru q, y, a-1, f-1, h-1, i-1, l-1, m-1, n-1, p-1, s-1 thru w-1, y-1, b-2, d-2, e-2.
aven Co., The, h, j, l, f-1, j-1, p-1, r-1, w-1, x-1, y-1, z-1, a-2.
aystrom Pacific Div.-Daystrom, Inc., a, c, a-1, i-1.
elco-Remy Div., General Matars Corp., a.
emarnay-Banardi, e-1, k-2, l-2.
estron Co., d-2.
etranic Industries, n, x-1.
iamand Antenno & Microwave Carp., e-1, k-2, l-2.
i-An Contrals, Inc., n, g-2.
enry G. Dietz Co., Inc., b, i-1, d-2, h-2.
imca-Gray Co., d-2.
anner Scientific Co., a, c.
auglas Microwave Co., Inc., e-1, k-2, l-2.
urakool, Inc., c-1.
ynamic Cantrols Corp., i-1, b-2, c-2.
agle Electric Mfg. Co. Inc., m, x, a-1, p-1, v-1, e-2.
astern Specialty Co., The, s-1, z-1.
bert Electranics Carp., a, q, a-1, h-1, w-1, w-1, h-2.
itel-McCullaugh, Inc., h-2.
ldema Corp., u, f-1, l-1, y-1, g-2.
lectra Development Co., p-1, s-1, y-1.
lectro Products Labaratarles, Inc., y.
lectro Tec Corp., h, j, m, q, t, f-1, k-1, p-1 thru s-1, y-1, a-2, d-2.
lectracraft, Inc., i, j, v, w, d-1, f-1, l-1, w-1, e-2.
lectro-Mechanical Products Co., e, g, i, j, n, y, b-1, h-1, i-1, k-1, n-1, w-1, b-2.
lectro-Mechanical Research, Inc., h, a-2.
lectra-Mechanical Specialties Co., Inc., q, b-1, f-1, p-1 thru s-1, x-1, y-1, d-2.
lectra-Miniatures Carp., h, p-1, q-1, r-1, a-2.
lectron-Radar Products, c.
lectro-Seal Carp., q.
ELECTROSNAP CORP., a, i, q, u, y, z, b-1, f-1, h-1, l-1, k-1, l-1, m-1, a-1, p-1, s-1, t-1, v-1 thru y-1, e-2.
lectra-Tech Equipment Co., a, p, u, y, a-1, f-1, v-1, y-1, d-2, e-2.
lgin Micranics Div.-Elgin National Watch Co., a, t, d-2.
lgin Micranics, West Coast Div.-Elgin National Watch Co., a, t.
merson Electric Mfg. Co., The, Electranics & Avionics Div., e-1.
ngelhard Industries Inc., D. E. Makepeace Div., h, p-1, q-1, r-1, s-1.
ra Engrg. Inc., a.
ssex Mfg., Co., Inc., b, a, r, z, i-1, n-1, s-1, u-1, e-2.
XR, Inc., n, e-1, p-1, k-2, l-2.
armer Electric Products Co., Inc., y.
enwal Inc., d, j, b-2, c-2.
erratran Electranics Co., Inc., g-2.
oto-Video Labs., Inc., k-1, n-1.
rebank Co., b, c, r, z, i-1.
urnas Electric Co., j, a, p, y, i-1, l-1.
-V Cantrols Inc., b-2, c-2, d-2.
eneral Cement Mfg. Co., Div.-Textran, Inc., l-1, p-1, u-1, e-2.
eneral Communication Co., n, e-1, k-2, l-2.
eneral Devices, Inc., a, d, e, h, i, j, m, n, q, t thru w, a-1, e-1, j-1 thru m-1, a-1 thru r-1, x-1, z-1, b-2.
eneral Electric Co., Apparatus Sales Div., e, f, g, i, j, a, q, x, y, g-1, h-1, i-1, l-1, n-1, a-1, p-1, v-1, w-1, b-2 thru f-2, h-2.
enisca, Inc., a.
enisco, Inc., Instrument Div., a, h.
. M. Giannini & Ca., Inc., a-1, i-1.
bson Electric Co., i.
lfillan Bros. Inc.
lossco Instrument Co., i-1.
hn Gombas Co., Inc., e-1.
od Electronic Carp., l, j-1.
. F. Goodrich Aviation Products, i-1.
rdos Carp., c-1.
raphite Metallizing Corp., h, p-1, q-1.
ray Instrument Co., l.
uardian Electric Mfg. Co., i, j, q, f-1, l-1, n-1, v-1, w-1, y-1.
uided Missile Div.-De Havilland Aircraft of Canada, Ltd., b, r, i-1.
amilton Watch Co.-Industrial Div., d-2.
amlin, Inc., q, u, a-1, f-1, y-1, h-2.
ammarlund Mfg., Co., Inc., i, p-1, s-1.
art Mfg., Co., The, e, i, n, q, p-1, s-1, u-1, v-1, b-2, e-2.
. W. HAYDON CO., THE, e, f, h, n-1, x-1, a-2, d-2.
aydon Switch, Inc., a, c, q, t, u, y, b-1, f-1, h-1, i-1, l-1, a-1, v-1, y-1, e-2.
gh Vacuum Equipment Carp., h-2.
Vernon Hill & Co., b-2.
hn W. Hobbs Corp., Div.-Stewart-Warner Corp., i-1, d-2.
offman Electranics Carp., Semiconductor Div., e, l, n, j-1, k-1.
umphrey, Inc., t.
lter J. Hyatt Co., The, r, e-1.
HYDRO-AIRE CO., DIV.-CRANE CO., a.
dromatics, Inc., q, u, z, b-1.
T-E Circuit Breaker Co., g, k-2, l-2.
inois Testing Labaratories, Inc., b-2.
tra Corp., x-1.

Indusl. Prod.-Danbury Knudsen Div. Amphenol-Borg Electranics Corp., n, w-1, e-2, k-2.
Industrial Timer Carp., c-2, d-2.
Inertia Switch, Inc., a, q, t, u, f-1, n-1, a-1, t-1, v-1, w-1.
Instrument Develapment Labs., Inc., f, h, q, j-1, r-1, a-2.
International Instruments Inc., f-1, s-1.
Internatianal Register Co., v-1, d-2.
Jaidinger Mfg. Co., Inc., v-1.
Janco Carp., q, y, f-1, p-1.
Jansky & Bailey, Inc., n.
Javex Electranics, i, m-1, p-1.
Jennings Radio Mfg. Corp., h-2.
Kahn & Co., Inc., e, j, n, b-1.
Kauke & Co., a-2.
***KEARFOTT CO., INC., MICROWAVE DIV.**, e-1.
Kemp Aera Products, r, z.
Wolter Kidde & Ca., Inc., Aviation Div., t, i-1.
Kilgen Aircraft Div., k, n-1.
Kinney Mfg. Div., The New York Air Brake Co., h-2.
H. Kach & Sons, w-1, d-2.
Kollsman Instrument Corp., Sub.-Standord Cail Products Co. Inc., c, a-1, i-1, a-2.
Kulka Electric Corp., n, e-2.
Land-Air Inc., j, b-1, p-1, s-1, x-1, a-2, d-2.
Londis & Gyr Inc., d-2.
Lear, Inc.
Lear, Inc., Grand Rapids Div., w-1.
Lear Inc., Lear-Ramec Div., r, i-1.
Lee Co., The
Leeds & Northrup Co., l, w, l-1, p-1, s-1, z-1, e-2.
G. H. Leland, Inc., q, n-1, a-1, s-1.
***WALLACE O. LEONARD, INC.**, i-1.
***LEWIS ENGRG. CO., THE**, s-1.
Lican Switch & Contral Div., Illinais Taal Warks, q, y, f-1, h-1, l-1, a-1, p-1, s-1, v-1, y-1, d-2, e-2, h-2.
Lieco, Inc., e-1, i-2, j-2, k-2, l-2.
Littan Industries, Inc., q-1.
Livingston Electranic Corp., p, q, c-2, d-2, j-2.
Magnavox Ca., The, a.
Magnetral, Inc., a, z.
P. R. Mallory & Ca. Inc., e, f, i, j, l, n, q, v, y, b-1, f-1, h-1, i-1, j-1, l-1, m-1, a-1, p-1, q-1, t-1, u-1, v-1, y-1, z-1, d-2, e-2.
Marco Industries Co., u, f-1, l-1.
Masan-Neilan, i-1, h-2.
Mc Gill Mfg. Ca. Inc., Bearing Div., l-1, e-2.
Meletron Corp., b, c, r, i-1, p-1, v-1, h-2.
Meridian Metalcraft, Inc., e-1, k-2, l-2.
Metals & Cantrals Carp., Spencer Div., g, i, j, n, q, y, b-1, f-1, l-1, p-1, v-1, y-1, b-2, c-2.
Micra Switch, Div.-Minneapolis-Haneywell Reg. Ca., p, q, u, y, b-1, a-1, f-1, h-1, k-1, l-1, n-1, a-1, p-1, s-1 thru w-1, y-1, b-2, c-2, e-2.
Microwave Associates, Inc., e-1, i-2, j-2, k-2, l-2.
Miller-Robinson Co., i-1.
Minneapolis-Haneywell Regulator Co., Boston Div., q, y.
Minneapolis-Haneywell Regulator Co., Industrial Product Graup, v, w, g-1, p-1, r-1, s-1, x-1, b-2.
Minneapolis-Haneywell Regulatar Co., Drdnance Div., a, n, g-2.
Managram Precision Industries, n, e-1, q-1, k-2, l-2.
Donald P. Mossman, Inc., w, l-1.
Motorola Inc., Military Electranics Div., e-1, k-2, l-2.
N.R.K. Mfg. & Engrg. Co., k-2.
George L Nankervis Co., y.
National Pneumatic Co., Inc., Haltzer-Cabot Divs., v, w.
Nelson Labs., Inc., j, b-1.
Networks Electranic Corp., n, w-1, c-2, g-2.
Newark Cantrols Co., a, e, i-1, h-2.
North Electric Co., e, f, h thru k, n, q, w, l-1, n-1, p-1, x-1, a-2, d-2.
Dhia Semiconductars, Inc., n.
Oil-Dyne, Inc., r, i-1.
Pacific Scientific Co., a, p-1 thru s-1.
Paragon Electric Co., d-2.
Penta Labs., Inc., h-2.
Peschel Electronics, Inc., n, g-1.
Philco Corp., Gavernment & Industrial Div.
Phillips Aviotion Co.-Marples Gears, a.
Photobell Co., Inc., n, c-2, d-2.
Photacan Research Products, e.
Photo-Crystals, Inc., c-1.
Pickering & Ca., Inc., a.
Joseph Pallak Carp., g, i, j, q, s, w, f-1, l-1, p-1, s-1, v-1, e-2.
Portchester Instrument Corp., e-1, k-2.
Precision Circuits, Inc., j-1.
Printranics Corp., j-1.
Radar Design Carp., e-1, l-2.
Radar Relay, Inc., c-1, l-1.
Radiation, Inc., h, n, a-2.
Rauland Corp., The, g-2.
Raymand Engrg. Lab., Inc., a, t.
Raytheon Mfg. Co., k-2.
Reed Research Inc., q.
Republic Mfg. Co., r.
Research Appliance Co., h-2.
Revere Carp. af America, a, q.
M. H. Rhades, Inc., d-2.
Ripley Co., Inc., n.
Raanwell Corp., d-1, l-1.
Rabat Industries Inc., e, j, c-1, n-1.
Rogers Carp., j-1.
Ranson Hydraulic Units Corp., r, i-1.
Milton Ross Metals Co., The, j-1, p-1, y-1.
Ratran Mfg. Co., n-1.
Sage Labs., Inc., e-1.
St. Regis Paper Co., Panelyte Div., j-1.
Sanborn Co., n.
Sangomo Electric Co., c-2, d-2.
Sargent Engrg. Corp., r, a-1, b-1.
Scaica Cantrals, Inc., d, e, n, q, r, f-1, i-1, n-1, b-2, c-2, d-2.
Schaevitz Engrg., a.
Scientific Instrument Ca., b-2.
Sealectric Switch & Relay Corp., d, y, a-1, i-1, p-1, v-1, w-1.
Seguaia Wire & Cable Co., Div.-Mandrel Industries, Inc., j, b-2.
Servamechanisms, Inc., a, r, a-1, f-1, i-1, n-1, b-2.
Shallcross Mfg. Co., i, l, n, f-1, l-1, p-1, s-1.
Singer Mfg. Ca., The, Military Products Div., h, i, j, q, u, x, b-1, f-1, g-1, k-1, n-1, p-1, s-1, a-2, d-2.
Slip Ring Co. of America, h, p-1 thru s-1, a-2.
Southwestern Industries, Inc., a, c, r, i-1.
Special Instruments Div., British Industries Corp., k-2, l-2.
Spectral Electranics Corp., f-1, j-1, p-1, z-1.
Spencer Div., Metals & Contrals Carp., g, q, y, f-1, h-1, l-1, v-1, w-1, y-1, b-2, c-2, e-2.
Sperry Microwave Electranics Co., Div.-Sperry Rand Corp., e-1, k-2, l-2.
Stackpole Carban Co., b-1, s-1, i-2 thru l-2.
Standard-Thamsan Corp., Cliffard Mfg. Ca. Div., p, w-1, a-2.
Stanley Aviotian Corp., x-1.
Stevens Mfg. Co., Inc., b-2, c-2.
Strand Engrg. Ca., e-1.
Stramberg-Carlson Div.-General Dynamics Corp., x-1.
Sun Electric Corp., Aeronautical Div., x-1.
Superior Carbon Products, Inc., i.
Switchcraft, Inc., i, k, v, w, d-1, f-1, l-1, p-1.
Talley Corp., The, h, p-1, q-1, s-1, a-2.
Tapca Group, Thampsan-Ramo-Wooldridge Inc., n, e-1, k-2, l-2.
Technical Apparatus Builders, g-2.
Technalagy Instrument Corp., n, f-1, s-1, w-1.
Telechrome Mfg. Corp., h, n, j-1, a-2.
Telectro Industries Corp., h, q, w, b-1, m-1, n-1, a-2, f-2.
Telerad Mfg. Corp., e-1, k-2, l-2.
Teletranics Lab. Inc., n.
Tempa Instrument Inc., d-2.
Therma Electric Ca., Inc., b-2.
Torsian Balance Ca., The, n, j-1, y-1, g-2.
Tower Mfg. Carp., i, n, x, h-1, l-1, w-1.
Transca Products, Inc., q, e-1, k-2.
Tronsistar Electranics Carp., u, f-1, l-1, a-1, w-1, y-1.
Ucinite Ca., The, Div.-United-Carr Fostener Carp., j-1, l-1, p-1, s-1, v-1, w-1.
Gearge Ulanet Ca., q, b-2, c-2.
Unimax Switch Div., The W. L. Maxsan Carp., y, h-1, l-1, a-1, t-1, v-1, y-1, e-2.
Unisan Products, Inc., f-1, p-1, r-1, y-1, a-2.
United Aircraft Products, Inc., r, z, g-1, i-1, b-2, c-2.
United Cantral Corp., n, z, b-2, c-2.
United Electric Cantrols Ca., c thru g, i, j, q, r, t, u, y, z, a-1, b-1, i-1, n-1, a-1, t-1, v-1, w-1, x-1, b-2, c-2, d-2, h-2.
U. S. Science Carp., Div.-Tapp Industries, Inc., a, i, t, y, a-1, b-2, d-2.
United Supply Ca.
Universal Circuit Controls Corp., j, w, y, l-1, p-1.
Vap-Air Aeronautical Products Div., Vapor Heating Carp., q, b-2, c-2.
Vemaline Products Ca., p, l-1.
Vickers Inc., Marine & Ordnance Dept., Machinery Hydraulics Div., h-1.
Victar Adding Machine Co.
Victar R. F. & Microwave Ca., e-1.
Vitro Labs., n, g-2.
Waldarf Fluid Systems, Div.-F.C. Huyck & Sans, r, i-1.
Walkirt Co., n, d-2.
Wallace & Tiernan Inc., c.
Waltham Engrg. Carp., a, c, s, d-2, h-2.
Waveline, Inc., e-1.
Webcar, Inc., Government Div., h, j-1.
Western Design, Div.-U.S. Industries, Inc.; Santa Barbara Div., d-2.
Western Internatianal Ca., e-2.
Westinghouse Electric Corp., d, e, g, g-1.
Wilks Precision Instrument Co., Inc., h, q-1, r-1, a-2, d-2.
G. C. Wilson & Co., d-2.
Zenith Electric Co., n-1, d-2.

SWITCHING COMMUTATORS
See COMMUTATORS, SWITCHING

SWITCHING EQUIPMENT, ANTENNA

Aircam Inc.
Alford Mfg. Co.
American Machine & Foundry Co., Gavernment Products Group
Andrew Corp.
Atlas Precision Products, Co.
Babcock Radio Engrg., Inc.
Bendix Aviation Corp., York Div.
Electro Tec Carp.
Houston Fearless Corp.
Lear, Inc., Grand Rapids Div.
Microwave Associates, Inc.
Managram Precision Industries
National Pneumatic Co., Inc., Haltzer-Cabat Divs.
Philco Corp., Government & Industrial Div.
Radiatronics, Inc.
Telectra Industries Corp.
Transca Products, Inc.
Wind Turbine Co.

SWITCHING EQUIPMENT, CAMERA

C. P. Clare & Co.
Electronic Engrg. Co. of California
Elgin Micronics, West Coast Div.-Elgin National Watch Co.
Flight Research, Inc.
General Precision Lab. Inc.
Houston Fearless Corp.
Hycon Mfg. Co.
ITT-Kellogg
Land-Air Inc.
Philco Corp., Government & Industrial Div.
Singer Mfg. Co., The, Military Products Div.

SYNCHRONIZER STROBOSCOPE
See STROBOSCOPE, SYNCHRONIZER

SYNCHROS

Allis-Chalmers
American Electronics, Inc.
American Electronics, Incorporated
American Machine & Foundry Co., Government Products Group
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix Aviation Corp.-Montrose Div.
Clifton Precision Products Co., Inc.
Daystrom Transicoil Div., Daystrom Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Apparatus Sales Div.
Hamilton Watch Co.-Industrial Div.
Helipot Div.-Beckman Instruments Inc.
Hoffman Labs. Div., Hoffman Electronics Corp.
Induction Motors Corp.
***KEARFOTT CO., INC.**
Ketay Dept., Norden Div., United Aircraft Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Land-Air Inc.
Lear, Inc.
Luther Mfg. Co.
Minneapolis-Honeywell Regulator Co., Boston Div.
P. S. P. Engrg. Co., Div.-Induction Motors Corp.
Servomechanisms, Inc., Mechatrol Div.
Solartron Inc.

SYNCHROSCOPES

Edgerton, Germeshausen & Grier, Inc.
FXR, Inc.
General Communication Co.
General Electric Co., Apparatus Sales Div.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Polarad Electronics Corp.
Waterman Products Co., Inc.
Weston Instruments, Div.-Daystrom, Inc.

SYSTEMS, MULTIPLEX
See MULTIPLEX SYSTEMS

SYSTEMS, NAVIGATION
See NAVIGATION SYSTEMS

SYSTEMS, PROPULSION
See PROPULSION SYSTEMS

SYSTEMS, PUBLIC ADDRESS
See PUBLIC ADDRESS SYSTEMS

SYSTEMS, REMOTE CONTROL

Aeronca Mfg. Corp.
Allis-Chalmers
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Atlas Precision Products, Co.
Automatic Electric Sales Corp.
Babcock Radio Engrg., Inc.
Belock Instrument Corp.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix Aviation Corp., York Div.
Bliss Electronic Corp.
Bristol Co., The
Collins Radio Co.
Conoflow Corp.
Consolidated Diesel Electric Corp.
Cutler-Hammer Inc.
Dolmotor Div., Yubo Consolidated Industries, Inc.
Dato-Control Systems, Inc.
Doytan Aviation Radio & Equipment Corp.
Dresser Industries, Inc.
Edgerton, Germeshausen & Grier, Inc.
Electronic Engrg. Co. of California
***ELECTROSNAP CORP.**
FAE Instrument Corp.
Feedback Controls, Inc.
General Devices, Inc.
General Electric Co., Apparatus Sales Div.
Gordon Enterprises
Hamilton Standard, Div.-United Aircraft Corp.
Hammarlund Mfg., Co., Inc.
Paul Hardeman, Inc.
Haskel Engrg. & Supply Co.
ITT Labs.
Intercontinental Dynamics Corp.
Kahn & Co., Inc.
***KEARFOTT CO., INC.**
Kilgen Aircraft Div.
Land-Air Inc.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
Lundy Mfg. Corp.
Milgo Electronic Corp.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Motorola Inc., Military Electronics Div.
Nelson Labs., Inc.
North Electric Co.
Philco Corp., Government & Industrial Div.
Raytheon Mfg. Co., Government Equipment Div.
Ryan Aeronautical Co.
Sequoia Wire & Cable Co., Div.-Mandrel Industries, Inc.
Soroban Engrg., Inc.
Technical Apparatus Builders
Thermo Electric Co., Inc.
Transco Products, Inc.
United Electric Controls Co.
Vard Inc.
Waldorf Electronics, Div.-F.C. Huyck & Sons
Washington Technological Associates Inc.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp.
Westronics Inc.

TABS

Acromark Co., The
Adept Industries Inc.
Breeze Corporations, Inc.
Colonial Aircraft Corp.
Eljay Corp.
Intercontinental Mfg. Co., Inc.
Roovers-Latsch Corp.
Santa Anita Engrg. Co.
Twin Coach Co., Aircraft-Missiles
Zippertubing Co., The

TABS, DIAL ACCESS

Adept Industries Inc.
Eljay Corp.

TABS, TRIM
See TRIM TABS

TACHOMETERS

Acromag Inc.
Actuator Products Div., Geartronics Corp.
Airguide Instrument Co.
American Electronics, Inc.
American Electronics, Inc.-Instrument Div.
American Machine & Foundry Co., Greenwich
Amthor Testing Instrument Co., Inc.
Associated Research, Inc.
Atlas Precision Products, Co.
B & H Instrument Co., Inc.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Boulin Instrument Corp.
Bristol Co., The
Diehl Mfg. Co.
Electronics Div., Van Norman Industries Inc.
Epic, Inc.
General Electric Co., Apparatus Soles Div.
Ideal Industries, Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Metron Instrument Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group.
Heinz Mueller Eng. Co. Inc.
National Electronics
Potter Aeronautical Corp.
Servomechanisms, Inc., Mechatrol Div.
Singer Mfg. Co., The, Military Products Div.
Talley Corp., The
Waltham Precision Instrument Co.
Waugh Engrg. Co.
Weston Instruments, Div.-Daystrom, Inc.
Westronics Inc.

TACHOMETERS, ELECTRONIC

Airguide Instrument Co.
American Machine & Foundry Co., Greenwich
Astronetics, Inc.
B & H Instrument Co., Inc.
Crown Controls Co., Inc.
Dymec Inc.
Electric Auto-Lite Co., The
Electro Products Laboratories, Inc.
Erie Resistor Corp.
G–M Labs. Inc.
Kahn & Co., Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co., Inc.
Minneapolis-Honeywell Regulator Co., Industriol Product Group
Potter Aeronautical Corp.
Slaughter Co., Inc.
Talley Corp., The
Varo Mfg. Co., Inc.
Waugh Engrg. Co.
Westronics Inc.

TAILPIPES, JET ENGINE

ACF Industries Inc.
Basic Tool Industries, Inc.
Curtiss-Wright Corp.-Wright Aeronauticol Div.
Dresser Industries, Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Dunbar-Kapple Inc.-Aircroft Components Div.
Intercontinentol Mfg. Co., Inc.
Kaiser Aircroft & Electronics, Div.-Kaiser Industries Corp.
Kaiser Metal Products, Inc. – Fleetwings Div.
Kanorr Corp.
***LAVELLE AIRCRAFT CORP.**
Mercury Tool & Mfg. Corp.
Newbrook Machine Corp.
Penn-Michigan Mfg. Corp.
Piosecki Aircraft Corp.
Portlond Copper & Tank Works Inc.
Precision Sheet Metal, Inc.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Rohr Aircraft Corp.
Ryan Aeronoutical Co.
Smith-Morris Corp.
Solar Aircraft Co.
South Wind Div., Stewart Worner Corp.
Stainless Steel Products, Inc.
C. W. Torngren Co., Inc.
Turbo Products, Inc.
Twin Coach Co., Aircraft-Missiles

TANK SEALERS, FUEL & OIL
See SEALERS, FUEL & OIL TANK

TANKS
a. Auxiliary
b. Auxiliary Drop
c. Fuel
d. Liquid Nitrogen
e. Liquid Oxygen
f. Liquified Gas Storage
g. Low Temperature
h. Oil
i. Self-Sealing
j. Transportation & Storage

ACF Industries Inc., **d, e, f, j.**
Aerojet-General Corp., **d, e, f.**
Aeronca Mfg. Corp., **a, b, c, f, j.**
Air Logistics Corp., **j.**
Air Products, Inc., **d thru g.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., d, e, f.**
Alco Products, Inc., **c thru g.**
Alsop Engrg. Corp., **j.**
Aluminum Co. of America, **a, b, c, j.**
American Aeroparts, **a, b, c.**
American Agile Corp., **g.**
American Aluminum Co., **a.**
American Car & Foundry, Div.-ACF Industries, Inc., **d, e, f, h, j.**
American Machine & Foundry Co., Government Products Group, **a, b, c.**
Anchor Metal Spinning Co., The, **a, b.**
Apex Reinforced Plastics, Div.-White Sewing Machine Corp., **f.**
Aro Equipment Corp., **d thru g.**
B. H. Aircroft Co., Inc., **h.**
Basco Metal Products, Inc., **j.**
Basic Tool Industries, Inc., **a, b, c, j.**
Bendix Utica Div., Bendix Aviation Corp., **d, e.**
Benson Mfg., Co., The, **a thru h, j.**
Brighton Corp., **d, e, f, j.**
Brooks & Perkins, Inc., **c, d, e, g, h.**
Butler Mfg. Co., **j.**
Cambridge Co.-Div.-Carrier Corp., **d thru g, j.**
Chemold Co., **a, b, g, j.**
Chicago Bridge & Iron Co., **c thru h.**
Colonial Aircroft Corp., **a, c.**
Conco Engrg. Works, **a, j.**
Curtiss-Wright Corp.-Wright Aeronautical Div.
D K Mfg. Co., **d, e, f.**
Doyle & Roth Mfg. Co., Inc., **c thru g, j.**
Dresser Mfg. Div., Dresser Industries, Inc., **j.**
Electric Heater Co., The, **j.**
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., **a, c.**
FWD Corp., **c, j.**
G. W. Galloway Co., **c thru g, j.**
General American Transportation Corp., **c, d, e, g.**
B. F. Goodrich Aviation Products, **c, i.**
Goodyear Tire & Rubber Co., The, Aviation Produc Div., **a, c, g thru j.**
Hahn & Cloy, **d thru h, j.**
Paul Hardeman, Inc., **d thru g.**
Hardman Tool & Engrg. Co., **a, b, c.**
Harris Refrigeration Co., **g.**
Hofman Labs., Inc., **d thru g.**
Ludwig Honold Mfg. Co., **a, b, c, h, j.**
Houston Fearless Corp., **a, h.**
Hupp Aviation Co., **c.**
Internationol Pump & Mochine Works, **d, e.**
Javelin Aircroft Co. Inc., **a thru g.**
Joclin Mfg. Co., **a.**
Kaiser Aircroft & Electronics, Div.-Koiser Industri Corp., **a thru e, h, i, j.**
Koiser Metal Products, Inc.-Fleetwings Div., **c.**
Koiser Steel Corp., Fabricoting Div., **e.**
Konorr Corp., **b.**
M. W. Kellogg Co., The, **a thru g.**
Kirk & Blum Mfg. Co., The, **j.**
Ladish Co., **d, e.**
Lamtex Industries, Inc., **c, j.**
***LAVELLE AIRCRAFT CORP.**, **a, h.**
Linde Co., Div.-Union Corbide Corp., **d thru g.**
Longren Aircroft Co., Inc., **a, b, c, g, j.**
Menasco Mfg. Co., **d thru g.**
Mercury Tool & Mfg. Corp., **h, j.**
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**, **a, c, j.**
John Mohr & Sons, **d, e, g, i.**
Monogram Precision Industries, **a, b, j.**
Monrovia Aviation Corp., **a, b, c.**

Notional Tube Div.-United States Steel Corp., d, e, f, j.
Newbrook Machine Corp., a, b, d thru h.
Nooter Corp., j.
Norris-Thermador Corp., b, d, e.
Nucleor Products-Erco Div.-ACF Industries, Inc., a, b.

Opelika Welding, Machine & Supply Inc., c, f, h, j.
Piasecki Aircraft Corp., a, b, c, h, j.
Pittsburgh-Des Moines Steel Co., d thru h, j.
Portland Copper & Tank Works Inc., e, f, g.
Precision Sheet Metal, Inc., a thru g, j.
Pressed Steel Tank Co., a, c thru f, j.
Project Fabrication Corp., c thru g, j.

R & R Engrg. Co., j.
Reaction Motors Div., Thiokol Chem. Corp., c, e.
Regent Jack Mfg. Co., Inc., h.
Reinhold Engrg. & Plastics Co., a, b, c.
Rdw. Renneburg & Sons Co., a, c, h.
*RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV., a, c thru h.
Rohr Aircraft Corp., a thru e, g.
Ronon & Kunzl, Inc., d thru g, j.
Royol Industries, Inc., a thru e, g, h, j.
Ryan Aeronautical Co., a, b, c, h.
Sandberg-Serrell Corp., j.
Santo Anita Engrg. Co., a, b, c, h.
Scaife Co.-Div.-Wilson Bros., c, j.
Seamless Products Co., Inc., h.
Shaw Metal Products Corp., c, h.
Skyline Products, Inc., c, h.
Smith-Morris Corp., a, b, c, h.
Solar Aircraft Co., c, h.
Space Corp., j.
Stainless Steel Products, Inc., a, c, d, e, h.
Standard Steel Corp., d thru g, j.
Stearns-Roger Mfg. Co., c thru g, j.
Superior Air Products Co., d thru g, j.
Tapco Group, Thompson-Ramo-Wooldridge Inc., d thru g.
Trailmobile Inc., c, j.
Twin Coach Co., Aircraft-Missiles, a, b, h, j.
United Aircraft Products, Inc., a, b, c, g thru j.
U. S. Industries, Inc.
United States Chemical Milling Corp., b, c.
United States Rubber Co., c, i, j.
Universal Moulded Products Corp., b.
Universal Unlimited, Inc., j.
Washington Aluminum Co., Inc., e, j.
Weber Aircraft Corp., a thru e, h.
Western ARC Welding, Inc., d, e, g.
Westline Products Div.-Western Lithograph Co., h.
Winder Aircraft Corp. of Florida, a, b.
Woolf Aircraft Products, Inc., c, h.

NKS, PROPELLANT
See PROPELLANT TANKS

PES
a. Asbestos
b. Coated & Impregnated
c. Electrical Insulation
d. Fabric
e. Friction
f. Heat Resistant
g. Plastic
h. Pressure Sensitive
i. Recording
j. Rubber, Naturol & Synthetic
k. Test

Accurate Mfg. Co., c, e, g, j.
Adept Industries Inc., h.
Aero Leather Products Co., d, e.
Allied International Co., a thru h, j.
Allied Plastics Supply Corp., a thru h, j.
American Aeroparts, h, j.
American Super-Temperature Wires, Inc., g.
Ampex Magnetic Tape, i.
Arnold Engrg. Co., The, i.
Auburn Mfg. Co., The, a, c, g, j.
Audio Devices, Inc., i.
Barrett-Christie Co., a, c, j.
Bemis Brothers Bag Co., h.
Carl H. Biggs Co., b, f, g.
Bishop Mfg. Corp., c, g, h, j.
Bonny Mfg. Corp., c, g.
Borden Chemical Co., c, f, g.
W. H. Brady Co., h.
Carborundum Co., Refroctories Div., f.
Chemold Co., b, d, g.
Chemplast, Inc., c, f, g.
Chicago Gasket Co., c, g, h.
Colonial Rubber Co., j.
Connecticut Hard Rubber Co., The, b, c, d, f, h.
Continentol Diomond Fibre Corp., b, c, d, f.
Continental Rubber Works, c, e, g, j.
Cooper Industries, Inc., c.
Crystol-X Corp., g.
Dilectrix Corp., c, h.
Dixon Corp., g.
A. W. Dunton Co. Inc., The, c, e.
Duotone Co., Inc., i.
E. I. Du Pont De Nemours & Co. Inc., b, c, h, j.
Duracote Corp., b, d, g, h, j.
Electro Technical Products Div. Sun Chemicol Corp., b, c, h.
Flexrock Co., g.
Fluorocarbon Co., The, g.
Fronklin Fibre-Lamitex Corp., c, g, h.
Gotke Corp., a.
General Plastics Corp. of New Jersey, b, f, h.
Gering Products, Inc., g, h.
B. F. Goodrich Industrial Products Co., j.
Greene, Tweed & Co., b, d, f, j.
Halogen Insulator & Seal Corp., g.
Haveg Industries, Inc., b, f, g.
Huntington Rubber Mills, j.
Integrated Mico Corp., b, c, f.
Jessall Plastics, g.
Joclin Mfg. Co., b, c, f, g, h.
Johns-Manville, a thru h, j.
Johns-Manville Soles Corp., a thru h.
Labelon Tape Co., Inc., g, h.
Livingston Electronic Corp., i, k.
M & Q Plastic Products, g.
Mico Insulator Div.-Minnesota Mining & Mfg., Co., b, c.
Minicom Div., Minnesota Mining & Mfg. Co., i.
Minnesota Mining & Mfg. Co., a thru k.
Monogram Precision Industries, b, j.
Motorola Inc., Military Electronics Div., i.
Norvar Corp., b, c, g.
New England Tape Co., Div.-United-Carr Fastener Corp., g.
New York Rubber Corp., j.
Dkonite Co., The, Subsidiary of Kennecott Copper Corp., c, e, g, j.
Orradio Industries, Inc., i.
Pee Cee Tape & Label Co., f, h.
Permacel, b thru h, j, k.
Plastic Age Sales, Inc., g.
Polyken Sales Div., The Kendall Co., b, c, d, f, g, h.
Polymer Corp., The, c, g, h.
H. K. Porter Co., Inc., Thermoid Div., c, d, e, h.
Products Research Co., b.
Raybestos-Manhattan, Inc., a, c, g, j.
Raybestos-Manhattan, Inc., Po., a, b, c, f, g, j.
Rubbercraft Corp. of California, j.
Schlegel Mfg. Co., d.
Simplex Wire & Cable Co., c, j.
Somers Brass Co. Inc., i.
Sparto Mfg. Co., Div.-U.S. Ceramic Tile Co., b, c, g.
A. T. Stevens Co., b, d.
Technical Tape Corp., b, c, f, g, h.
Thermech Engrg. Corp., g.
H. I. Thompson Fiber Glass Co., c.
Turbo Products, Inc., c, g.
Union Asbestos & Rubber Co., a, b, f.
United States Rubber Co., a thru e, j.
Western Felt Works & Acadia Synthetic Products Div., j.
Westinghouse Electric Corp., b, c.
Westline Products Div.-Western Lithograph Co., h.
Zippertubing Co., The, a, b, c, d, f, g.

TARGET DEVICES

Aerolob Development Co.
Aeronca Mfg. Corp.
Aircraft Armaments, Inc.
American Machine & Foundry Co., Government Products Group
Andersen Labs.
Astrodyne, Inc.
Bell Aircraft Corp., Niagoro Frontier Div.
Belock Instrument Corp.
Benson Mfg., Co., The
Bulow Electric Co.
Burton-Rodgers, Inc.
Centronix Inc.
Colonial Aircraft Corp.
Cooper Development Corp., Sub.-Marquordt Aircraft Co.
Curtiss-Wright Corp., Santo Barbara Div.
DBM Reseorch Corp.
Dynamic Devices, Inc.
Emerson & Cuming, Inc.
Gordon Enterprises
Wolter J. Hyott Co., The
Intercontinental Mfg. Co., Inc.
Monogram Precision Industries
Monrovio Aviation Corp.
Motorola Inc., Military Electronics Div.
Nucleor Products-Erco Div.-ACF Industries, Inc.
Philco Corp., Government & Industrial Div.
Piosecki Aircraft Corp.
Raytheon Mfg. Co., Government Equipment Div.
Republic Aviotion Corp.
Royal Industries, Inc.
Ryon Aeronoutical Co.
Singer Mfg. Co., The, Military Products Div.
Squiers Goge Co.
Stanley Aviation Corp.
Telectro Industries Corp.
Twin Cooch Co., Aircroft-Missiles
U. S. Industries, Inc.
Wolthom Engrg. Corp.
Winzen Reseorch Inc.

TELEMETERING, GUIDED MISSILE
See GUIDED MISSILE TELEMETERING

TELEVISION GUN MOUNTS
See GUN MOUNTS, TELEVISION

TEMPERATURE CONTROL SYSTEMS

Airborne Accessories Corp.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Airtemp Div., Chrysler Corp.
American Air Filter Co., Defense Products Div.
American Instrument Co., Inc.
American Machine & Foundry Co., Government Products Group
Andersen Labs.
*ARNOUX CORP.
*ASSOCIATED TESTING LABS., INC.
Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Avien, Inc.
Barber-Colman Co.
Bar-Ray Products, Inc.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bendix Utica Div., Bendix Aviation Corp.
Bogue Electric Mfg., Co.
Bristol Co., The
CDC Control Services, Inc.
Carrier Corp.
Components Corp.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Crown Controls Co., Inc.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Data-Control Systems, Inc.
Daystrom Pacific Div.-Daystrom, Inc.
Dean & Benson Research, Inc.
Electronic Control Corp.
Electronic Processes Corp. of California
Electro-Tech Equipment Co.
Ellis & Watts Products, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Fenwal Inc.
Fischer & Porter Co.
General Electric Co., Apparatus Sales Div.
Claud S. Gordon Co.
Gulton Industries, Inc.
Hagan Chemicals & Controls, Inc.
Hallikainen Instruments
Hamilton Standard, Div.-United Aircraft Corp.
Hesco Engrg.
Hoover Electric Co.
Illinois Testing Laboratories, Inc.
Jet-Heet, Inc.
*KEARFOTT CO., INC.
Lear, Inc.
Leeds & Northrup Co.
Leslie Co.
Magnetic Controls Co.
Mason-Neilan
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
New England Scientific Instruments Co.
Norwood Controls Unit Detroit Controls Div.
DPW-Jordan
Perkin-Elmer Corp.
Projects Unlimited Inc.
Pyrometer Instrument Co., Inc.
Arthur C. Ruge Associotes, Inc.
Scientific Engrg. Labs., Inc.
Scientific Instrument Co.
Servomechanisms, Inc.
Spoce Corp.
Spencer Div., Metols & Controls Corp.
Stondard-Thomson Corp., Clifford Mfg. Co. Div.
Stevens Mfg. Co., Inc.
Stratos, Div.-Fairchild Engine & Airplone Corp.
Sun Electric Corp., Aeronautical Div.
Temperature Engrg. Corp.
Thermo Electric Co., Inc.
Tronter Mfg., Inc.
United Aircroft Products, Inc.
United Control Corp.
United Electric Controls Co.
U. S. Science Corp., Div.-Topp Industries, Inc.
Vap-Air Aeronouticol Products Div., Vapor Heating Carp.
Victory Engrg. Corp.
West Instrument Corp.
Western Design, Div.-U.S. Industries, Inc.; Sonto Barbara Div.
Weston Instruments, Div.-Doystrom, Inc.
Westronics Inc.
Wilcolotor Co., The
Winzen Reseorch Inc.
Yellow Springs Instrument Co., The

TEMPERATURE MEASURING EQUIPMENT

Aero Reseorch Instrument Co. Inc.
Aerojet-General Corp.
Airguide Instrument Co.
Allegony Instrument Co., Inc.
Americon Instrument Co., Inc.
*ARNOUX CORP.
Atlantic Instrument Corp., Sub.-Americon Electronics, Inc.
Avien, Inc.
B G Corp., The
B & H Instrument Co., Inc.
Baird-Atomic, Inc.
Beckmon & Whitley, Inc., Missile Products Div.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bristol Co., The
Brown Engrg. Co., Inc.
Consolidoted Controls Corp.
Consolidoted Diesel Electric Corp.
Curtiss-Wright Corp., Princeton Div.
Doto-Control Systems, Inc.
Doystrom Pacific Div.-Daystrom, Inc.
W. C. Dillon & Co., Inc.
Electric Auto-Lite Co., The

Electronic Processes Corp. of California
Electra-Tech Equipment Co.
Epic, Inc.
Fenwal Inc.
Fischer & Porter Co.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Claud S. Gordon Co.
Gray Instrument Co.
Gultan Industries, Inc.
Hagan Chemicals & Controls, Inc.
Hallikainen Instruments
Harco Labs., Inc.
Harris Refrigeration Co.
Hesco Engrg.
Illinois Testing Labaratories, Inc.
Kahn & Co., Inc.
***KEARFOTT CO., INC.**
Leeds & Northrup Co.
***LEWIS ENGRG. CO., THE**
Mason-Neilan
Mergenthaler Linotype Co.
Meters Inc.
Minco Products, Inc.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
National Beryllia Corp.
National Electronics
New England Scientific Instruments Co.
North Atlantic Industries, Inc.
Pacific Scientific Co.
Perkin-Elmer Corp.
Projects Unlimited Inc.
Pyrometer Instrument Co., Inc.
Revere Corp. of America
Rochester Mfg. Co. Inc.
Royco Instruments, Inc.
Arthur C. Ruge Associates, Inc.
Scientific Instrument Co.
Servomechanisms, Inc.
T-C Div., Dyna-Empire, Inc.
Technique Associates Div., Duncan Electric Co., Inc.
Thermo Electric Co., Inc.
Thwing-Albert Instrument Co.
Trans-sonics, Inc.
United Electric Controls Co.
Victory Engrg. Corp.
West Instrument Corp.
Weston Instruments, Div.-Daystrom, Inc.
Westronics Inc.
Winzen Research Inc.
Yellow Springs Instrument Co., The

TEMPERATURE RESISTANCE BULBS

Aero Research Instrument Co. Inc.
Allegany Instrument Co., Inc.
American Aeroparts
***ARNOUX CORP.**
Barber-Colman Co.
Bristol Co., The
Consolidated Diesel Electric Corp.
Electronic Processes Corp. of California
Electro-Tech Equipment Co.
Fisher Scientific Co.
Hallikainen Instruments
Hesco Engrg.
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
***LEWIS ENGRG. CO., THE**
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
New York Coil Co.
Pacific Scientific Co.
Arthur C. Ruge Associates, Inc.
Servomechanisms, Inc.
T-C Div., Dyna-Empire, Inc.
Thermo Electric Co., Inc.
Thwing-Albert Instrument Co.
Trans-sonics, Inc.
United Control Corp.
West Instrument Corp.
Weston Instruments, Div.-Daystrom, Inc.

TEMPERATURE RESISTANT BULBS

See BULBS, TEMPERATURE RESISTANT

TEMPERATURE WARNING UNITS

See WARNING UNITS, TEMPERATURE

TENSIONS, COIL WINDING

Allied Control Co., Inc.
Boulin Instrument Corp.
Coil Winding Equipment Co.
Rollan Electric Co.
T-C Div., Dyna-Empire, Inc.

TERMINAL BLOCKS

AMP Inc.
Accurate Electronics Corp., Dept. D
Adept Industries Inc.
Allied Plastics Supply Corp.
American Aeroparts
Armel Electronics, Inc.
Audio Development Co.
Automatic Electric Sales Corp.
Carmac Aviation
Century Fasteners Carp.
Cutler-Hammer Inc.
Detronic Industries
Dauble E Products Co.
Electrical Insulation Co., Inc.
Eljay Corp.
Emerson Plastics Carp.
Emmca Plastic Fabricators — Div.-E. M. McCarthy Machine Co.
Fisher & Crame
General Electric Co., Apparatus Sales Div.
General Products Carp.
Gardon Enterprises
ITT-Kellagg
Janca Carp.
Jadee Plastics Co.
Howard B. Jones Div.-Cinch Mfg. Carp.
Keystone Electranics Carp.
Kulka Electric Corp.
Lerco Electronics, Inc.
Litton Industries, U.S. Engrg. Co., Div.
Thomas J. Long, Inc.
Molding Corp. of America
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
National Tel-Tronics Corp.
Piasecki Aircraft Corp.
Pilgrim Products Inc.
Milton Ross Metals Co., The
St. Regis Paper Co., Panelyte Div.
Silicone Insulation, Inc.
Slip Ring Co. of America
States Co., The

TERMINAL BOARDS

AMP Inc.
Accurate Electronics Corp., Dept. D
Adept Industries Inc.
Aerolite Electronics Corp.
Alac, Inc.
Alden Products Co.
Allied Plastics Supply Corp.
Amotom Electronic Hardware Co. Inc.
American Aeroparts
Anchor Metal Spinning Co., The
Armel Electronics, Inc.
Cambridge Thermionic Corp.
Cleveland Metal Specialties Co., Electronics Div.
Comco Plastics Inc.
Cutler-Hammer Inc.
Dalmore Corp.
Detronic Industries
Double E Products Co.
Electrical Insulation Co., Inc.
Electro-Mechanical Products Co.
Eljay Corp.
Emerson Plastics Corp.
Emmco Plastic Fabricators — Div.-E. M. McCarthy Machine Co.
Engineered Plastics, Inc.
***ETS-HOKIN & GALVAN**
Fidelity Amplifier Co.
Fisher & Crome
General Electric Co., Apparatus Sales Div.
General Products Corp.
Globe Electrical Mfg. Co.
Gordon Enterprises
Hampden Mfg. Co., Inc.
Hobson Brothers, Inc.
Jadee Plastics Co.
Johns-Manville
Howard B. Jones Div.-Cinch Mfg. Corp.
Keystone Electronics Corp.
Kulka Electric Corp.
Lerco Electronics, Inc.
Litton Industries, U.S. Engrg. Co., Div.
Thomas J. Long, Inc.
Molding Corp. of America
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
National Tel-Tronics Corp.
Panel Engrg. Corp.
Penn Fibre & Specialty Co., Inc.
Piosecki Aircraft Corp.
Pilgrim Products Inc.
Printronics Corp.
Rimak, Inc.
Milton Ross Metals Co., The
Russell Reinforced Plastics Corp.
St. Regis Paper Co., Panelyte Div.
Silicone Insulation, Inc.
Slip Ring Co. of America
States Co., The
Tri-Dex Co.
Vector Electronic Co.
Virginia Electronics Co., Inc.

TERMINAL LUG SWAGGERS

AMP Inc.
Alac, Inc.
Alden Products Co.
Amotom Electronic Hardware Co. Inc.
American Aeroparts
Cambridge Thermionic Corp.
Electrical Insulation Co., Inc.
Keystone Electronics Corp.
Kulka Electric Corp.
Lerco Electronics, Inc.
Litton Industries, U.S. Engrg. Co., Div.
Edward Segal
Thompson-Bremer & Co.
Waldom Electronics Inc.

TERMINAL STRIPS

AMP Inc.
Accurate Electronics Corp., Dept. D
Aerolite Electranics Corp.
Alac, Inc.
Alden Products Co.
Allied Plastics Supply Corp.
Amotam Electronic Hardware Co. Inc.
American Aeroparts
American Printed Circuits Co., Inc.
Armel Electronics, Inc.
Automatic Electric Sales Corp.
Birnbach Radia Co., Inc.
Cambridge Thermionic Corp.
Carmac Aviation
Century Fasteners Carp.
Cutler-Hammer Inc.
Detranic Industries
Double E Products Co.
Duralith Corp.
Electric Terminal Corp.
Electricol Insulation Co., Inc.
Electro-Tech Equipment Co.
Eljay Corp.
Emerson Plastics Corp.
Emmco Plastic Fabricators — Div.-E. M. McCarthy Machine Co.
Fisher & Crame
General Products Corp.
Gladding, McBean & Co.
Helipot Div.-Beckman Instruments Inc.
Hobson Brothers, Inc.
ITT-Kellogg
Industrial Engravers, Inc.
Jadee Plastics Co.
Howard B. Jones Div.-Cinch Mfg. Corp.
Kulka Electric Corp.
Lerco Electronics, Inc.
Litton Industries, Inc.
Litton Industries, U.S. Engrg. Co., Div.
Thomas J. Long, Inc.
Molding Corp. of America
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
National Tel-Tronics Corp.
North Electric Co.
Pilgrim Products Inc.
Milton Ross Metals Co., The
St. Regis Paper Co., Panelyte Div.
Sangamo Electric Co.
Sealectric Switch & Relay Corp.
Silicone Insulation, Inc.
Slip Ring Co. of America
Stanley-Judd Div.-The Stanley Warks
Teiner Engrg. Corp.
Tri-Dex Co.
Vector Electronic Co.
Waldom Electronics Inc.
Westline Products Div., Western Lithograph Co.

TERMINALS

a. Hermetically Sealed
aa. High Pressure Electric
b. Miniature & Subminiature
c. Snap
d. Solderless
e. Standoff
f. Wire & Cable

AMP Inc., a, b, d, f.
Accurate Electronics Corp., Dept. D, b, d, e.
Alac, Inc., b, d, e.
Alden Products Co., b.
All Specs Corp., b, f.
Alpine Electronic Components, Inc., b, d, e.
Amotom Electronic Hardware Co. Inc., b, e, f.
American Aeroparts, c, f.
Armel Electronics, Inc., b, e.
Atmo Seal Co., a.
B G Corp., The
Baldwin Mfg. Co. Inc., The
Best Aircraft Corp., f.
Birnbach Radio Co., Inc., b, e, f.
Burndy Corp., Omaton Div., b, d, f.
Cambridge Thermionic Corp., b, e.
***CANNON ELECTRIC CO.**, b, e.
Carborundum Co., Latrobe Plant, Refractories Div., a, b, e.
Century Fasteners Corp., b, d, f.
Ceramaseal, Inc., a, e.
Cole-Hersee Co., d, f.
Dalmore Corp., e.
Dante Electric Mfg. Co., d, f.
Diamonite Products Mfg. Co., e.
Electric Terminal Corp., f.
Emmco Plastic Fabricators — Div.-E. M. McCarthy Machine Co.
Erie Resistor Corp., e.
Frenchtown Porcelain Co., a, b.
Freeman Co., The, f.
Fusite Corp., a, b, e.
Garde Mfg. Co., a, b, d, e.
Gladding, McBean & Co., a, e.
Goe Engrg. Co., b, e.
Hallett Mfg., Co., f.
Harco Labs., Inc., f.
Hobson Brothers, Inc., d.
Holex, Inc., a.
Hollingsworth Co., Solderless Terminol Div., d.
Janco Corp., f.
Javex Electronics, d.
Joclin Mfg. Co., a, b, d, e, f.
Howard B. Jones Div.-Cinch Mfg. Corp.

Kennedy Aircraft Supply Co., f.
Keystone Electronics Corp., b, d, e.
Kulka Electric Corp., f.
Lerco Electronics, Inc., a thru f.
Litton Industries, Inc., b thru e.
Litton Industries, U.S. Engrg. Co., Div., b, e, f.
Livingston Electronic Corp., a.
Lundey Associates Inc., a, b, d, e.
Malco Mfg. Co., b thru f.
Monger Electric Co., b, d.
Mc CORMICK SELPH ASSOCIATES, a, aa.
M. E. Menaugh Co., f.
Mercury Air Parts Co., Inc., b.
Microdot Inc., b, f.
Minnesota Mining & Mfg. Co., a.
Mitronics Inc., a.
Molding Corp. of America, a, b, e.
Monk W. Morse Co., f.
Motional Coil Co., b.
Motional Tel-Tronics Corp., e.
Networks Electronic Corp., a, b, e.
North Electric Co., a, b, d, f.
Pacific Cut Washer Co., b, d.
Pilgrim Products Inc., b, e, f.
Pimak, Inc., b thru e.
Pilton Ross Metals Co., The, a, b, e, f.
Pervwell Products Co., d.
Pilicone Seals, Inc., o, e.
R. Sjoberg & Son, b, d, f.
Sphere Co. Inc., The, a, b, e.
Stanley-Judd Div.-The Stanley Works, c, d, f.
Edwin B. Stimpson Co., Inc., f.
Strot-o-Seal Mfg. Co., a, b, e.
Thompson-Bremer & Co., f.
Torwico Electronics, Inc., a.
Triad Transformer Corp., a.
Tri-Point Plastics Inc., e.
Vector Electronic Co., b, d, e.
Voldom Electronics Inc., d, f.
Vorren Components, Div. EI-Tronics, Inc., a.
Vesrep Corp., b.
Winchester Electronics, Inc., a thru e.
Zierick Mfg. Corp., c, f.

RMINATIONS

AMP Inc.
Alford Mfg. Co.
Ceramaseal, Inc.
Diamond Antenna & Microwave Corp.
Empire Products Sales Corp.
Entron, Inc.
ETS-HOKIN & GALVAN
Lundey Associates Inc.
Manger Electric Co.
Meridian Metalcraft, Inc.
Microlab
Omega Labs., Inc.
Portchester Instrument Corp.
Radar Design Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Weinschel Engrg.

ST CHAMBERS, ENVIRONMENTAL

American Instrument Co., Inc.
American Research Corp.
Anchor Specialty Mfg. Co. Inc.
ASSOCIATED TESTING LABS., INC.
Astravac Corp.
Atlas Engrg. Corp.
Avtron Mfg., Inc.
Bell Aircraft Corp., Niagara Frontier Div.
Blue M Electric Co.
CDC Control Services, Inc.
Carrier Corp.
Chicago Bridge & Iron Co.
Cincinnati Sub Zero Products
Conrad, Inc.
Consolidated Electrodynamics Corp., Rochester Div.
Delta Design Engineers, Inc.
Environmentol Equipment Co.
E. W. Golloway Co.
Gardner Laboratory, Inc.
General Testing Labs., Inc.
Guardite Co., Div. of American Marietta Co.
Paul Hardeman, Inc.
Harris Refrigeration Co.
Hoskel Engrg. & Supply Co.
High Vacuum Equipment Corp.
Hughes Tool Co., Aircraft Div.
Hull Corp.
Huppert, K. H., Co.
Instruments Div.-Philips Electronics, Inc.
International Radiant Corp.
Jamison Cold Storage Door Co.
Metal Fabricators Corp.
Missimers Inc.
John Mohr & Sons
Murphy & Miller Inc.
NRC Equipment Corp.
Newbrook Machine Corp.
Pittsburgh-Des Moines Steel Co.
Project Fabricotion Corp.
Sandberg-Serrell Corp.
Scientific Engrg. Labs., Inc.
Space Corp.
Stondard Cabinet Co.
State Testing Lab. Inc.
S. J. Stokes Corp.
Temperature Engrg. Corp.
Tenney Engrg., Inc.
Washington Technological Associates Inc.
Webber Engrg. Corp.

TEST CHAMBERS, FLIGHT SIMULATION

American Machine & Foundry Co., Government Products Group
American Reseorch Corp.
Atlas Engrg. Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Products Div.-Missiles, Bendix Aviation Corp.
A. Biederman, Inc.
Bulow Electric Co.
CDC Control Services, Inc.
California Technical Industries, Div.-Textron Inc.
Conrad, Inc.
Epic, Inc.
General Testing Labs., Inc.
Guardian Electric Mfg. Co.
Guardite Co., Div. of Americon Marietta Co.
Paul Hardeman, Inc.
Hughes Tool Co., Aircraft Div.
International Radiant Corp.
Missimers Inc.
NRC Equipment Corp.
Newbrook Machine Corp.
Pittsburg-Des Moines Steel Co.
Project Fabrication Corp.
Raytheon Mfg. Co., Government Equipment Div.
Rototest Labs., Inc.
Royal Industries, Inc.
Scientific Engrg. Labs., Inc.
Smith-Morris Corp.
F. J. Stokes Corp.
Temperature Engrg. Corp.
Tenney Engrg., Inc.
Thompson-Ramo-Wooldridge Products Co., The

TEST EQUIPMENT

a. Accelerator
b. Altitude Simulating
c. Aural
d. Aviation
e. Centrifuge
f. Combustion
g. Electrical
h. Electronic
i. Environmental
j. Flight
k. Humidity
l. Hypersonic
m. Ignition
n. Impact
o. Microwave
p. Oxygen System
q. Pneumatic
r. Temperature
s. Vibration

***AC ELECTRONICS DIV., GENERAL MOTORS CORP., h.**
ACF Industries Inc.
Accessory Controls & Equipment Corp., q.
Actuation Research Corp., q.
Advanced Electronics, Inc., g, h, r, s.
Aero Research Instrument Co. Inc., r.
Aerodex, Inc., d.
Aeroflex Corp., The, Aeroflex Labs. Div., b, g, h, i.
Aerojet-General Corp., a, b, d, f, r.
Aerolab Development Co., d, j.
Aeroscience, Inc.
Air Logistics Corp., g, h.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., h, o
Aircom Inc., o.
Aircom Inc. of New Jersey, o.
Aireco, Inc., i, k, r.
Airguide Instrument Co., k.
Airpax Electronics Inc. Seminole Div., d, g, h.
Airtron Inc., Div.-Litton Industries, o.
Airtronics International Corp.
All American Tool & Mfg. Co., s.
Allegany Instrument Co., Inc., h.
Allen Tool Corp.
Allied International Co., d, h.
Amelco, Inc., g, h.
Amerac Inc., o.
American Bosch Arma Corp., g, h.
American Electronics, Inc., Taller & Cooper Div., b.
American Felt Co., i, k, q, r.
American Instrument Co., Inc., h, i, k, r.
American Machine & Foundry Co., Government Products Group, o, e, g, h, i.
American Measurement & Control, Inc., g, h.
American Research Corp., b, i, k, r.
American Research & Mfg. Corp., s.
Amthor Testing Instrument Co., Inc., p.
Anaheim Electronics Co., Inc., h.
Analogue Controls, Inc., h.
Anchor Specialty Mfg. Co. Inc., o, b, d, e, g thru k, m, o thru s.
Andersen Labs., g, h.
Applied Science Corp. of Princeton, d, j.
Arde-Portland, Inc., b, l, r.
Arenberg Ultrasonic Lab., Inc., h.
***ARNOUX CORP., r.**
Aro Equipment Corp., p.
Associated Engineers, Inc., d, f, g, h, j, m, q, r.
Associated Research, Inc., g, h.
***ASSOCIATED TESTING LABS., INC., o, b, c, e thru i, k, m, n, q, r, s.**
Astravac Corp., b, i, j, k, r, s.
Atlas Coil Inc., h.
Atlas Precision Products, Co., d, g, h.
Automotion Instruments Inc., h.
***AVCO MFG. CORP., CROSLEY DIV., h.**
Avo Ltd., g, h.
Avtron Mfg., Inc., d, g, h, i.
B & F. Instruments, Inc., j, s.
B G Corp., The, m.
B & H Instrument Co., Inc., d, r.
Babcock Radia Engrg., Inc., j.
Baird-Atomic, Inc., h.
Ballantine Labs., Inc., h.
Barker & Williamson Inc., h.
Barry Controls Inc., d, g, h, i, n, s.
Basic Tool Industries, Inc., r, s.
Rex Bassett, Inc., h.
Bearing Inspection, Inc.
Beckmon Instruments, Inc., Berkeley Div., o.
Beckman-Spinco Div., e, i.
Belock Instrument Corp., j.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Bendix Aviation Corp., Pioneer-Central Div., d, p.
Bendix Aviation Corp., Red Bank Div., g thru j, o
Bendix Aviation Corp., York Div., g, h, j, o.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., h.**
Bendix Products Div.,-Missiles, Bendix Aviation Corp., o, f, g.
Bendix Radio Div., Bendix Aviation Corp., h, o.
Bendix Utica Div., Bendix Aviation Corp., g, h, q.
Beva Labs, Inc., h.
A. Biederman, Inc., o, f, g, h, p.
Bliss Electronic Corp., h.
Blue M Electric Co., i, k, r.
Bogue Electric Mfg., Co., g.
Briggs Associates, Inc., h, s.
Bristol Co., The, q, r.
Brown Engrg. Co., Inc., h, q.
Brush Instruments, Div.-Clevite Corp., o, h, i, r.
Bulow Elecric Co., o.
Burr-Brown Reseorch Corp., h.
Burroughs Corp., h.
Burton-Rodgers, Inc., b, d.
CDC Control Services, Inc., b, d, i, j, k, q, r, s.
CGS Labs., Inc., h.
California Technical Industries, Div.-Textron Inc., b, g, h, j, o.
Captive Seal Corp., q.
Centronix Inc., g, h.
Chadwick-Helmuth Co., i.
John Chotillon & Sons, n.
Chemalloy Electronics Corp., o.
Chicago Aerial Industries, Inc., i.
Cincinnati Sub-Zero Products, b, h, i, k, r.
Conrad, Inc., b, g, i, j, k, r, s.
Consolidated Avionics Corp., c, s.
Consolidated Diesel Electric Corp., d, g, q, r.
Consolidated Diesel Electric Corp., Test Equip. Div., d, f.
Consolidated Diesel Electric Corp., Western Div., g, q.
Consolidated Electrodynomics Corp., o, d, h, i, j, n, s.
Continentol Technical Service, Inc., b, d, g, h, j, q.
Control Engrg. Co., Div. Jervis B. Webb Co., d, g, h, q.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., h, i, o, q.
Cornelius Co., The, Aero Div., q.
Cubic Corp., h, o.
Curtiss-Wright Corp.-Princeton Div., l, r.
Datran Electronics, Div.-Mid-Continent Mfg. Co., Inc., h.
Daven Co., The, g, h, i, r.
Davenport Mfg. Co., g, h.
Daystrom Pacific Div.-Daystrom, Inc., d, g, h.
Doyton Aviation Radio & Equipment Corp., h.
Delsen Corp., g.
Delto Design Engineers, Inc., i, r.
Demornay-Bonardi, o.
Development Engrg. Co., Inc., i.
Diamond Antenna & Microwave Corp., o.
DI-AN Controls, Inc., h.
DIT-MCO, Inc., Electronics Div., d, g, h.
Divco-Wayne Electronics, Div.-Divco-Wayne Corp., g, h.
Diversey Engrg. Co., f.
Donner Scientific Co., o, h.
Douglas Microwave Co., Inc., o.
Dresser Industries, Inc., g, h.
Dymec Inc., o.
Dynamic Devices, Inc., p, q.
Dytronics Co., h.
Eastern Specialty Co., The, g, h.
Edgerton, Germeshausen & Grier, Inc., g, h, o
Eldorado Electronics, h.
Electro Instruments, Inc., h.
Electro Precision Corp., h.
Electromath Corp., g, h.
Electro-Mechanical Products Co., b, g, h.
Electronic Communications, Inc., h. o.
Electronic Tube Corp., h.
Electronics Div., Van Norman Industries Inc., h. o.
Electro-Tech Equipment Co., g, h, r.
Elsin Electronics Corp., h.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., d, g, h, j, o.
Empire Products Sales Corp., h, o.
Endevco Corp., i, s.
Engrg. Associates, g, h, o
Environmental Equipment Co., b, i, k, r, s.
Epic, Inc., k, r, s.
Ewold Instruments, i, s.

FXR, Inc., h, o
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., g, h, o
Federol Mfg. & Engrg. Corp., d, h, o.
Federol Products Corp., f, g.
Fisher & Porter Co., h, i, q, r.
Fisher Research Lab., Inc., h, s.
Fisher Scientific Co., e, f, r.
Flow Corp., h.
John Fluke Mfg. Co., Inc., h.
Foto-Video Labs., Inc., h.
Furane Plastics, Inc., g.
Goertner Scientific Corp., The, s.
Gardner Laboratory, Inc., i, k.
General Communication Co., h. o.
General Electric Co., Apporotus Sales Div., d, g, l.
General Electric Co., Missile & Space Vehicle Dept., g, h.
General Electric Co., X-Roy Dept., h.
General Testing Lobs., Inc., o, e, g thru k, m, n, q, r, s.
Genisco, Inc., o, e, i, s.
Genisco, Inc., Instrument Div., o.
Gionnini Plosmodyne Corp., b, i.
Gilfillon Bros.,Inc., h.
Gordon Enterprises, d, h, s.
Green Rectifier Co., d, g.
Greer Hydraulics, Inc., g, h, i, q.
Grieve-Hendry Co., Inc., r.
Guardion Electric Mfg. Co., d, g.
Guardite Co., Div. of Americon Marietta Co., b, i, k, r.
Guided Missile Div.- De Hovillond Aircroft of Conodo, Ltd., d, g, h.
Gulton Industries, Inc., s.
Hollomore Electronics Co., b, j.
Hollicrofters, h, o.
Hollikoinen Instruments, r.
Hamilton Stondord, Div.-United Aircraft Corp., g, l.
Horco Labs., Inc., r.
Poul Hardemon, Inc.
Horris Refrigerotion Co., b, i, k, r.
Haskel Engrg. & Supply Co., b, q, r.
Hazeltine Electronics Div.-Hozeltine Corp., h, o
Helipot Div.-Beckmon Instruments Inc., g.
Hevi-Duty Electric Co., f, r.
Hewlett-Packord Co., h, o.
Hicks Corp., The, e, i.
High Vacuum Equipment Corp., b.
High Voltoge Engrg. Corp., o, i.
E. Vernon Hill & Co., i, k.
Corl Hirschmonn Co., Inc., s.
Hoffman Labs. Div., Hoffmon Electronics Corp., h.
C. G. Hokonson Co., Inc., i, k, r.
Hufford Corp., The, s.
Hughes Tool Co., Aircroft Div., h.
Hull Corp., i.
Huppert, K. H., Co., r.
Wolter J. Hyott Co., The, o.
Hycon Mfg. Co., e.
I-L-S Instrument Div., The Meriam Instrument Co., h.
I-T-E Circuit Breoker Co., o.
ITT-Kellogg, g.
Illinois Testing Loborotories, Inc., r.
Impact-D-Groph Corp., The, h, m, s.
Industrial Control Co., h.
Industriol Engrg. Corp., b, g, h, q.
Industrial Instruments Inc., h.
Industrial Test Equipment Co., h.
Inertio Switch, Inc., n.
Infrored Industries Inc., h.
Insco Co., Div.-Borry Controls Inc., s.
Instrumentotion Div.-Ampex Corp., j, l
Instruments For Industry, Inc., h, o.
Intercontinentol Dynomics Corp., b, d, h, j, q.
Internotional Equipment Co., f.
Internotionol Fermont Machinery Co., Inc., g.
Internotional Pump & Mochine Works, b.
Internotional Rodiant Corp., b, i, k, r.
Itemco, Inc., b, i, k, r.
J-V-M Microwove Co., o.
Jon Hordwore Mfg. Co., Inc., h, i, n.
J. W. Johnson & Co., Inc., s.
Kahn & Co., Inc., g, h, k, q, r, s.
Koiser Aircroft & Electronics, Div.-Koiser Industries Corp., b, h, i.
Kouke & Co., j.
Koy Electric Co., o, s.
***KEARFOTT CO., INC.**, d, g thru j, o, q, r.
***KEARFOTT CO., INC., MICROWAVE DIV.**, o
Keithley Instruments, Inc., h.
Kinney Mfg. Div., The New York Air Broke Co., b, i.
Kingston Electronics-Div.-Kingston Industries Inc., h.
Knopp Inc., g.
L. A. B. Corp., i, n, s.
Lompkin Lobs., Inc., M. R. Div., h.
Lond-Air Inc., h, j, s.
La Roe Instruments, Inc., h.
Lovoie Loboratories Inc., h.
Leoch Corp., g.
Lear, Inc., o, d, g, h, j.
Leor, Inc., Grand Rapids Div., d, h.
Leeds & Northrup Co., r.
Leetronics, Inc., h.
Lelond Airborne Products, Div.-Americon Machine & Foundry Co., g, h.
***WALLACE O. LEONARD, INC.**, j.
Levinthol Electronic Products, Inc., h, o
***LEWIS ENGRG. CO., THE**, r.
Lieco, Inc., o.
Ling Electronics, Inc., i, s.
Liquidometer Corp., The, h.
Lumotron Electronics, Inc., h.
MB Mfg. Co., s.
Mogee-Bralla & Associotes., i.
Mognosync Mfg. Co., Ltd., h.
Monson Labs., Inc., h. o.
Marconi Instruments, g, h.
Morotto Valve Corp., q.
Marquordt Aircraft Co., g, h, q.
Mosso Div.-Cohu Electronics, Inc., h.
Most Development Co., Inc., i.
W. L. Moxson Corp., The, d.
Measurements Div., McGrow Edison Co., h.
Meletron Corp., q.
Mergentholer Linotype Co., h.
Merz Engrg., Inc.
Metal Fobricotors Corp.
Metronix, Inc., Sub.-Assembly Products, Inc., h.
Micrometrical Mfg. Co., h, s.
Millitest Corp., h.
Mine Sofety Appliances Co., k.
Minneopolis-Honeywell Regulator Co.-Aeronouticol Div., d, g, h, j, q.
Minneapolis-Honeywell Regulator Co., Boston Div., g, h.
Minneapolis-Honeywell Regulotor Co.-Dovies Labs. Div., j, s.
Minneopolis-Honeywell Regulator Co., Industrial Product Group, b, g, h, i, q, r.
Minneopolis-Honeywell Regulator Co., Drdnance Div., h, j, k.
Mirotel, Inc., h.
Missimers Inc., b, f, i, k, r.
Monogram Precision Industries., h, o.
Moran Instrument Corp., j.
Motorola Inc., Military Electronics Div., g, h, o.
Heinz Muetler Eng. Co. Inc., g.
Multi-Amp Corp., g, h.
Murphy & Miller Inc., b, i, k, r.
NRC Equipment Corp., b, i.
George L. Nonkervis Co., d, g, h, m, p thru s.
Nordo Microwove Corp., The, o.
Notional Electronics., g, r.
Notional Instrument Loborotories, Inc., g, h, p.
Notional Spectrographic Labs., Inc., g, h.
Notional Welding Equipment Co., p.
Networks Electronic Corp., b, g, h, i, k, r, s.
New Englond Scientific Instruments Co., g, k.
Non-Linear Systems, Inc., h.
North Atlontic Industries, Inc., h.
North Electric Co., g, h.
North Hills Electric Co., Inc., g, h.
Nucleor Products-Erco Div.-ACF Industries., h.
Omega Labs., Inc., o.
Orbitron Co., Inc., h.
Otis Elevator Co., Electronic Div., g.
Oxygen Equipment & Service Co., p.
PCA Electronics Inc., o, g, h.
Pocific Scientific Co., r, s.
Paco Electronics Co., Inc., h.
Perkin-Elmer Corp., r.
Peschel Electronics, Inc., g, h.
Philco Corp., Government & Industrial Div., g, h, o.
Photron Instrument Co., h.
Physics Research Loboratories, Inc., g.
Polarad Electronics Corp., g, h, o.
Polytechnic Reserch & Development Co., Inc., o.
Power-Tronic Systems Inc., g, h, j.
Precise Development Corp., g, h, m.
Precision Apporatus Co., Inc., h.
Precision Thermometer & Instrument Co., k, r.
Pre-Flite Industries Corp.-Sub.-Avco Corp., q.
Projects Unlimited Inc., g, h, r.
Puritan Compressed Gas Corp., Aviotion Div., p.
Pyrometer Instrument Co., Inc., r.
Rodar Design Corp., o.
Radex Corp., h.
Radiophone Co. Inc., h.
Rodiation, Inc.
Romo-Wooldridge Div., Thompson Romo Wooldridge of Calif.
Raymond Engrg. Lob., Inc., e.
Reflectone Corp., The, g, h.
Republic Aviotion Corp., d, g, h, j.
Resdel Engrg. Corp., h, o.
Rese Engrg., Inc., h.
Research Appliance Co., f, l, m.
Rototest Lobs., Inc., s.
Rayco Instruments, Inc., r.
Rucker Co., The, o, e, i, q.
Arthur C. Ruge Associotes, Inc., r.
Rutherford Electronics Co., h.
Sage Lobs., Inc., o.
Sandberg-Serrell Corp., d, r.
Sanders Associotes, Inc., d.
Schoevitz Engrg., o, e, s.
Schaffer Air Industries, Inc., d, g, p, q.
Scientific Engrg. Labs., Inc., b, h, i, k, r.
Scientific Instrument Co., k, r.
Scientific-Atlanta, Inc., o.
H. H. Scott, Inc., s.
Sequoio Wire & Cable Co.-Div.-Mandrel Industries, Inc., d, h.
Shollcross Mfg. Co., g.
Simpson Electric Co., g, h, r.
Skyline Electric & Mfg. Co., g, h, i, k, r.
Slaughter Co., Inc., g, h.
Smith-Morris Corp.
Solartron Inc., g, h, j.
Spoce Corp., b, i, j, s, x.
Specialties, Inc., j, q.
Sperry Microwove Electronics Co., Div.-Sperry Rand Corp., h, o.
Stainless Inc., e.
Standard Cabinet Co., b, l, k, r.
Stanley Aviation Corp., j.
State Testing Lab. Inc.
States Co., The, g.
Stavid Engrg., Inc., o.
Stearns-Roger Mfg. Co., i, k, p, q, r.
F. J. Stokes Corp., b, i.
Stromberg-Carlson Div.-Generol Dynamics Corp., d, g, h.
Suffolk Products Corp., g, h.
H. W. Sullivon Ltd., g, h.
Sun Electric Corp., Aeronautical Div., d, f, g, h, m, p, q, s.
Surface Combustion Corp., i.
Systems Inc., h, o.
Systron Corp., h.
Tomar Electronics, Inc., h, o.
Topco Group, Thompson-Ramo-Wooldridge Inc., h, o.
Technical Apparatus Builders, g, h.
Technique Associotes Div., Duncan Electric Co., Inc., g, r.
Technitrol Engrg. Co., h.
Telechrome Mfg. Corp., h, o.
Telerod Mfg. Corp., h, o.
Tel-Instrument Electronics Corp., h, s.
Temperoture Engrg. Corp., g thru k, r.
Tenney Engrg., Inc., b, d, f, i, j, k, m, r.
Thermo Electric Co., Inc., r.
Theta Instrument Corp., d, g, h.
Thiokol Chemical Corp., h.
Thomas Electronics, Inc., g, h.
Thompson-Ramo-Wooldridge Products Co., The, h.
Thwing-Albert Instrument Co., r.
Topotron, Inc., s.
Towaco Electronics Co., f, g.
Troid Corp., j.
Transco Products, Inc., h, o.
Transonic, Inc.,h.
Trans-Sonics, Inc., r.
Triplett Electrical Instrument Co., g. h.
Tucson Instrument Corp., g, h.
Turbo Machine Co., o.
Twenty-First Century Electronics, Inc., h.
***ULTRA-VIOLET PRODUCTS, INC.**,p.
Unit Process Assemblies, Inc., h.
United Aircroft Products, Inc., q, r.
United Electric Controls Co., b, d, g, i, k, p, q, r.
United Mfg. Co., Div., The W. L. Maxson Corp., d, g q.
U. S. Science Corp., Div.-Topp Industries, Inc., d, g h, q.
Universal Dynomics Corp., k.
Vord Inc., g, h, q, s.
Varian Associates, h, o.
Vicon Corp., h.
Victory Engrg. Corp., r.
Virginio Electronics Co., Inc., h.
Woldorf Electronics. Div.-F. C. Huyck & Sons, d, h.
Wollace & Tiernan Inc., q.
Walthom Electronics Corp., h.
Waltham Engrg. Corp., o.
Washington Technologicol Associates Inc., a, b, d, g, thru k, q, s.
Woste King Corp., Technicol Products Div., j.
Woterman Products Co., Inc., g, h.
Wough Engrg. Co., j.
Waveline, Inc., o.
Webber Engrg. Corp., b, i, k, r.
Webcor, Inc., Government Div., h, q.
Weinschel Engrg., h, o.
Western Gear Corp., s.
Westinghouse Electric Corp., g.
Weston Instruments, Div.-Daystrom, Inc., g, h.
Westronics Inc., h, i, r.
Yellow Springs Instrument Co., The, r.

TEST LEADS

Aerolite Electronics Corp.
Alden Products Co.
Amatom Electronic Hordware Co. Inc.
Anchor Specialty Mfg. Co. Inc.
Birnboch Radio Co., Inc.
Bud Rodio Inc.
Devcon Corp.
Chicago Aeriol Industries, Inc.
Eastern Specialty Co., The
Electro-Mechonicol Products Co.
Electro-Tech Equipment Co.
First Electronics Corp., The
Generol Cement Mfg. Co., Div.-Textron, Inc.
Hamilton Stondord, Div.-United Aircroft Corp.
Industrial Transformer Corp.
Javex Electronics
Keystone Electronics Corp.
Mutron Corp.
National Electronics
Poul Nurches Co.
Poco Electronics Co., Inc.
Poroplegics Mfg. Co., Inc.
Pomono Electronics Co., Inc.
Precise Development Corp.
Precision Apparotus Co., Inc.
Projects Unlimited Inc.
Sancor Corp.
Simpson Electric Co.
Slaughter Co., Inc.
Specialty Engrg. H Electronics Co.
Stanley-Judd Div.-The Stanley Works
Technical Apporotus Builders
Triplett Electrical Instrument Co.
Western International Co.
Whitaker Coble Corp.

EST SETS, RADAR
See RADAR TEST SETS

EST STANDS
See STANDS, TEST

EST STANDS, STATIC

Acco Equipment Div., Americon Choin & Cable Co., Inc.
Aerojet-Generol Corp.
Allegony Instrument Co., Inc.
Associoted Engineers, Inc.
Astronoutics Engrg. Co.
Avtron Mfg., Inc.
Borry Controls Inc.
Bosic Tool Industries, Inc.
Bendix Utico Div., Bendix Aviotion Corp.
Bobrick Mfg. Corp.
Chompion Co., The
Chicogo Aeriol Industries, Inc.
C. B. Christionsen Co.
Coloniol Aircroft Corp.
Continentol Technicol Service, Inc.
Control Engrg. Co., Div. Jervis B. Webb Co.
Devco Engrg. Inc.
Diversey Engrg. Co.
Dresser Industries, Inc.
Dynometrics Corp.
Electro-Mechanicol Products Co.
Federol Mfg. & Engrg. Corp.
G. W. Golloway Co.
Greer Hydraulics, Inc.
Paul Hordemon, Inc.
Hordman Tool & Engrg. Co.
Hoover Electric Co.
Huffard Corp., The
Industrial Engrg. Corp.
Koiser Steel Corp., Fabricating Div.
Land-Air Inc.
Lear, Inc.
Leor, Inc., Grand Rapids Div.
Lelond Airborne Products, Div.-American Mochine & Foundry Co.
Machine Products Div., New Hoven Trap Rock Co.
Metol Fabricators Corp.
*MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.
Multi-AMP Corp.
Newbrook Mochine Corp.
Performance Measurements Co.
Piosecki Aircraft Corp.
Projects Unlimited Inc.
Rucker Co., The
Sequoio Wire & Coble Co.-Div.-Mandrel Industries, Inc.
Smith-Morris Corp.
Space Corp.
Squiers Gage Co.
Sun Electric Corp., Aeronautical Div.
Thiokol Chemical Corp.
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
Vard Inc.
Woshington Technologicol Associates Inc.
Western Gear Corp.
Westronics Inc.

EST UNITS, ACCELERATION, MILITARY

Americon Machine & Foundry Co., Government Products Group
*ASSOCIATED TESTING LABS., INC.
Electronic Communications, Inc.
Epic, Inc.
Genisco, Inc.
Hycon Mfg. Co.
Metal Fobricators Corp.
Rucker Co., The

ESTERS
a. Amplitude Linearity
b. Automatic Tube
c. Battery
d. Cable
e. Capacitor
f. Cathode Ray Tube
g. Circuit
h. Coat Thickness
i. Coil
j. Color Infra-Red
k. Continuity
l. Crystal Testing
m. Diode
n. Distortion
o. Induction
p. Insulation
q. Insulation Breakdown
r. Meter
s. Microwave
t. Theodolites

Acme Electric Corp., q.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., l, m, s.
Aircom Inc., s.
Aircom Inc. of New Jersey, s.
Airtron Inc., Div.-Litton Industries, s.
Airtronics International Corp., d.
Allied Internotional Co., s.
Amerac Inc., s.
American Instrument Co., Inc., h.
American Machine & Foundry Co., Government Products Group, d, g.
Anchor Specialty Mfg. Co. Inc., c, d, g, i, k, p, q.
Associoted Reseorch, Inc., d, p, q.
Atlas Precision Products, Co., b, m.
Automotion Dynomics Corp., d.
Avo Ltd., g.
Avtron Mfg., Inc.
Rex Bossett, Inc., l.
Bendix Aviotion Corp., Red Bonk Div., s.
Bendix Aviotion Corp., York Div., g.
Bevo Lob., Inc., o, q.
Jomes G. Biddle Co., h, k, p.
Bliss Electronic Corp., d, e, g, k, q.
Bogue Electric Mfg., Co., c, g.
Brocke-Seib X-Roy Co., Inc., q.
Bronson Instruments, Inc., h.
Bristol Co., The, g.
Brush Instruments, Div.-Clevite Corp., a.
Californio Technicol Industries, Div.-Textron Inc., d, g, k, q, s.
Conogo Div., Underwood Corp., s.
Corol Electronics Corp., f.
Centronix Inc., g, k.
Chemolloy Electronics Corp., s.
Christie Electric Corp., c.
Consolidated Avionics Corp., a, n, p, q.
Consolidated Diesel Electric Corp., b, k, l, m.
Control Engrg. Co., Div. Jervis B. Webb Co., c.
Cornell-Dubilier Electric Corp., e.
Curtiss-Wright Corp., Electronics Div., p, q.
Daven Co., The, l, n.
Dovenport Mfg. Co., p, q, r.
Dayton Aviation Radio & Equipment Corp., g, m.
Delsen Cor., p.
Demornay-Bonardi, s.
J. W. Dice Co., d.
Dit-Mco, Inc., Electronics Div., d, g, k, p.
Douglos Microwove Co., Inc., s.
Eogle Electric Mfg. Co. Inc., g.
Eastern Speciolty Co., The, p.
Eder Engrg. Co., Inc., e, g, k, m.
Edgerton, Germeshousen & Grier, Inc., f, m.
Electro Instruments, Inc., e, m.
Electronic Brozing Co., q.
Electronic Communications, Inc., g, s.
Electronic Control Corp., k.
Electronic Instrument Co., Inc. (EICO), b, c, e, f, i, k.
Electronic Research Associotes, Inc., m.
Electro-Tech Equipment Co., c, g, h, k, p, q.
Engrg. Associates, s.
Epic, Inc., p.
Exide Industrial Div.-The Electric Storage Battery Co., c.
FXR, Inc., s.
Federol Mfg. & Engrg. Corp., e, m.
Foto-Video Labs., Inc., a.
Freed Transformer Co. Inc., p.
General Cement Mfg. Co., Div.-Textron, Inc., g.
General Communication Co., s.
General Electric Co., Apporotus Sales Div., h, q.
General Scientific Equipment Co., b.
Good Electronic Corp., g.
Gordon Enterprises, k, t.
Green Rectifier Co., g, m.
Hi-Lo Manufacturing Corp., f.
Holtzer-Cabot Div., Notional Pneumatic Co., Inc., p.
Hunter Tool Co., g.
Walter J. Hyatt Co., The, s.
ITT-Kellogg, g.
Ideal Industries, Inc., g, k, q.
Indikon Co., Inc., The, e, m.
Industriol Control Co., c, e, g.
Industrial Engrg. Corp., k.
Industriol Instruments Inc., d, k, q.
Industrial Test Equipment Co., e, n thru q.
Industrial Transformer Corp., q.
Jan Hardware Mfg. Co., Inc., r.
Janco Corp., p.
Kohn & Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., d.
Koy Electric Co., o, s.
*KEARFOTT CO., INC., o thru e, g, i, k, l, m, o thru t.
Kordo Industries, k.
Land-Air Inc., f, g.
Lovoie Laboratories Inc., d, g, k.
Leeds & Northrup Co., p.
Lieco, Inc., s.
Magnoflux Corp., h.
Manson Labs., Inc., q.
Marion Instrument Div., r.
McLean Development Lobs., Inc., g.
Monogram Precision Industries, s.
Motorola Inc., Military Electronics Div., g, s.
Multi-AMP Corp., p, q, r.
Notional Electronics, k, m, q, r.
North Hills Electric Co., Inc., r.
Northrop Corp., The, Norironics Div.
PCA Electronics Inc.
Poco Electronics Co., Inc., e, f, g.
Penn Keystone Corp., c.
Perkin-Elmer Corp., t.
Peschel Electronics, Inc., d, g, k, p, q.
Philco Corp., Government & Industrial Div., f, g, m, s.
Pioneer Industries Div., Almar-York Co. Inc., f, j.
Polarad Electronics Corp., s.
Precise Development Corp., b, c, e, f, n.
Precision Apporatus Co., Inc., e, f, g.
Projects Unlimited Inc., d, k.
Radar Design Corp., s.
Republic Aviotion Corp., c.
Ryon Aeronauticol Co., g.
Schoffer Air Industries, Inc., g.
Seco Mfg. Co., b, k.
Shollcross Mfg. Co., c, q.
Simpson Electric Co., c, e, g, r.
Sittler Corp., g.
Skyline Electric & Mfg. Co., g, k.
Sloughter Co., Inc., a, k, p, q.
Solartron Inc., a, n.
Sorensen & Co., Inc., d, q.
Spectrol Electronics Corp., a.
Sperry Microwove Electronics Co., Div.-Sperry Rond Corp., s.
Stotes Co., The, q, r.
Steel City Testing Mochines, Inc., d.
Stromberg-Corlson Div.-Generol Dynamics Corp., e, i, k, m.
H. W. Sullivon Ltd., i.
Sun Electric Corp., Aeronautical Div., c, p, q, r.
B. K. Sweeney Mfg., Co., d.
Systron Corp.
Technicol Apporotus Builders, c, l, m, p, q.
Technitrol Engrg. Co., m.
Telechrome Mfg. Corp., s.
Telerod Mfg. Corp., s.
Teletronics Lab. Inc., m.
Theta Instrument Corp., t.
Thomos Electronics, Inc., b, f, h.
Towaco Electronics Co., n.
Trons Electronics, Inc., m.
Transformer Design, Inc. of Milwaukee, q.
Transistor Electronics Corp., l, m.
Trans-Western Electronics, m, s.
Tricraft Products Corp., f.
Unit Process Assemblies, Inc., h.
Vorian Associates, s.
Vitro Labs., c,
Waveline, Inc., s.
Weinschel Engrg., s.
Westinghouse Electric Corp., p, q.
Weston Instruments, Div.-Daystrom, Inc., b, g, h, k, p, q, r.

THERMAL CONDITIONING EQUIPMENT

Aerojet-General Corp.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
American Air Filter Co., Defense Products Div.
*ASSOCIATED TESTING LABS., INC.
Blue M Electric Co.
Ellis & Watts Products, Inc.
Hallicrafters
International Rodiont Corp.
Morlo Coil Co.
Missimers Inc.
Pacific Scientific Co.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Trane Co., The
United Aircraft Products, Inc.
U. S. Industries, Inc.
Wenzlau Engrg. Co.
York Corp.

THERMAL CONDUCTIVITY CELLS

Davis Instruments
Greenbrier Instruments Inc.
Industrial Instruments Inc.
Leeds & Northrup Co.
Mine Sofety Appliances Co.
National Beryllia Corp.
Thermal Refractories Corp.
Victory Engrg. Corp.

THERMISTOR MOUNTS
See MOUNTS, THERMISTOR

THERMOCOUPLES

Advanced Electronics, Inc.
Aero Research Instrument Co. Inc.
Aerojet-General Corp.
American Aeroparts
American Instrument Co., Inc.
B G Corp., The
Barker Sales Co.
J. Bishop & Co., Platinum Works
Bristol Co., The
Conax Corp.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Electro-Tech Equipment Co.
Engelhard Industries, Inc.
Epic, Inc.
Fenwal Inc.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Good Electronic Corp.
Claud S. Gordon Co.
Harco Labs., Inc.
High Vacuum Equipment Corp.
A. F. Holden Co., The
Illinois Testing Laboratories, Inc.
Kanthal Corp., The
Leeds & Northrup Co.
*LEWIS ENGRG. CO., THE
Meters Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
New England Scientific Instruments Co.
Norton Co., New Products Dept.
Pacific Scientific Co.
Papesch & Kolstod, Inc.

Philco Corp., Government & Industriol Div.
Pyrometer Instrument Ca., Inc.
Revere Corp. af Americo
Arthur C. Ruge Associates, Inc.
Servomechanisms, Inc.
Simpsan Electric Co.
E. C. Smith Mfg. Ca.
Smith-Marris Carp.
T-C Div., Dyna-Empire, Inc.
Thermo Electric Co., Inc.
Thwing-Albert Instrument Ca.
Vacuum Tube Products, Div.-Hughes Aircraft Co.
West Instrument Carp.
Westan Instruments, Div.-Daystrom, Inc.
Wilks Precisian Instrument Co., Inc.

THERMOCOUPLES, CABLE ASSEMBLIES
See CABLE ASSEMBLIES, THERMOCOUPLES

THERMOMETERS, RESISTANCE

Aera Research Instrument Co. Inc.
American Aeroparts
***ARNOUX CORP.**
Avien, Inc.
Bristol Co., The
Consolidated Diesel Electric Corp.
Electro-Tech Equipment Co.
Epic, Inc.
Fisher Scientific Co.
Flow Carp.
General Electric Co., Apparatus Sales Div.
Hallikainen Instruments
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
***LEWIS ENGRG. CO., THE**
Meters Inc.
Minco Products, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
National Beryllio Corp.
New England Scientific Instruments Co.
Pacific Scientific Co.
Rosemount Engrg. Co.
Arthur C. Ruge Associates, Inc.
Servomechanisms, Inc.
Simpson Electric Co.
T-C Div., Dyna-Empire, Inc.
Thermo Electric Co., Inc.
Trans-Sonics, Inc.
West Instrument Corp.
Weston Instruments, Div.-Daystrom, Inc.

THERMOPILES

Aero Research Instrument Co. Inc.
Aerojet-General Corp.
James G. Biddle Co.
Bristol Co., The
Curtiss-Wright Corp., Research Div.
Eppley Laboratory, Inc., The
Illinois Testing Laboratories, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Minnesota Mining & Mfg. Co.
Thermo Electric Co., Inc.

THERMOSTATIC BIMETAL
See BIMETAL, THERMOSTATIC

THERMOSTATS

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Alloy Bellows Inc.
Bristol Co., The
Components Corp.
Consolidated Diesel Electric Corp.
Crown Controls Co., Inc.
Electro-Tech Equipment Co.
Fenwal Inc.
G-V Controls Inc.
General Electric Co., Apparatus Sales Div.
Hagan Chemicals & Controls, Inc.
Hart Mfg., Co., The
Metals & Controls Corp., Spencer Div.
Precision Thermometer & Instrument Co.
Spencer Div., Metals & Controls Corp.
Standard-Thomson Corp., Cliffard Mfg. Co. Div.
Stevens Mfg. Co., Inc.
George Ulanet Co.
United Aircraft Products, Inc.
United Control Corp.
United Electric Controls Co.
Vap-Air Aeronautical Products Div., Vapor Heating Corp.
Wilcolator Co., The

THICKNESS EQUIPMENT

American Instrument Co., Inc.
B. C. Ames Co.
***BAUSCH & LOMB OPTICAL CO.**
Branson Instruments, Inc.
Curtiss-Wright Corp., Research Div.
J. W. Dice Co.
Electronic Control Corp.
Electro-Tech Equipment Co.
Era Engrg. Inc.
Fleetwood Labs., Inc.
Gardner Laboratory, Inc.
General Electric Co., Apparatus Sales Div.
Magnaflux Corp.
Piasecki Aircraft Corp.
Taft-Peirce Mfg. Co., The
Weston Instruments, Div.-Daystrom, Inc.
Westranics Inc.

THRUST CHAMBERS

Aerojet-General Carp.
Aeralab Develapment Ca.
Aeranca Mfg. Carp.
Alca Praducts, Inc.
Astradyne, Inc.
CDC Cantral Services, Inc.
Diversey Engrg. Co.
Dynamic Devices, Inc.
Haveg Industries, Inc.
C. B. Kaupp & Sans, Inc.
M. W. Kellagg Ca., The
Newbraak Machine Corp.
Narris-Thermadar Carp.
Partland Capper & Tank Warks Inc.
Reaction Matars Div., Thiakal Chem. Carp.
Reinhold Engrg. & Plastics Co.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Rohr Aircraft Corp.
Ryan Aeronautical Co.
Smith-Morris Corp.
Space Corp.
Special Projects Lab., Food Machinery & Chemical Corp.
Stainless Steel Products, Inc.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
C. W. Torngren Co., Inc.
Western Gear Corp.

THRUST MEASURING INSTRUMENTS

Aero Research Instrument Co. Inc.
Aerojet-General Corp.
Aeroscience, Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
American Machine & Foundry Co., Government Products Group
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
W. C. Dillon & Co., Inc.
Dynametrics Corp.
G. M. Giannini & Co., Inc.
Hagan Chemicals & Controls, Inc.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Revere Corp. of America
Schoevitz Engrg.
Spoce Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Westronics Inc.

TIMERS

a. Automatic Cycle
b. Automatic Reset
c. Automatic Sequence
d. Clock Radio
e. Counting
f. Cycle
g. Electronic
h. Hour Counting
i. Impulse
j. Inertia
k. Interval
l. Motor Operated
m. Multicontact
n. Percentage
o. Sequence
p. Special
q. Thermal
r. Welding, Electronic

Advanced Products Co., The, a, b, c, f, h, k, l, m, a, p.
Aero Instrument Co., h, k.
Aerolab Development Co., f, g, i, k, o, p.
Air Logistics Corp., g, p.
Airpax Electronics Inc. Seminole Div., g, i.
Allegany Instrument Co., Inc., g, k, p.
Alto Scientific Co., Inc., a, b, c, g, o.
Amelco, Inc., g.
American Missile Products Co., Inc., p.
Atlas Precision Products, Co., l, p.
Baird-Atomic, Inc., g.
Beckman Instruments, Inc., Berkeley Div., e, f, g, k.
Beckman-Systems Div., b, e, g, k.
Belock Instrument Corp., a, b, c, g, j, k, l, o, p.
Bendix Aviation Corp., Friez Instrument Div., l.
Bendix-Pacific Div., Bendix Aviation Corp., a, b, c, l, m, o, p.
Bendix Urica Div., Bendix Aviation Corp., a, b, g, a.
Bernco Engrg. Corp., a, b, c, f, k, l, m, a, p.
Branson Corp., a, b, c, e, f, k, m, a, p, q.
Briggs Associates, Inc., g, p.
Bristol Co., The, a, b, c, f, i, k thru p.
Bulow Electric Co., a, b, c, l, p.
Centronix Inc., g.
Chicago Aerial Industries, Inc., a, b, c, f, g, i, k, l, a, p.
Cleveland Metal Specialties Co., Electronics Div., e, g.
Cole Electric Co., a, p.
Consolidated Avionics Corp., c.
Control Engrg. Co., Div.-Jervis B. Webb Co., g.
Controls Co. of America, a, c, f, i, k, l, a.
Cooper Development Corp., Sub.-Marquardt Aircraft Co., g, k, p.
Cramer Controls Corp., a thru d, f, h, i, k thru p.
Cutler-Hammer Inc., a, g, l.
DBM Research Corp., g.
Daystram Pacific Div.-Daystram, Inc., a, p.
Destron Co., a, b, c, g, k, m, a, p.
Detranic Industries, c, g, a, r.
Di-An Cantrols, Inc., a, b, c, e, f, g, k, a, p.
Henry G. Dietz Co., Inc., a, c, g, k, m, a, p.
Dimco-Gray Ca., k, l.
Divca-Wayne Electranics, Div.-Divco-Wayne Corp., g, p.
M. Ducommun Co., h, p.
Dynamic Controls Corp., g.
Dynamic Devices, Inc., c, a, p.
Edgertan, Germeshausen & Grier, Inc., c.
Eisler Engrg. Co., Inc., r.
Eldarado Electronics, g, p.
Electro Instruments, Inc., e, g, a.
Electro Precisian Carp., g.
Electranic Cantral Carp., a, g.
Electranic Engrg. Ca. af Califarnia, a, b, c, e, g, h, k, a, p.
Electranic Specialty Co., g, p.
Electro-Tech Equipment Co., a, b, c, e thru i, k, l, r a, p, r.
Elgin Micronics Div.-Elgin Natianal Watch Co., a, f, h thru l, p.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., a thru p.
Emerson Radio & Phonograph Corp., g.
Erie Instrumation, Div. Erie Resistor Corp., e, g, k.
Erie Resistor Corp., b, e, g, k.
Ewald Instruments, r.
FXR, Inc., c, g, a.
Farmer Electric Products Co., Inc., a, b, c, g, r.
Federal Tool Engrg. Co., r.
Fidelity Amplifier Co., f, a.
First Electronics Corp., The, g, h, r.
Flight Research, Inc., c, g, p.
G-V Controls Inc., b, g, q.
General Devices, Inc., g, i, m, a.
General Electric Co., Apparatus Sales Div., a, f, h, k, l.
Globe Industries, Inc., a, b, c, l.
Gordon Enterprises, a, b, c, e, f, g, i, k, l, a, p.
Grimes Mfg. Co., l.
Guardian Electric Mfg. Co., k, a.
Haller, Raymond & Brown Inc. Div., Singer Mfg. Co. g, p.
Hamilton Watch Co., d, i.
Hamilton Watch Co.-Industrial Div., d, e, f, h, p.
***A. W. HAYDON CO., THE,** a, b, c, e thru i, k, l, r o, p.
Haydon Div.-General Time Corp., a, b, c, e, f, h, k, a.
C. I. Hayes, Inc., p.
Holtzer-Cabot Div.-National Pneumatic Co., Inc., l,
I-L-S Instrument Div., The Meriam Instrument Co., o b, c, f, g, i, p.
ITT Labs., g.
Industrial Timer Corp., a, b, c, f, h, k thru q.
Ingraham Co., The, p.
Intercontinental Dynamics Corp., i.
International Register Co., a, b, d, l.
Janco Corp., i.
Jordan Electronics, Div.-Victoreen Instrument Co., c, g.
H. Koch & Sons, a, b, c, f, j, k, m, a, p.
Land-Air Inc., c, e, g, i, k, l, a, p.
La Roe Instruments, Inc., e, g.
Leach Corp., g, k, a, p.
Lear, Inc., Grand Rapids Div., l, m, a, p.
Librascope Inc., g.
Litton Engrg. Labs., r.
Livingston Electronic Corp., r.
Lux Clock Mfg. Co., Inc., k, l, a.
P. R. Mallory & Co. Inc., a, b, c, f, g, k, l, m, a, p.
Marion Instrument Div., h.
Jas. P. Marsh Corp., f.
Mast Development Co., Inc., p.
Minneapolis-Honeywell Regulator Co., Ordnance Div g, k, p.
Morse Instrument Co., The, g.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., a.
Navigation Computer Corp., c, e, k.
Ernest Norrman Laboratories, l.
Paul Nurches Co., l, m, a.
Orbitran Co., Inc., g.
Pacific Scientific Co., a, b, c.
Paragon Electric Co., a, b, c, f, k, l, a, p.
Ralph M. Parsons Co., The, Electronics Div., g, k,
Patterson, Moos Div. - Universal Winding Co., Inc., a, b, i, j, k, a.
Philco Corp., Government & Industrial Div., g, p.
Photobell Co., Inc., e, g.
Pomona Electronics Co., Inc., a.
Radiation Instrument Development Lab., Inc., g.
Raymond Engrg. Lab., Inc., a, b, c, e thru p.
Raytheon Mfg. Co., r.
Resdel Engrg. Corp., g.
M. H. Rhodes, Inc., p.
Royal Industries, Inc., a, b, c, e, f, g, i, j, k, m, a,
Rutherford Electronics Co., g.
Sangamo Electric Co., k, l.
Sequoia Wire & Cable Co.-Div.-Mandrel Industries, Inc., g, k, a.
Servomechanisms, Inc., g, j.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., c
Singer Mfg. Co., The, Military Products Div., a, b, f, h thru l, a, p.
Spectrol Electronics Corp., a, c, k, l, m, a, p.
Standard Electric Time Co., The, f thru j.
Systron Corp., a, b, c, e, g, h, i, k, n.
Taylor Winfield Corp., a, c, g, k, a, p, r.
Telechrome Mfg. Corp., a, b, c, e thru i, l, n, a, p.

Telectro Industries Corp., g, l.
Teletronics Lab. Inc., g.
Tempo Instrument Inc., o, b, c, f, g, k, m, o, p.
Textran Corp., g.
George Ulanet Co., o.
Unit Process Assemblies, Inc., o.
U. S. Science Corp.-Div. Topp Industries, Inc., g, k, l, o.
Vacuum Tube Products, Div.-Hughes Aircroft Co., r.
Vemaline Products Co., o, b, c, g, k.
Virginia Electronics Co., Inc., g.
Vitro Labs., g.
Wacline, Inc., h.
Wakmann Watch Co. Inc.
Walkirt Co., o, b, c, e, f, g, i, o, p.
Waltham Engrg. Corp., o thru r.
Waltham Precision Instrument Co., h.
Wong Labs., Inc., g.
Waugh Engrg. Co., g, o.
Webcor, Inc., Government Div., o, b, c, e, g, k, l, o, q.
Western Design, Div.-U.S. Industries, Inc.; Santa Barbara Div., o, b, c, i, k, o.
Western Gear Corp., o, b, c, l, o.
Weston Instruments, Div.-Daystrom, Inc., h.
Wilks Precision Instrument Co., Inc., l, m, o.
G. C. Wilson & Co., o, b, f, g, k, o, r.

'N ZINC PLATING
See PLATING, TIN ZINC

'NNING, HOT DIPPED

Amatom Electronic Hardware Co. Inc.
Kelsey-Hayes Co.
Penn-Michigan Mfg. Corp.
Somers Brass Co. Inc.
Steiner Engrg. Corp.

'PS, SOLDERING IRON
See SOLDERING IRON TIPS

'GGLE OR EXPANSION BOLTS
See BOLTS, TOGGLE OR EXPANSION

'OLS, ALIGNMENT

Aerolite Electronics Corp.
Amatom Electronic Hardware Co. Inc.
Ball Machine Products Co., The
Basic Tool Industries, Inc.
Capital City Mfg. Co.
Continental Technical Service, Inc.
Dockendorff & Co. Inc.
ENGIS EQUIPMENT CO.
General Cement Mfg. Co., Div.-Textron, Inc.
Hunter Tool Co.
Industrial Tectonics, Inc.
Kent-Moore Organization Inc.
Keystone Electronics Corp.
Penn Fibre & Specialty Co., Inc.
Snap-On-Tools Corp.
Squiers Gage Co.
Washington Technological Associates Inc.

'OLS, HAND OR MECHANICAL

Aircraft Tools, Inc.
Allen Tool Corp.
Apex Machine & Tool Co., The
Arraw Tool Co. Inc.
Basic Tool Industries, Inc.
Bendix Aviation Corp., Eclipse-Pioneer Div.
Billings & Spencer Co., The
Capewell Mfg. Co.
Continental Technical Service, Inc.
Dockendorff & Co. Inc.
Duro Specialty Co., Inc.
Eyelet Tool Co. Inc.
Forsberg Mfg. Co., The
General Cement Mfg. Co., Div.-Textron, Inc.
Hardman Tool & Engrg., Co.
Hunter Tool Co.
ITT-Kellogg
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Jo-Line Tools, Inc.
Kelsey-Hayes Co.
Kent-Moore Organization Inc.
L. Konigslow Stamping & Tool Co.
Lemert Engrg. Co., Inc.
Lico Instrument Co.
Paul Nurches Co.
Overload Control Co.
Owotonna Tool Co.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Penn Fibre & Specialty Co., Inc.
R. K. Porter Co., Inc.
Joseph T. Ryerson & Son, Inc.
Snap-On-Tools Corp.
Spec Tool Co.
Squiers Gage Co.
Stanley-Judd Div.-The Stanley Works
S. A. Sturtevant Co.
Superior Pneumatic & Mfg., Inc.
T. K. Sweeney Mfg. Co.
Taft-Peirce Mfg. Co., The
Torque Controls Inc.
TOWNSEND CO., CHERRY RIVET DIV.
Ulman Devices Corp.
U. S. Industries, Inc.
Vascoloy-Ramet Corp.
Vichek Tool Co., The
Waldes Kohinoor, Inc.
Washington Technological Associates Inc.
Wetzler Clamp Co. Inc.
J. H. Williams & Co.

TOOLS
- a. Pneumatic Assembly
- b. Resistance Soldering
- c. Thermal Soldering
- d. Ultrasonic Soldering
- e. Wire Tapping

Block & Decker Mfg. Co., The
Buckeye Tools Corp., a.
Chicago Pneumatic Tool Co., a.
Continental Technical Service, Inc., a.
Curtiss-Wright Corp., Princeton Div., c.
Federal Machine Co. Inc.
Forsberg Mfg. Co., The
Gardner-Denver Co., a.
Gulton Industries, Inc., d.
High Speed Hammer Co., Inc., The, a.
Ideal Industries, Inc., b.
Metal Carbides Corp.
M. M. Newman Corp., c.
PIC Design Corp., Sub.-Benrus Watch Co., Inc.
Pioneer Tool & Engrg. Co.
Printronics Corp., a.
Smith-Morris Corp.
Superior Pneumatic & Mfg., Inc., a.
United Supply Co.
Virginio Electronics Co., Inc., b.
Wossco Electric Products Corp., b.
Winkler Labs., e.
Wye Industries, d.
Zephyr Mfg. Co. Inc., b.

TOROIDAL COIL WINDING MACHINES
See COIL WINDING MACHINES, TOROIDAL

TOROIDS

Airpox Electronics Inc. Seminole Div.
Aloddin Electronics, Div.-Aladdin Industries Inc.
Alden Products Co.
American Research & Mfg. Corp.
Arnold Engrg. Co., The
Audio Development Co.
Bendix Aviation Corp., York Div.
Coilcraft Inc.
Collins Radio Co.
Control Circuits Inc.
Double E Products Co.
Dresser Industries, Inc.
ESC Corp.
Ferroxcube Corp. of America
Forbes & Wogner, Inc.
Geotronic Labs. Inc.
Goslin Electric & Mfg. Co.
Gulton Industries, Inc.
Hammarlund Mfg., Co., Inc.
Industrial Tectonics, Inc.
Industriol Winding Machinery Corp.
Jack & Heintz, Inc.
Litton Industries, Inc.
Magnetic Core Corp.
Mico Instrument Co.
Motorola Inc., Military Electronics Div.
NYT Electronics, Inc.
National Pneumotic Co., Inc., Holtzer-Cabot Div.
Newbrook Machine Corp.
North Hills Electric Co., Inc.
Ortho Filter Corp.
PCA Electronics Inc.
Pacific Magnetic Corp.
Palo Alto Engrg. Co.
Portland Copper & Tank Works Inc.
Precision, Inc.
Qutronic Transformer Corp.
Railway Communications Inc.
Redman Electronics Corp.
Reflectone Corp., The
Rixon Electronics Inc.
Rohr Aircraft Corp.
Milton Ross Metals Co., The
Rytron Co., Inc.
Sangamo Electric Co.
Technicol Apparatus Builders
Topper Mfg. Co., Inc.
Transonic, Inc.
Triad Transformer Corp.
Universal Toroid Coil Winding, Inc.
Varo Mfg. Co., Inc.
Westbury Electronics Inc.
Westinghouse Electric Corp.
Zallea Brothers

TOWER LIGHTING EQUIPMENT
See LIGHTING EQUIPMENT, TOWER

TRACERS, SIGNAL

Philco Corp., Government & Industrial Div.

TRAILERS, VANS, SHELTERS
See SHELTERS, TRAILERS, VANS

TRANSCEIVERS, PORTABLE

Allied International Co.
Amelco, Inc.
American Missile Products Co., Inc.
Rex Bassett, Inc.
Bendix Aviation Corp., York Div.
Bendix Radio Div., Bendix Aviation Corp.
Centronix Inc.
Collins Radio Co.
Doven Co., The
Electronic Communications, Inc.
Hoffman Labs. Div., Hoffman Electronics Corp.
ITT Labs.
Lear, Inc.
L E L, Inc.
Litton Industries, Maryland Div.
Motorolo Inc., Military Electronics Div.
National Pneumatic Co., Inc., Holtzer-Cabot Div.
Philco Corp., Government & Industriol Div.
Projects Unlimited Inc.
Telectro Industries Corp.

TRANSCEIVERS, UHF

Allied International Co.
Amelco, Inc.
American Electronics, Incorporoted
American Electronics, Inc.-Instrument Div.
American Missile Products Co., Inc.
Bendix Aviation Corp., York Div.
Bendix Radio Div., Bendix Aviotion Corp.
Centronix Inc.
Chrysler Corp., Defense Operations Div.
Collins Radio Co.
Dolmotor Div., Yuba Consolidated Industries, Inc.
Daven Co., The
Divco-Wayne Electronics, Div.-Divco-Wayne Corp.
Electronic Communications, Inc.
Gilfillan Bros. Inc.
Hoffmon Labs. Div., Hoffmon Electronics Corp.
ITT Federal Div., Internationol Telephone & Telegraph Corp.
ITT Labs.
Instruments For Industry, Inc.
Lear, Inc.
L E L, Inc.
Litton Industries, Maryland Div.
Magnavox Co., The
Motorolo Inc., Military Electronics Div.
Munston Mfg. & Service, Inc.
Philco Corp., Government & Industrial Div.
Stavid Engrg., Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
Telectro Industries Corp.
Webcor, Inc., Government Div.

TRANSCEIVERS, VHF

Allied Internotional Co.
Amelco, Inc.
American Electronics, Inc.
American Electronics, Incorporated
Bendix Aviotion Corp., York Div.
Bendix Radio Div., Bendix Aviation Corp.
Centronix Inc.
Collins Radio Co.
Dalmotor Div., Yuba Consolidated Industries, Inc.
Daven Co., The
Divco-Wayne Electronics, Div.-Divco-Wayne Corp.
Electronic Communications, Inc.
Hoffman Labs. Div., Hoffman Electronics Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
ITT Labs.
Instruments For Industry, Inc.
Land-Air Inc.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
L E L, Inc.
Litton Industries, Maryland Div.
Livingston Electronic Corp.
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Stavid Engrg., Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
Telectro Industries Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Webcor, Inc., Government Div.

TRANSDUCERS
- a. Accelerometer
- b. Flow
- c. Industrial
- d. Measurement
- e. Pressure
- f. Sonar
- g. Strain
- h. Temperature
- i. Vibration

Aero Research Instrument Co. Inc., b, e, h.
Aeroscience, Inc.
*AIRESEARCH MFG. CO. OF ARIZ., e.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, e, h.
Airpax Electronics Inc. Seminole Div.
Allegany Instrument Co., Inc., e, g, h.
Allied Research & Engrg., Div.-Allied Record Mfg. Co.
American Machine & Foundry Co., Government Products Group, o, f, i.
American Measurement & Controls, Inc., b.
*ARNOUX CORP., h.
Atlantic Instrument Corp., Sub.-American Electronics, Inc., h.
Atlantic Research Corp., d, e, f.
B & F Instruments, Inc., a.
BJ Electronics, Borg-Warner Corp., a thru e, g, h, i.
B & K Instruments, Inc., a.
Beaver Precision Products Inc., b, e.
Beckman & Whitley, Inc., Missile Products Div., h.
Bell Aircraft Corp., Niagara Frontier Div., a.
Belock Instrument Corp., a, e, g.
Bendix Aviation Corp., Friez Instrument Div., e.
Bendix Aviation Corp., Montrose Div., e.

A. Biederman, Inc., d, e, h.
Blackstone Corp., c.
Bogue Electric Mfg. Co., d.
Baurns Labs., Inc., a, e.
Branson Instruments, Inc., d.
Bristal Co., The, b thru e, g, h.
Brush Instruments, Div.-Clevite Corp., a thru i.
Cadillac Gage Co., a.
Cardinal Instrumentatian Corp., c, d, h.
Cedar Engrg. Div.-Control Data Corp., a.
Chesapeake Instrument Corp., a, f, i.
Chrysler Corp., Defense Operations Div.
Clark Electronic Labs., a, e, g.
G. L. Callins Carp., d, e, i.
Colarado Research Corp.
Colvin Labs., Inc., c, e.
Computer Instruments Corp., e.
Consolidated Diesel Electric Carp., d, e, h.
Consolidated Electrodynamics Carp., a, d, e, g, i.
Cantral Circuits Inc., h.
Contral Data Corp., a.
Crescent Engrg. & Research Co., b thru e, g, h, i.
Curtiss-Wright Corp., Electronics Div., e, g.
Curtiss-Wright Electronics Div., IMI Branch, e.
Dalmotar Div., Yuba Consolidated Industries, Inc., e.
Datran Electronics, Div.-Mid-Continent Mfg., Inc., e.
Daystrom Pacific Div.-Daystrom, Inc., a, d, e.
Daytronic Corp., c, d, e, g.
Decker Corp., The, d.
Delco-Remy Div., General Motors Corp., a, e.
W. C. Dillon & Co., Inc., g.
Donner Scientific Co., a, e.
Dresser Industries, Inc., b, d, e, h.
Dynamic Instrument Co., Inc., b, e.
Edcliff Instruments, a, d, e.
Edgerton, Germeshausen & Grier, Inc., d.
Electro Products Laboratories, Inc., c, d, i.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., a, d, f, g, h.
Endevco Corp., a, e, i.
Era Engrg. Inc., a.
Erie Resistor Corp.
Fairchild Controls Corp., Components Div., a, e.
Fenwal Inc., h.
Fischer & Porter Co., b, c, e, h.
Fisher Governor Co., c, e.
General Crystal Co., Inc., c, d.
General Electric Co., Apparatus Sales Div., b, h:
Genisco, Inc., a.
Genisco, Inc., Instrument Div., a.
Geotronic Labs. Inc.
G. M. Giannini & Co., Inc., a, e, h.
Good Electronic Corp., g, h.
Gulton Industries, Inc., a, d, f, h, i.
Hagan Chemicals & Controls, Inc.
Hesco Engrg., h.
Hewlett-Packard Co., c.
I-L-S Instrument Div., The Meriam Instrument Co., c.
International Research & Development Corp., i.
International Resistance Co., c, d, e.
***KEARFOTT CO., INC.**, a, h.
Kin Tel Div.-Cohu Electronics, Inc., a, e, f, i.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., a, e.
Land-Air Inc., b, i.
Lear, Inc., a.
Lear, Inc., Grand Rapids Div., a, e.
Leeds & Northrup Co., h.
***WALLACE O. LEONARD, INC.**, a, b, d, e.
***LEWIS ENGRG. CO., THE**, h.
Librascope Inc., b.
Ling Electronics, Inc., i.
Litton Industries, Maryland Div., a thru i.
MB Mfg. Co., i.
Maico Electronics, Inc., f.
Massa Div.-Cohu Electronics, Inc., a, d, f.
Micrometrical Mfg. Co., i.
Minatron Corp., d.
Minco Products, Inc., h.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., a, e.
Minneapolis-Honeywell Regulator Co., Boston Div., a, i.
Minneapolis-Honeywell Regulator Co., Industrial Div., b, c, e, h.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, b thru e, g, h.
Minneapolis-Honeywell Regulator Co., Ordnance Div., a, f.
Motorola Inc., Military Electronics Div., f.
NRC Equipment Corp., e.
Narda Ultrasonics Corp., The, f, i.
National Beryllia Corp., h.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., f.
Norwood Controls Unit, Detroit Controls Div., b, e, g.
Pace Engrg. Co., a, b, e.
Pacific Radionics, b, c, d, f, i.
Pacific Scientific Co., a, c, h, i.
Photocon Research Products, e.
Pickering & Co., Inc., d.
Potter Aeronautical Corp., b.
Power-Tronic Systems Inc., a thru e.
Projects Unlimited Inc., e.
Radiation, Inc.
Rahm Instruments, Div.-American Machine & Metals, Inc., a, b, c, e.
Revere Corp. of America, b, e, g, h.
Rosemount Engrg. Co., e, h.
Arthur C. Ruge Associates, Inc., h.
Sanborn Co., e.
Sangamo Electric Co., f.
Schaevitz Engrg., a, d, e.
Servomechanisms, Inc., a, e, h.
Singer Mfg. Co., The, Military Products Div., e, f.
Space Corp., I.
Specialties, Inc., e.
Standard Controls, Inc., b, e.
Statham Instruments, Inc., a thru e, g.
Stromberg-Carlson Div.-General Dynamics Carp., f.
Technalagy Instrument Carp., a, d, e, i.
Therma Electric Co., Inc., h.
Thiokal Chemical Corp., e, f, g.
Trans-Sanics, Inc., b, d, e, g, h.
Trionics Corp., a, h.
Ultradyne, Inc., a, e.
United Control Corp., e, h.
U. S. Science Carp., Div.-Topp Industries, Inc., a, e, h.
Valpey Crystal Corp.
Victor R. F. & Microwave Ca., d.
Vinson Mfg. Co. Inc., b thru e.
Wallace & Tiernan Inc., e.
Waugh Engrg. Ca., b.

TRANSFER EQUIPMENT

American Machine & Foundry Co., Government Products Group
Bowser, Inc., Defense Dept.
Cambridge Co., Div.-Carrier Corp.
Continental Technical Service, Inc.
***JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.**
Kenhos Corp., Div.
Linde Co., Div.-Union Carbide Corp.
Merz Engrg., Inc.
Project Fabrication Corp.
Edw. Renneburg & Sons Co.
Resistoflex Corp.
Special Projects Lab., Food Machinery & Chemical Corp.
Stearns-Roger Mfg. Co.
Washington Technological Associates Inc.

TRANSFORMER LAMINATIONS
See LAMINATIONS, TRANSFORMER

TRANSFORMER WINDING BOBBINS
See BOBBINS, TRANSFORMER WINDING

TRANSFORMER WINDINGS

Advanced Electronics, Inc.
Atlas Coil Inc.
Central Transformer Co.
Dietz Design & Mfg. Co.
Dinion Coil Co., Inc.
Dresser Industries, Inc.
Eisler Engrg. Co., Inc.
Ferrotran Electronics Co., Inc.
Forest Electric Co., The
Fugle-Miller Labs. Inc.
Good-All Electric Mfg. Co.
Goslin Electric & Mfg. Co.
Green Rectifier Co.
Industrial Transformer Corp.
Integrated Mica Corp.
Langevin Div., The W. L. Maxsan Corp.
Microtran Co. Inc.
Minitran Corp.
NYT Electronics, Inc.
National Coil Co.
Networks Electronic Corp.
New York Coil Co.
Palo Alto Engrg. Co.
Perry Plastics, Inc.
Qutronic Transformer Corp.
Rollan Electric Co.
Rytron Co., Inc.
Signal Transformer Co.
Topper Mfg. Co., Inc.
Transformer Design, Inc. of Milwaukee
Transonic, Inc.
Universal Toroid Coil Winding, Inc.
Westbury Electronics Inc.
Westinghouse Electric Corp.

TRANSFORMERS

a. Audio
b. Fly Back
c. Foil Waund
d. General
e. High Valtage Pawer Supply
f. Instrument
g. Intermediate Frequency
h. Miniature
i. Output
j. Pawer
k. Precisian Valtage Dividing
l. Pulse
m. RF & IF
n. Ultrasonic

ACF Industries Inc., a, h, i.
AMP Inc., I.
A.P.W. Co., h.
Ace Coil & Electronics Co., I, m.
Acme Electric Corp., d, h, i, j, l.
Acromag Inc., f, k.
Aerolab Development Co., h, j.
Airpax Electronics Inc., Seminole Div., a, e, i, j, l.
Aladdin Electronics, Div.-Aladdin Industries Inc., a, d, g, h, l, m.
All-Tronics, Inc., m.
Amelco, Inc., a, d, g thru j, m, n.
American Machine & Foundry Co., Greenwich, c.
Amplifier Corp. of America, a, h, i, j.
R. B. Annis Co., f.
Associated Research, Inc., f.
Atlas Coil Inc., c thru n.
Atlas Engrg. Co. Inc., a thru x, m.
Audio Develapment Co., a, c thru f, h thru I, n.
Ballastran Corp., a, d, g thru I, n.
Barker & Williamson Inc., g, m.
Barwaod Electronics Inc., a, d, h, i, j.
Bell Aircraft Corp., Niagara Frantier Div., h, I.
Bendix Aviatian Carp., York Div., e, h, j, I.
Bogue Electric Mfg. Co., e, j.
Brawn Engrg. Co., Inc., f, h, i, j, m.
Cable Electric Products Inc., d, i.
Carol Electronics Carp., a, j, m.
Carruthers & Fernandez, Inc., d, h, i, j.
Celco, (Constantine Engrg. Labs. Co.), a thru n.
Central Transfarmer Ca., a, c thru f, h, i, j, n.
Chicago Electronic Engrg. Ca., Inc., a, d, i, j, k.
Chicago Standard Transformer Corp., a, b, d, e, h, i, j, l.
Clippard Instrument Lab., Inc., b, m.
Coil Co. of America, a, c, d, e, i thru I, n.
Coilcraft Inc., g, h, m.
G. L. Callins Carp., k.
Control Circuits Inc., e, n.
Cycle Transformer Corp., a, d, e, f, h thru I, n.
Davenport Mfg. Co., e, k.
Dayton Aviation Radio & Equipment Corp., g, m.
Del Electronics Corp., e, h, i, j.
Dietz Design & Mfg. Co., a, d, e, f thru n.
Dinion Coil Co., Inc., a, e, f, h, i, j, l.
Double E Products Co., m.
Dresser Industries, Inc., a, b, d, e, h thru l, n.
ESC Corp., h, l.
Eagle Electric Mfg. Co. Inc., d.
Eisler Engrg. Co., Inc., e, i, j.
Elcor, Inc., f, h, j.
Electrical Windings, Inc., a, d, f, g, i, j.
Electro Development Corp.
Electro Engrg. Works, a, d, e, f, i, j, k.
Electronic Coils, Inc., k.
Electronic Research Associates, Inc., a, e, h, i, j.
Electronic Transformer Co., Inc., a, h, i, j, l, n.
Electro-Tech Equipment Co., f, j.
Electro-Winders Co. Inc., g, h, l, m.
Era Electric Corp., a, c, d, e, h thru l.
Erie Resistor Corp., h, l.
Ferranti Electric Inc., a, d, e, h thru k, n.
Ferrotran Electronics Co., Inc., a, g thru j.
Ferroxcube Corp. of America, b, h, l, m.
Filtron Co., Inc., l.
Forbes & Wagner, Inc., b, g, l, m.
Forest Electric Co., The, a, d, e, i, j.
Foster Transformer Co., a, d, e, h, i, j, l.
Freed Transformer Co. Inc., a, c thru f, h thru l, n.
Fugle-Miller Labs. Inc., e, g, m.
General Coil Products Corp., a, d, g, h, i, m.
General Electric Co., Apparatus Sales Div., d, e, f, j, l.
Geotronic Labs. Inc., a, c, d, f thru j.
Good-All Electric Mfg. Co., c, e, i, j.
Goslin Electric & Mfg. Co., a, c thru n.
Green Rectifier Co., c, d, j.
Gudeman Co. of California, Inc., The, Monrovia Div., h, l.
Hevi-Duty Electric Co., d, e, f, i, j, l.
Hindle Transformer Co. Inc., c thru f, i, j.
A. F. Holden Co., The, d.
Industrial Transformer Corp., a, c thru l.
Jensen Mfg. Co., a.
Johnson Electronics Inc., h, m.
Keystone Products Co., a, d, e, f, h thru l, n.
Knopp Inc., d, e, f, i.
Land-Air Inc., d, e, j.
Landis & Gyr Inc., f.
Langevin Div., The W. L. Maxson Corp., a, c thru f, h thru l, n.
Levinthal Electronic Products, Inc., l.
Litton Industries, Inc., b, d, h, j.
Magnetico, Inc., h, k.
Merit Coil & Transformer Corp., a, b, d, f thru j, m.
Microtran Co. Inc., a, d, e, f, h thru l, n.
J. W. Miller Co., e, g, h, l.
Sanford Miller Co., i, j.
Minitran Corp., a, d, f, h thru l.
Minneapolis-Honeywell Regulator Co., Boston Div., I
Mucon Corp., e, j.
NYT Electronics, Inc., d thru m.
National Coil Co., a, d, f thru i, k, m, n.
National Pneumatic Co., Inc., Holtzer-Cabot Div., a, b, e, j, m.
Networks Electronic Corp.
New England Scientific Instruments Co., i, j.
New England Transformer Co., Inc., a, c, d, e, h, i, j, l
New York Coil Co., a, c thru f, h thru n.
New York Transformer Co. Inc., a, c thru f, h thru l, n
North Hills Electric Co., Inc., g, l, m, n.
Ortho Filter Corp., a, f, i thru l.
Osborne Electronic Sales Corp., a thru n.
Oxford Components, Inc., a, d, e, f, h thru k.
PCA Electronics Inc., I.
Pacific Magnetic Corp., a, d, e, f, h thru l.
***PACKARD-BELL ELECTRONICS CORP.**, l.
Palo Alto Engrg. Co., a, d, f, h thru l.
Pearson Electronics, Inc., l.
Penn-Tran Corp., b, m.
Perkin Engrg. Corp., c, d, e, j.
Perry Plastics, Inc., a, h, i.
Peschel Electronics, Inc., e.
Portchester Instrument Corp.
Qutronic Transformer Corp., a, c, d, f thru l.
RS Electronics Corp., g, l, m.
Radio Industries, Inc., g, h, m.

uglas Rondall Inc., d, h, i, j.
ytheon Mfg. Co., a, e, l.
dman Electronics Corp., g, l, m, n.
xon Electronics Inc., l.
llon Electric Co., a, i, m.
lton Ross Metals Co., The, h, l.
rtron Co., Inc., g thru m.
ngomo Electric Co., a, e, f, h, j, k, l, n.
ermon Industrial Electronics, Div.-Engrg. Design Inc., e.
gnal Transformer Co., a, c, d, e, h thru l, n.
rensen & Co., Inc., e.
ecialties, Inc., f thru i, k, l, m.
anwyck Winding Co., Inc., g, m.
avid Engrg., Inc., a, e, i, j.
erling Transformer Corp., a, d, e, h, i, j, n.
romberg-Carlson Div.-General Dynamics Corp., a, h, l.
perex Electronics Corp., g, h, m.
chnical Apparatus Builders, c, d, e, j.
chnitrol Engrg. Co., l.
lectro Industries Corp., a, e.
pper Mfg. Co., Inc., n.
rwico Electronics, Inc., a, d, f, h, i, k.
ansformer Design, Inc. of Milwaukee, a thru l.
onsformer Specialty Co., a, c thru f, i, j.
ansonic, Inc., a, d, e, f, h thru l, n.
esco, Inc., a thru e, g, h, i, k.
iod Transformer Corp., a, b, d thru l, n.
niversal Toroid Coil Winding, Inc., f, l.
niversity Loudspeakers, Inc., a.
anguard Electronics Co., g, m.
aro Mfg. Co., Inc., a, d, e, g thru l.
rginio Electronics Co., Inc., a, d thru g, m.
arren Transformer Co., Inc., a, c thru n.
estbury Electronics Inc., a, c, d, e, i, j, l.
estinghouse Electric Corp.
eston Instruments, Div.-Daystrom, Inc., f, k.
heeler Electronic Corp., Sub.-Sperry Rand Corp., a, d thru m.
ye Industries, n.
enith Rodio Corp., a, g, j, m.

TRANSISTORS
- a. Germanium
- b. Germanium, Power
- c. Junction
- d. Photo
- e. Point-Contact
- f. Power
- g. Selenium
- h. Silicon
- i. Silicon, Power
- j. Surface Barrier
- k. Switching
- l. Tetrode

ACK RADIO SUPPLY CO., a thru l.
ndix Aviation Corp., Red Bank Div., a, b, c, e, g, h, i, k.
endix Aviation Corp.-Semiconductor Products, Red Bank Div., a, b, k.
ague Electric Mfg., Co., h, i.
BS-Hytron, Div. Columbia Broadcasting System, Inc., a, b, c, f, k.
alvert Electronics Inc., a thru l.
levite Transistor Products, Div.-Clevite Corp., a, b, c, f, k.
elco Radio Div.-General Motors Corp., b.
enalex Div.-British Industries Corp., a, b, e, f, h, i, k.
eneral Transistor Corp., a, c, d, h, k.
offman Electronics Corp., Semiconductor Div., f, h.
oover Electric Co.
ughes Aircraft Co., a, h.
dustro Transistor Corp., a, c, k.
nneapolis-Honeywell Regulator Co., Ordnance Div., a, b, f, l.
otorola Inc., Military Electronics Div., a, b, c, e, f, h, i, k, l.
acific Semiconductors, Inc., h, i, k.
hilco Corp., Government & Industrial Div., a, b, c, e thru l.
hilco Corp., Lansdale Tube Co. Div., a, b, c, h, i, k.
rtchester Instrument Corp.
aytheon Mfg. Co., a, c, h, i.
ilicon Transistor Corp., h, i.
perry Semiconductor Div., Sperry Rand Corp., h, k.
ylvania Electric Products Inc., Semiconductor Div., a, b, e, f, h.
echnical Apparatus Builders, b, c, f, g, h, k.
ransitron Electronic Corp., a, h, i, k.
rans-Sil Corp., i.
nited States Dynamics Corp., h, i.
arren Components, Div.-El-Tronics, Inc., b.
estinghouse Electric Corp., a, b.
enith Radio Corp., k.

TRANSMISSION LINE, WIRE & CABLE
luminum Co. of America
merican Super-Temperature Wires, Inc.
arker Sales Co.
irnbach Radio Co., Inc.
illiam Brand & Co., Inc.
hose Brass & Copper Co., Inc.
hemplast, Inc.
opperweld Steel Co., Wire & Cable Div.
ornish Wire Co. Inc.
ntron, Inc.
ssex Wire Corp.
T-Kellogg
recision Tube Co., Inc.
Sequoia Wire & Cable Co., Div.-Mandrel Industries, Inc.
Western Internationol Co.
Westwood Cable Corp.
Wind Turbine Co.

TRANSMISSION LINES, MICROWAVE
Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
American Super-Temperature Wires, Inc.
Borker Sales Co.
Bendix Aviation Corp., York Div.
Bogort Mfg. Corp.
Budd Stanley Co. Inc.
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
FXR, Inc.
ITT Federal Div., Internationol Telephone & Telegraph Corp.
ITT Labs.
J-V-M Microwove Co.
Lieco, Inc.
Litton Industries, Inc.
Meridion Metalcroft, Inc.
Monogram Precision Industries
N.R.K. Mfg. & Engrg. Co.
Philco Corp., Government & Industrial Div.
Precision Tube Co., Inc.
Tamor Electronics, Inc.
Technical Appliance Corp.
Telerad Mfg. Corp.
Victor R. F. & Microwove Co.
Western Internotional Co.

TRANSMISSION MONITORING EQUIPMENT
See MONITORING EQUIPMENT, TRANSMISSION

TRANSMITTER BLOWERS
See BLOWERS, TRANSMITTER

TRANSMITTER TUNING DEVICES, MECHANICAL
See TUNING DEVICES, TRANSMITTER MECHANICAL

TRANSMITTERS
Aerojet-General Corp.
Amelco, Inc.
Applied Science Corp. of Princeton
Babcock Radio Engrg., Inc.
Rex Bassett, Inc.
Bendix Radio Div., Bendix Aviation Corp.
Bristol Co., The
Budelman Electronics Corp.
Centronix Inc.
Collins Rodio Co.
Communications Co.
Communications Research Co.
Continental Electronics Mfg. Co.
Cooper Development Corp., Sub.-Marquardt Aircraft Co.
Crosby Laboratories, Inc.
Daven Co., The
Dorsett Labs., Inc.
DuKane Corp.
Electro-Mechanical Research, Inc.
Electronic Communications, Inc.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div.
Emerson Radio & Phonograph Corp.
General Devices, Inc.
Gilfillan Bros. Inc.
Goslin Electric & Mfg. Co.
Hammarlund Mfg. Co. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Hoffman Labs. Div., Hoffman Electronics Corp.
ITT Federol Div., International Telephone & Telegraph Corp.
ITT Labs.
E. F. Johnson Co.
Kaar Engrg. Corp.
Kaiser Aircroft & Electronics, Div.-Kaiser Industries Corp.
Land-Air Inc.
Leaming Engrg., Inc.
Lear, Inc.
Levinthal Electronic Products, Inc.
Ling Electronics, Inc.
Litton Industries, Maryland Div.
W. L. Maxson Corp., The
Motorola Inc., Military Electronics Div.
Ralph M. Parsons Co., The, Electronics Div.
Philco Corp., Government & Industrial Div.
Radiaphone Co. Inc.
Raytheon Mfg. Co., Government Equipment Div.
Seeburg Corp., The
Stromberg-Carlson Div.-General Dynamics Corp.
Telerad Mfg. Corp.
Television Utilities Corp.
Thiokol Chemical Corp.
Virginia Electronics Co., Inc.
Zenith Radio Corp.

TRANSMITTERS, PORTABLE & MOBILE RADIOTELEPHONE
Automatic Electric Sales Corp.
Barker Soles Co.
Rex Bassett, Inc.
Bendix Radio Div., Bendix Aviation Corp.
Centronix Inc.
Collins Radio Co.
Communications Co.
Communicatjons Research Co.
Daven Co., The
Emerson Rodio & Phonograph Corp.
Goslin Electric & Mfg. Co.
Hammorlund Mfg. Co. Inc.
Hoffman Labs. Div., Hoffman Electronics Corp.
ITT Lobs.
E. F. Johnson Co.
Kaar Engrg. Corp.
Leor, Inc.
L E L, Inc.
Litton Industries, Maryland Div.
Livingston Electronic Corp.
Motorola Inc., Military Electronics Div.
Munston Mfg. & Service, Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Div.
Philco Corp., Government & Industrial Div.
Rodio Specialty Mfg., Co.
Rowe Industries
Stromberg-Carlson Div.-General Dynamics Corp.
Telectro Industries Corp.
Thiokol Chemical Corp.
Virginia Electronics Co., Inc.

TRANSPONDERS
American Missile Products Co., Inc.
Bristol Co., The
Centronix Inc.
Collins Radio Co.
Communications Reseorch Co.
Cooper Development Corp., Sub.-Morquardt Aircraft Co.
Cubic Corp.
Curtiss-Wright Corp., Santa Borbaro Div.
Daven Co., The
Dorsett Lobs., Inc.
Electronic Communications, Inc.
Emerson Radio & Phonograph Corp.
Gilfillan Bros. Inc.
Hollomore Electronics Co.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federol Div., Internationol Telephone & Telegraph Corp.
ITT Labs.
Land-Air Inc.
Lear, Inc.
Litton Industries, Maryland Div.
W. L. Moxson Corp., The
Minneapolis-Honeywell Regulator Co., Ordnance Div.
Motorola Inc., Military Electronics Div.
Rolph M. Parsons Co., The, Electronics Div.
Space Corp.
Telectro Industries Corp.
Telerad Mfg. Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Varian Associates

TRANSPORT UNITS
Aerodex, Inc.
Aerolab Development Co.
Alwac Corp.
Cambridge Co., Div.-Carrier Corp.
Consolidoted Diesel Electric Corp.
Crane Carrier Corp.
Donner Scientific Co.
Dresser Industries, Inc.
Eidal Mfg. Co., Inc.
FWD Corp.
Lyncoach & Truck Co. Inc.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV.**
Ordnance Div.-Food Machinery & Chemicol Corp.
Shepard Laboratories, Inc.
Trailmobile Inc.
United Mfg. Co., The
U.S.A.C. Transport, Inc.

TRAPS, WAVE
See WAVE TRAPS

TRIM TABS
Adept Industries Inc.
Intercontinental Mfg. Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Longren Aircraft Co., Inc.
Monrovio Aviation Corp.
Sonta Anita Engrg. Co.
Tolley Corp., The

TRIPODS
Acco Equipment Div., American Chain & Cable Co., Inc.
Burke & James Inc.
Colson Corp., The
Davidson Mfg., Co., Inc.
Gordon Enterprises
Houston Fearless Corp.
Mitchell Camera Corp.
Peerless Products Industries
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Traid Corp.
Wind Turbine Co.

TUBE
- a. Cooling Units
- b. Pin Straighteners
- c. Pullers
- d. Seal Leads
- e. Shields
- f. Sockets

Aerovox Corp., f.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a.**
Alden Products Co., f.
Aluminum Co. of America, a.
Amphenal Connector Div., Amphenal-Borg Electronics Corp., f.
Art Wire & Stamping Co., d, e.
Associated Engrg. & Mfg. Corp., d.
Atlas E-E Corp., e.
Augat Brothers, Inc., a, e.
W. A. Beauchaine & Sons Inc., b, c.
Birtcher Corp., The, e.
Continental Electronics Mfg. Co., a.
Dean Products, Inc., a, e.
Doyle & Rath Mfg. Co., Inc., a.
Eastern Industries Inc., a.
Eitel-McCullough, Inc., f.
Elco Corp., f.
Electronic Parts Mfg. Co., Inc., d.
General Electric Co., Lamp Metals & Components Dept., d.
Griscom-Russell Co., The, a.
International Electronic Research Corp., a, e.
Jettron Products, Inc., f.
C. B. Kaupp & Sons, Inc., e.
Kling Metal Spinning & Stamping Co., e.
Livingston Electronic Corp., e, f.
Metal Textile Corp., Electronics Div., a, d, e, f.
Methode Mfg. Corp., e, f.
Monagram Precision Industries, a.
Mueller Brass Co., a.
Northrop Corp., The, Nortronics Div., a.
Paul Nurches Co., f.
Omega Electronic Corp., e, f.
Parts Engrg. Co., Inc., a.
C. F. Raark Welding & Engrg. Co., Inc., a.
Milton Ross Metals Co., The, b, f.
Slip Ring Co. of America, f.
Specialty Engrg. & Electronics Co.
Star Expansion, b.
Stover Co., Inc., The, e.
Sylvania Electric Products Inc., Parts Div., f.
United Aircraft Products, Inc., a.
Vilter Mfg. Co., The, a.
Waldom Electronics Inc., e, f.
Westinghouse Electric Corp., Lamp Div., d.
Westline Products Div.-Western Lithograph Co., e.
Winchester Electronics, Inc., f.
Zippertubing Co., The, e.

TRIMMERS, POTENTIOMETER
See POTENTIOMETER TRIMMERS

TUBE ASSEMBLIES, IGNITION
See IGNITION TUBE ASSEMBLIES

TUBE CAPS
See CAPS, TUBE

TUBE CHEMICALS
See CHEMICALS, TUBE

TUBE PARTS

Art Wire & Stamping Co.
Associated Engrg. & Mfg. Corp.
Astronautics Engrg. Co.
B. H. Aircraft Co., Inc.
Ball Machine Products Co., The
***BEATON & CORBIN MFG. CO., THE**
Corning Glass Works
Diamanite Products Mfg. Co.
Electronic Parts Mfg. Co., Inc.
GAR Mfg. Corp.
Lancaster Glass Corp.
Mercury Tool & Mfg. Corp.
Metal Textile Corp., Electronics Div.
Mueller Brass Co.
National Beryllia Corp.
New Process Metals, Inc.
Parts Engrg. Co., Inc.
Precision Sheet Metal, Inc.
Milton Ross Metals Co., The
Shaw Metal Products Corp.
Smith-Marris Corp.
Stover Co., Inc., The
Superior Electronics Corp.
Sylvania Electric Products Inc., Parts Div.
Thomas Electronics, Inc.
Universal Unlimited, Inc.
Veet Industries
Westinghouse Electric Corp., Lamp Div.
Woolf Aircraft Products, Inc.

TUBE SLEEVES
See SLEEVES, TUBE

TUBE STAMPED PARTS
See STAMPED PARTS, TUBE

TUBE SUPPORTS
See SUPPORTS, TUBE

TUBES

- **a. ATR**
- **b. Backward Wave**
- **c. Ballast**
- **d. Battery Charger**
- **e. Balameter**
- **f. Cathode, Multiple Gun**
- **g. Cathode Ray**
- **h. Cathode Ray, Instrument Use**
- **i. Ceramic**
- **j. Computer, Storage**
- **k. Counter Beam**
- **l. Electrometer**
- **m. Electron Multiplier**
- **n. Gamma Ray, Nuclear**
- **o. Geiger Counter, Nuclear**
- **p. Geiger Mueller**
- **q. Glaw ar Discharge**
- **r. Ignitron**
- **s. Infra-Red**
- **t. Ionization**
- **u. Klystron**
- **v. Magnetron**
- **w. Miniature**
- **x. Noise Saurce**
- **y. Photatubes**
- **z. Photatubes, Multiplier**
- **a1. Pirani**
- **b1. Pawer Amplifier**
- **c1. Projectian**
- **d1. Receiving**
- **e1. Rectifying**
- **f1. Rectifying, Gas-Filled Type**
- **g1. Rectifying, Transmitting**
- **h1. Rectifying, Vacuum Type**
- **i1. Scintillatian**
- **j1. Scintillatian, Nuclear**
- **k1. Sparkgap**
- **l1. Strabe**
- **m1. Subminiature**
- **n1. Switching**
- **o1. Thyratran**
- **p1. TR**
- **q1. Transducer**
- **r1. Transmitting**
- **s1. Transmitting-Receiving**
- **t1. Traveling Wave**
- **u1. Ultra-Violet**
- **v1. Vacuum**
- **w1. Valtage Reference or Regulating**
- **x1. X-Ray**

American Brass Co., The, x-1.
American Elite, Inc., g, u, v, w, b-1, d-1 thru h-1, m-1, o-1, r-1, s-1, t-1, v-1, w-1.
Amglo Corp., q, l-1, u-1.
Anton Electronic Labs., Inc., n thru q, t, w-1.
Applied Radiatian Corp., u.
Barker Sales Co., h, l, w.
Barry Electronics Corp., a thru y, a-1 thru w-1.
***BEATON & CORBIN MFG. CO., THE, r.**
Bendix Aviation Corp., Red Bank Div., a, b, c, i, j, k, n thru r, t thru x, b-1, d-1 thru k-1, m-1 thru w-1.
Bendix Aviation Corp., York Div.
Bomac Laboratories, Inc., a, b, u, v, x, k-1, p-1, s-1.
Brush Beryllium Co., The, i.
Burroughs Corp., Electronic Tube Div., q, v, x, n-1.
CBS-Hytran, Div.-Columbia Broadcasting System, Inc., g, h, q, w, b-1, d-1, e-1, h-1, n-1, o-1, r-1, s-1, v-1, w-1.
Calvert Electronics Inc., a thru z, a-1 thru x-1.
Carborundum Co., Refractaries Div., i.
Central Electronic Mfrs., Div.-Nuclear Corp. of America, a, i, t, x, b-1, e-1, g-1, h-1, i-1, k-1, n-1, p-1, r-1, s-1, u-1, v-1.
DBM Research Carp., k, q, l-1.
Diamanite Products Mfg. Co., i.
R. C. Dudek & Co., w-1.
Edgerton, Germeshausen & Grier, Inc., g, h, i, y, e-1, f-1, k-1, l-1, o-1, x-1.
Eitel-McCullough, Inc., i, u, v, w, b-1, e-1 thru h-1, n-1, r-1, t-1, v-1.
Electrical Refractaries Co., The, i.
Electranic Tube Carp., f, g, h.
Electrons, Inc., f-1, o-1.
Engelhard Industries, Inc., s, u-1.
Erie Resistar Corp., i, w.
Ferranti Electric Inc., g, h, l, u, v, x, l-1, p-1, x-1.
Genalex Div.-British Industries Carp., a, b, c, f, g, h, j thru p, t thru z, a-1, b-1, d-1 thru l-1, n-1, o-1, p-1, r-1, s-1, t-1, v-1, w-1.
General Electric Co., Apparatus Sales Div., x-1.
General Electric Co., Cathade Ray Tube Dept., f, g, h.
General Electric Co., X-Ray Dept., x-1.
General Electradynamics Corp., g, h, j, m, s, z, u-1, v-1.
Gladding, McBean & Co., i.
Glass Engrg. Div., Braun-Knecht-Heimann-Co., p.
Green Rectifier Co., t.
Haledy Electronics Co., v-1.
Herzog Miniature Lamp Works, Inc., e, w-1.
High Vacuum Equipment Corp., t.
Huggins Labs., Inc., b, t-1.
Hughes Aircraft Co., b, g, t-1, v-1.
ITT Labs., a, j, s, u, v, w, o-1, p-1, t-1.
ITT Labs.-Ft. Wayne, g, j, m, r, y, z.
Instruments Div.-Philips Electronics, Inc., a, p, x-1.
Isolantite Mfg. Corp., i.
Koiser Aircraft & Electronics, Div.-Kaiser Industries Corp., g, v, y.
Kemlite Laboratories, Inc., q, s, l-1, u-1, x-1.
Kip Electronics Corp., c, q, w, m-1, n-1, o-1, v-1, w-1.
Landsverk Electrometer Co., The, n, a, p.
Ling Electronics, Inc., b-1, e-1 thru h-1, o-1, r-1, v-1.
Litton Industries, Inc., b, g, i, u thru x, p-1, t-1.
Mackoy Reseorch Labs., g, m, q, s, t, v, y, z, o-1, r-1, v-1.
Menlo Research Lab., u-1.
Mica Fabricating Co., a, p.
Microwave Associates, Inc., a, e, v, p-1, s-1.
Monogram Precision Industries, a, b.
National Beryllia Corp., i.
National Ceramic Co., i.
National Unian Electric Corp., h, k, q, w, n-1.
Networks Electronic Carp., l-1.
Norton Co., New Products Dept., i.
Nuclear-Chicago Carp., n, a, p, l-1.
Penta Labs., Inc., b-1, e-1, o-1, r-1, v-1.
Philco Corp., Government & Industrial Div., f, s, t, w, d-1, m-1, n-1.
Philco Corp., Lonsdale Tube Co. Div., g, h, w, b-1, d-1, e-1, h-1, m-1, v-1.
Phata-Crystals, Inc., y.
Polarad Electranics Corp., u.
Radiation Research Corp., k-1, w-1.
Radiatian Instrument Development Lab., Inc., n, a, p, l-1.
Rouland Corp., The, g, h.
Raytheon Mfg. Co., b, d, f thru i, l, o, p, q, u, v, w, b-1, d-1 thru h-1, m-1, o-1, r-1, t-1, v-1, w-1.
Signalite Inc., w-1.
Sanatone Corp., w, d-1, m-1.
Sperry Electronic Tube Div., Sperry Rand Corp., u, t-1.
Strand Engrg. Co., o.
Stramberg-Carlson Div.-General Dynamics Carp., g.
Sylvania Electric Praducts Inc., Special Tube Operatians, a, b, u, v, a-1, p-1, t-1.
Sylvania Electric Products Inc., Sylvonio Electranic Tubes Div., f, g, h.
Sylvania Electric Products Inc., Electronic Tubes-Rec. Tubes Div., a, b, i, u, v, w, d-1, f-1, h-1, m-1, o-1, p-1, v-1.
Technical Apparatus Builders, c, d, l, s, e-1 thru h-1, l-1, w-1.
Thermosen Inc., w, x, d-1, w-1.
Thomas Electranics, Inc., g, h, c-1, v-1.
Triplett & Bartan, Inc., x-1.
***ULTRA-VIOLET PRODUCTS, INC., u-1.**
Universal Unlimited, Inc., g.
Vacuum Tube Praducts, Div.-Hughes Aircraft Co., f, g, h, j, q, t, a-1, b-1, e-1 thru h-1, o-1, r-1, v-1.
Varian Associates, b, u, b-1, r-1, t-1.
Veeca Vacuum Carp., t, a-1.
Veet Industries
Waterman Products Co., Inc., h.
Westinghouse Electric Corp., c, d, g, h, m, n, s, u, v, y, z, b-1, d-1 thru h-1, m-1, o-1 thru v-1.
Zenith Radio Corp., g, t-1, x-1.

TUBES, SHOCK
See SHOCK TUBES

TUBING

- **a. Aluminum**
- **b. Asbestas**
- **c. Brass or Copper**
- **d. Capillary**
- **e. Ceramic**
- **f. Fibre**
- **g. Finned**
- **h. Flexible Metal**
- **i. Fused Quartz**
- **j. Glass Fibre Insulation**
- **k. Glass, Precisian**
- **l. Metal & Alloy**
- **m. Metal Hose, Flexible**
- **n. Mica**
- **o. Molybdenum**
- **p. Monel**
- **q. Nickel**
- **r. Paper**
- **s. Phenalic**
- **t. Plastic**
- **u. Precious Metal**
- **v. Seamless**
- **w. Silver**
- **x. Steel**
- **y. Steel, Stainless**
- **z. Tantalum**
- **a1. Titanium**
- **b1. Tungsten**
- **c1. Varnished ar Lacquered**
- **d1. Varnished Cambric Insulatian**
- **e1. Waveguide**
- **f1. Waven ar Knitted Wire**

Adam Metal Supply Inc., a.
Aera Leather Products Co., j.
Aircom Inc. of New Jersey, e-1.
Airtron Inc., Div.-Litton Industries, h, o-1.
All Boro Metal Products Co., Inc., a, p, y.
Allegheny Ludlum Steel Corp., l, v, y.
Allied Plastics Supply Corp., b, f, j, m, n, r, s, t, c-1, d-1.
Alloys Unlimited Inc., u, w.
Almac Plastics Inc., s, t.
Alpha Metals, Inc., l.
Aluminum Co. of Americo, a.
American Aeroparts, a, c, j, x, y.
American Agile Corp., t.
American Brass Co., The, c, h, m, o-1.
American Instrument Co., Inc., y.
American Optical Co., Instrument Div., k.
American Rocket Co., b, j, s, t.
Americon Silver Co., c, d, u, v, w.
Americon Super-Temperature Wires, Inc., j, t.
Ampco Metal, Inc., l, v.
Anacondo Metal Hose Div., The Americon Brass Co., h, m, t, e-1, f-1.
Anchor Plastics Co., Inc., t.
Aristocrat Plastics, Inc., t.
Armco Steel Corp., x.
Associated Engrg. & Mfg. Corp., o, z, b-1.
Auburn Mfg. Co., The, b, f, t.

& C. Insulatian Products, Inc., j, c-1, d-1.
mon Bache & Co., k.
rker Sales Co., c.
elmont Smelting & Refining Works, Inc., l.
endix Aviation Corp., Red Bank Div.
rgen Carbide Co., d.
rnbach Radio Co., Inc., j, c-1, d-1.
Bishop & Co., Platinum Works, d, l, p, q, u, v, x, y.
nny Mfg. Corp., t.
rden Chemical Co., t.
rden Chemical Co,. The, Div.-The Borden Co., Resinite Dept., t.
am Metallurgical & Chemicol Co., a, c, l, l, n thru q, u, v, w, y, z, a-1, b-1.
lliom Brand & Co., Inc., j, t, c-1, d-1.
eeze Corparations, Inc., h.
idgeport Brass Co., a, c, f, g, l, m, o, p, q, u, v, w, z, a-1.
ush Beryllium Co., The, e.
alifornia Aircraft Products, a, l, x, y.
arbarundum Co., Refroctories Div., e, f.
arpenter Steel Co., The, l, q, y.
arpenter Steel Co., The, Alloy Tube Div., l, y, a-1.
entrolab, Div.-Glabe-Union, e.
hase Brass & Copper Co., Inc., a, c, g, l, v, y, e-1.
hemold Co., t.
hemplast, Inc., t.
hicoga Gasket Co., t.
leveland Cantainer Co., The, b, f, r, s.
mponents Corp., h, m, f-1.
ntinental Diamond Fibre Carp., f, s, t.
oper Industries, Inc., a, c.
rning Glass Works, d, e, l, k.
ucible Steel Ca. of Americo, l, p, q, x, y, a-1.
rystal-X Carp., s, t.
urtiss-Wright Corp., Research Div., e.
K Mfg. Co., h, m.
amascus Tube Co., a, c, g, l, a, p, q, u thru z, a-1, b-1.
ell Optics Co., Ltd., l, k.
elta Chemical Works, Inc., l.
elta Products Div.-Air Accessories, Inc., t.
emarnay-Bonordi, e-1.
iamonite Products Mfg. Co., e.
ielectric Materiols Co., j, t, c-1, d-1, f-1.
ivision Lead Co., l.
ixon Carp., t.
ouglas Microwove Co., Inc., e-1.
ow Chemical Co., The, l.
unbar-Kapple Inc.-Aircraft Components Div., h, l, m, v, y.
lectric Steel Faundry Co., l, y.
lectricol Insulation Co., Inc., b, f, j, r, s.
lectrical Refractories Co., The, e.
lloy Corp., s, t.
mpire State Aluminum Corp., a.
ngelhard Industries, Inc., l, l, u, v, w, e-1.
ngelhard Industries Inc., D. E. Makepeoce Div., l, u, w, a-1, e-1.
ngineered Plastics, Inc., f, s, t.
ischer & Porter Co., k.
isher Scientific Co., k, t.
lexaust Co., The, h, m.
lexible Metal Hose Mfg. Co., h, m.
lexible Tubing Corp., f, j.
FLEXONICS CORP., AERONAUTICAL DIV., d, h, l, m, x, y, a-1.
lexrack Co., t.
luorulan Labs., Inc., t.
ormica Corp., t.
orm-It Products, Inc., f, r, s.
ranklin Fibre-Lamitex Corp., f, j, s, t.
eneral Americon Transportotion Corp., t.
enerol Plostics Corp. of New Jersey, b.
ering Products, Inc., t.
lodding, McBean & Co., e.
loss Engrg. Div. Broun-Knecht-Heimonn-Co., k.
.F. Goodrich Industriol Products Co., t.
allett Mfg., Co., h, m.
alogen Insulotor & Seal Corp., s.
arvey Aluminum, a, l, a-1.
oveg Industries, Inc., b, e, f, l, j, s, t.
aynes Stellite Co., Div.-Union Corbide Corp., l, z.
ayward Scientific Gloss Corp., k.
itemp Wires Inc., j, t.
omolite Corp., The, s, t.
lumitronic Engrg. Co., s, t.
mperiol Bross Mfg. Co., The, t.
ntegrated Mico Corp., n.
nternotional Nickel Co., The, l, p, q, v.
solontite Mfg. Corp., e.
essall Plostics, t.
ohns-Manville, b, f, j, t.
onesville Paper Tube Corp., r.
oiser Aluminum & Chemicol Soles, Inc., a.
ennametol Inc., z, a-1.
ensico Tube Co. Inc., c, d, v.
ip Electronics Corp., e.
olcost Industries-Div. Thompson Romo Wooldridge Inc., p, q, x, y.
romer Fabricating Co., The, t.
amtex Industries, Inc., f, j, t, e-1.
o Pointe Industries Inc., a.
ewis & Saunders, g.
homos J. Long, Inc., f, r, s, t, c-1, d-1.
outhan Mfg. Co., The, Div.-Ferro Corp., e.
& Q Plostic Products, t.
. R. Mallory & Co. Inc., a-1.
etal Textile Corp., Electronics Div., h, f-1.
etols & Controls Corp., Generol Plote Div., l, u, w, z, a-1, e-1.
ica Fobricoting Co., e, f, l, n, s, t, d-1.
Mica Insulotar Div.-Minnesota Mining & Mfg., Co., n, s, t.
Microwave Associates, Inc., e-1.
Minnesota Mining & Mfg. Co., e, h, j, n, r, s, t, c-1, d-1.
Mitronics Inc., e.
Monogram Precision Industries, a, g, l, p, q, r, t, u, x, z, a-1, e-1.
Mueller Brass Co., c, t.
National Beryllia Corp., d, e.
National Ceramic Co., e.
Nationol Lead Co., a-1.
National Tube Div.,-United Stotes Steel Carp., g, l, t, v, x, y.
National Vulcanized Fibre Co., f, s, t.
Natvar Corp., t, c-1, d-1.
New England Electricol Works, Inc., d, f-1.
New England Tape Co., Div.-United-Carr Fostener Carp., t.
Narton Co., e.
Nartan Co., New Products Dept., e.
Ohio Seamless Tube Div.-Copperweld Steel Co., v, x.
Omega Labs., Inc., e-1.
Orchard Industries, Inc., Actionflex Div., f, j, t.
Pacific Scientific Co., u.
Pacific Tube Co., x, y.
Parts Engrg. Co., Inc., h, l, m, y.
Penn Fibre & Specialty Co., Inc., f, s, t.
Permacel, t.
Phelps Dodge Copper Products Corp., c, l, v.
Pilgrim Products Inc., f, s, t.
Plastic Age Sales, Inc., j, t.
Polymer Corp., The, s.
Precision Sheet Metal, Inc., j.
Precision Tube Co., Inc., a, c, d, l, p, q, v, x, y.
Raybestos-Manhattan, Inc., b, t.
Raybestos-Manhattan, Inc., Pa., b, j, s, t.
Reinhold Engrg. & Plostics Co., s, t.
Edw. Renneburg & Sons Co., v, x, y.
Resistoflex Corp., a, c, l, t.
Reynolds Metals Co., a.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**, f-1.
Roll Formed Products Co., a, x, y.
Rome-Turney Radiator Co., The, g.
Rubbercraft Corp. of California, u.
Joseph T. Ryerson & Son, Inc., a, l, t, v, x, y.
St. Regis Paper Co., Panelyte Div., s, t.
Sanford Plostics Carp., t.
Saylor Electric Products Corp., j, t, c-1.
Schlegel Mfg. Co., f-1.
W. S. Shamban & Co., t.
Sparta Mfg. Co., Div.-U.S. Ceramic Tile Co., t.
Spaulding Fibre Co., Inc., f, j, s, t.
Spectra-Strip Wire & Cable Corp., t.
Stainless Steel Products, Inc., y.
Standard Metals Corp., c, l, u, v, w, e-1.
Standard-Thomsan Carp., Clifford Mfg. Co. Div., g, h, m.
Sterling Gloss Carp., k.
Stevens Products, Inc., j, r, s.
Superior Steatite & Ceramic Corp., e.
Swan Rubber Co., t.
Telerad Mfg. Carp., e-1, f-1.
Thermal Refractories Corp., e.
Thermal Wire of America, t.
H. I. Thompson Fiber Gloss Co., l.
Timken Raller Bearing Co., The, l, v, x, y.
Titanium Metals Corp. of Americo, a-1.
Titeflex, Inc., h, m.
Tube Distributors Co., Inc., l, o, p, q, v, x, y, a-1.
Tube Methods Inc., l, p, q, v, y.
Tube Reducing Corp., p, v, x, y, a-1.
Turba Praducts, Inc., t.
Uniform Tubes, Inc., a, c, g, u thru y.
Union Asbestos & Rubber Co., b, j.
United Minerol & Chemicol Corp., q.
U. S. Flexible Metollic Tubing Co., h.
U. S. Industries, Inc.
U. S. Steel Supply Div., United Stotes Steel Corp., a, v, x, y.
United Wire & Supply Corp., a, c, d, g, l, v.
Universol Moulded Products Corp., b, j.
Volpey Crystal Corp., l, k.
Vanodium-Alloys Steel Co., l, p, v, x, y.
Vorflex Corp., j, t, c-1, d-1.
Veet Industries, y.
Woll Tube & Metol Products Co., v, y.
Wollingford Steel Co., y.
Waveline, Inc., e-1
Western Internotionol Co., e-1.
Western Pneumatic Tube Co., l, a, p, q, y, z, a-1.
Westinghouse Electric Corp., Lomp Div., l, a.
Wilmington Fibre Specialty Co., f, s.
Yordley Plostics Co., t.
Zolleo Brothers, h, m.
Zippertubing Co., The, a, b, c, h, l, j, m, t, f-1.

TUBULAR FABRICATIONS & ASSEMBLIES

Advonced Electronics, Inc.
Aerolite Electronics Corp.
Aeroquip Corp., Jockson Div.
Alpitec, Inc.
Amelco, Inc.
Americon Aeroports
Americon Tube Bending Co., Inc.
Anchor Metal Spinning Co., The
Arnolt Corp.
Atlantic Instrument Corp., Sub.-Americon Electronics, Inc.
B. H. Aircraft Co., Inc.
Basco Metol Products, Inc.
Bosic Tool Industries, Inc.
***BEATON & CORBIN MFG. CO., THE**
Bil-Jax Inc.
J. Bishop & Co., Platinum Works
Bridgeport Brass Co.
Brighton Corp.
California Aircroft Products
Cormac Aviation
C. B. Christiansen Ca.
Crystol-X Corp.
Damascus Tube Co.
Diversey Engrg. Co.
Dockendarff & Co. Inc.
Doyle & Roth Mfg. Co., Inc.
Double E Products Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Dresser-Ideco Co., Div.-Dresser Industries, Inc.
Dunbar-Kapple Inc.-Aircroft Components Div.
Electricol Insulotian Co., Inc.
Electrical & Mechanical Design Co.
Electronic Parts Mfg. Co., Inc.
Farwell Metal Fabricating
Firestane Tire & Rubber Ca., The, Guided Missile Div.
Flexible Metol Hose Mfg. Co.
***FLEXONICS CORP., AERONAUTICAL DIV.**
Flori Pipe Ca., The
Hallett Mfg., Co.
Hardman Tool & Engrg. Co.
Harvey Aluminum
Houstan Fearless Corp.
Hufford Carp., The
Intercontinentol Mfg. Co., Inc.
Kaiser Aircroft & Electronics, Div.-Kaiser Industries Corp.
Kanarr Corp.
Keystone Electronics Corp.
Kling Metal Spinning & Stamping Ca.
Lomtex Industries, Inc.
Lewis & Saunders
Thomas J. Long, Inc.
Longren Aircraft Co., Inc.
M & Q Plastic Products
Marman Div., Aeroquip Corp.
Mercury Tool & Mfg. Corp.
***MIRAX CHEMICAL PRODUCTS CORP., ELECTRO-MECHANICAL PRODUCTS DIV.**
Monagram Precisian Industries
Mueller Brass Co.
New England Tape Co., Div.-United-Carr Fastener Corp.
Newbrook Machine Corp.
Orchard Industries, Inc., Actionflex Div.
Ports Engrg. Co., Inc.
Peerless Products Industries
Penn-Michigan Mfg. Corp.
Piasecki Aircraft Corp.
Pilgrim Praducts Inc.
Portland Copper & Tank Works Inc.
Precision Sheet Metal, Inc.
Precision Tube Co., Inc.
Pressed Steel Tank Co.
R & R Engrg. Co.
Radiatronics, Inc.
Ravenna Metal Praducts, Div.-Standard Screw Co.
Red Lion Cabinet Co., Redco Taal Div.
Edw. Renneburg & Sons Co.
Resistoflex Corp.
Rimak, Inc.
Sonford Plastics Corp.
Skinner Precision Products
Skyline Praducts, Inc.
Stainless Steel Products, Inc.
Standard Metals Corp.
Stondord-Thomson Corp., Clifford Mfg. Co. Div.
Topco Group, Thompson-Romo-Wooldridge Inc.
Teiner Engrg. Corp.
Turbo Products, Inc.
Twigg Industries
Uniform Tubes, Inc.
United Aircroft Products, Inc.
United Mfg. Co., The
Universol Metal Products Inc.
Voriety Aircraft Corp.
Veet Industries
Woolf Aircroft Products, Inc.
Zippertubing Co., The

TUBULAR PINS

See PINS, TUBULAR

TUNERS

a. AM
b. Automatic
c. FM
d. FM & AM
e. Klystron
f. Microwave
g. Permeability
h. Tuning Units, Antenna

Aircom Inc., e, f.
Aircom Inc. of New Jersey, f.
Airtron Inc., Div.-Litton Industries, f.
Airtron Inc., Div.-Litton Industries, f.
Allied Internotionol Co., a thru d.
Amelco, Inc., b, c, d, f, g, h.
Atlos Precision Products, Co., h.
Borker & Williomson Inc., h.
Bendix Aviation Corp., York Div., e, f.
Blonder-Tongue Labs., Inc., c, d.
Bogen-Presto Co., Div.-Siegler Corp., The, a, c, d.
Budd Stonley Co. Inc., f.

Centronix Inc., **b.**
Christie Machine Works, **e.**
Continental Mfg., Inc., **a, c, d.**
Daven Co., The, **a, c, d.**
Demornay-Bonardi, **f.**
Diamond Antenna & Microwave Corp., **e, f, h.**
Douglas Microwave Co., Inc., **f.**
Eastern Industries Inc., **e.**
Electronic Applications, Inc., **c.**
Electronic Communications, Inc., **a thru d, f, h.**
Electronic Instrument Co., Inc. (EICD), **a, c, d.**
Empire Products Sales Corp., **e, f.**
Engrg. Associates, **e, f.**
Erie Resistor Corp., **d.**
FXR, Inc., **f.**
Ferrotron Electronics Co., Inc., **g.**
Forbes & Wagner, Inc., **g.**
General Communication Co., **f.**
John Gombos Co., Inc., **f.**
Hallicrafters, **h.**
Walter J. Hyatt Co., The, **f, h.**
ITT Labs., **a thru h.**
J-V-M Microwave Co., **f.**
***KEARFOTT CO., INC., f, h.**
***KEARFOTT CO., INC., MICROWAVE DIV., f.**
La Pointe Industries Inc., **f.**
Lear, Inc., **a, b, c, h.**
Lear, Inc., Grand Rapids Div., **h.**
L E L, Inc., **f.**
Litton Industries, Maryland Div., **e.**
W. L. Maxson Corp., The, **e, f.**
Meridian Metalcraft, Inc., **f.**
Microlab, **f.**
Microwave Associates, Inc., **f.**
J. W. Miller Co., **a, c, d.**
Miratel, Inc., **a, c, d.**
Motorola Inc., Military Electronics Div., **a thru e.**
N.R.K. Mfg. & Engrg. Co., **f.**
Narda Microwave Corp., The, **f.**
National Pneumatic Co., Inc., Holtzer-Cabot Divs., **a, c, d.**
Philco Corp., Government & Industrial Div., **a thru h.**
Polarad Electronics Corp., **e, f.**
Polytechnic Research & Development Co., Inc., **f.**
Portchester Instrument Corp., **f.**
Precise Development Corp., **a, c, d.**
Radar Design Corp., **f.**
Radiotronics, Inc., **f, h.**
Sperry Electronic Tube Div., Sperry Rand Corp., **e.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **f.**
Stromberg-Carlson Div.-General Dynamics Corp., **a, c, d.**
Superex Electronics Corp., **a.**
Telectro Industries Corp., **a, b, c, h.**
Telerad Mfg. Corp., **e, f.**
Victor R. F. & Microwave Co., **f.**
Waveline, Inc., **f.**
Webcor, Inc., Government Div., **e, f, h.**
Weinschel Engrg., **f.**

TUNING DEVICES

Atlas Precision Products, Co.
Barker & Williamson Inc.
Blonder-Tongue Labs., Inc.
CGS Labs., Inc.
Centronix Inc.
Christie Machine Works
Collins Radio Co.
Data-Control Systems, Inc.
Eastern Industries Inc.
Electronic Communications, Inc.
Empire Products Sales Corp.
Federal Mfg. & Engrg. Corp.
Instruments For Industry, Inc.
JFD Electronics Corp.
Lear, Inc.
Livingston Electronic Corp.
P. R. Mallory & Co. Inc.
Motorola Inc., Military Electronics Div.
Philco Corp., Government & Industrial Div.
Precise Development Corp.
Radiotronics, Inc.
Slip Ring Co. of America
Specialty Engrg. & Electronics Co.
Telectro Industries Corp.
Telerad Mfg. Corp.
Webcor, Inc., Government Div.

TUNING DEVICES, RECEIVER MECHANICAL

Atlantic Instrument Corp., Sub.-American Electronics, Inc.
Atlas Precision Products, Co.
Centronix Inc.
Collins Radio Co.
Data-Control Systems, Inc.
Erie Resistor Corp.
ITT Labs.
Instruments for Industry, Inc.
Lear, Inc.
Lear, Inc., Grand Rapids Div.
P. R. Mallory & Co. Inc.
W. L. Maxson Corp., The
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Philco Corp., Government & Industrial Div.
Radiatronics, Inc.
Telectro Industries Corp.
Western Gear Corp.

TUNING DEVICES, TRANSMITTER MECHANICAL

Atlas Precision Products, Co.
Centronix Inc.
Christie Machine Works
Collins Radio Co.
Data-Control Systems, Inc.
ITT Labs.
Instruments For Industry, Inc.
Lear, Inc.
P. R. Mallary & Co. Inc.
W. L. Maxson Corp., The
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Philco Corp., Government & Industrial Div.
Radiatronics, Inc.
Stainless Steel Products, Inc.
Telectro Industries Corp.
Telerad Mfg. Corp.
Western Gear Corp.

TUNING UNITS, ANTENNA

See ANTENNA TUNING UNITS

TUNNELS, SHOCK

See SHOCK TUNNELS

TUNNELS, WIND

See WIND TUNNELS

TURBINE ASSEMBLIES

Aerojet-General Corp.
Centrax Ltd., American Sales Office
Christie Machine Works
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Dresser Industries, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Houston Fearless Corp.
***LYCOMING DIV., AVCO MFG. CORP.**
Mercury Tool & Mfg. Corp.
Merz Engrg., Inc.
Monogram Precision Industries
Newbrook Machine Corp.
***RHEEM MFG. CO., DEFENSE & TECHNICAL PRODUCTS DIV.**
Ryan Aeronautical Co.
Smith-Morris Corp.
Stalker Corp., The
Stratos, Div.-Fairchild Engine & Airplane Corp.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Therm, Inc.
Turbo Products, Inc.

TURBINE SHAFTS

Aerojet-General Corp.
***CAMERON IRON WORKS, INC.**
Capital City Mfg. Co.
Christie Machine Works
Curtiss-Wright Corp.-Research Div.
Curtiss-Wright Corp.-South Bend Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dresser Industries, Inc.
Federal Machine Co. Inc.
Houston Fearless Corp.
Merz Engrg., Inc.
Newbrook Machine Corp.
Stratos Div.-Fairchild Engine & Airplane Corp.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Talley Corp., The
Tube-Turns Div., Chemetron Corp.
Turbo Products, Inc.
Walbar Machine Products Inc.
Western Gear Corp.

TURBINE WHEELS

Aerojet-General Corp.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Bendix Utica Div., Bendix Aviation Corp.
***CAMERON IRON WORKS, INC.**
Capital City MFG. Co.
Centrax Ltd., American Sales Office
Christie Machine Works
Curtiss-Wright Corp.-Research Div.
Curtiss-Wright Corp.-South Bend Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Diversey Engrg. Co.
Dresser Industries, Inc.
Federal Machine Co. Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Haynes Stellite Co., Div.-Union Carbide Corp.
Houston Fearless Corp.
Jarvis Corp.
Kelsey-Hayes Co.
Merz Engrg., Inc.
Newbrook Machine Corp.
Parker-Hartford Corp., The
Singer Mfg. Co., The, Military Products Div.
Stalker Corp., The
Steel Improvement & Forge., The
Stratos, Div.-Fairchild Engine & Airplane Corp.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Talley Corp., The
Therm, Inc.
Turbo Products, Inc.
Walbar Machine Products Inc.
Western Gear Corp
Westinghouse Electric Corp.

TURBINES, AIR

Aerojet-General Corp.
***AIRESEARCH MFG. CO. OF ARIZ.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Christie Machine Works
Coppus Engrg. Corp.
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
General Electric Co., Apparatus Sales Div.
Hamilton Standard, Div.-United Aircraft Corp.
Houston Fearless Corp.
Lear Inc., Lear-Ramec Div.
Stainless Steel Products, Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Therm, Inc.
Turbo Products, Inc.

TURBO FANS

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Blowers Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dresser Industries, Inc.
General Electric Co., Apparatus Sales Div.
Houston Fearless Corp.
Jorvis Corp.
Monogram Precision Industries
Newbrook Machine Corp.
Smith-Morris Corp.
Stalker Corp., The
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Talley Corp., The
Therm, Inc.

TURBO JET ENGINES

***AIRESEARCH MFG. CO. OF ARIZ.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Curtiss-Wright Corp., Research Div.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
General Electric Co., Apparatus Sales Div.
***LYCOMING DIV., AVCO MFG. CORP.**
Smith-Morris Corp.
Westinghouse Electric Corp.

TURBO PUMPS

Aerojet-General Corp.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Bendix Utica Div., Bendix Aviation Corp.
J. C. Carter Co., The
Chandler Evans Corp.
Christie Machine Works
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Utica Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Dresser Industries, Inc.
Eastern Industries Inc.
General Electric Co., Apparatus Sales Div.
Hamilton Standard, Div.-United Aircraft Corp.
Hydradyne Corp., Skinner Seal Div.
Lear Inc., Lear-Romec Div.
Reaction Motors Div., Thiokol Chem. Corp.
Rocketdyne Div.-North American Aviation, Inc.
Stalker Corp., The
Stratos, Div.-Fairchild Engine & Airplane Corp.
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Therm, Inc.

TURNTABLES, SOUND EQUIPMENT

Du Kane Corp.
Electronic Applications, Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Robot Industries Inc.
Wakefield Engrg. Co.

TURRETS, CAMERA

Gordon Enterprises
Houston Fearless Corp.
Luther Mfg. Co.
Kelsey-Hayes Co.
Monogram Precision Industries
Wollensak Optical Corp.

TWIST DRILLS

See DRILLS, TWIST

UHF TRANSCEIVERS

See TRANSCEIVERS, UHF

ULTRASONIC CLEANERS

See CLEANERS, ULTRASONIC

ULTRASONIC EQUIPMENT

Andersen Labs.
Arenberg Ultrasonic Lab., Inc.
Associated Engineers, Inc.
Atlantic Reseorch Corp.
Bearing Inspection, Inc.
Bendix Aviation Corp., Pioneer-Central Div.
Bendix Radio Div., Bendix Aviation Corp.
Birtcher Corp., The
Blackstone Corp.
Branson Instruments, Inc.
Branson Ultrasonic Corp.
Chesapeake Instrument Corp.
Corning Glass Works
Curtiss-Wright Corp., Princeton Div.
Curtiss-Wright Corp., Research Div.

etrex Chemical Industries, Inc.
u Kane Corp.
ngrg. Associates
eneral Electric Co., Apparatus Sales Div.
eneral Kinetics, Inc.
ulton Industries, Inc.
in Tel Div.-Cohu Electronics, Inc.
ing Electronics, Inc.
agnaflux Corp.
aico Electronics, Inc.
arquardt Aircraft Co.
assa Div.-Cohu Electronics, Inc.
cKenna Labs.
arda Ultrasonics Corp., The
otional Ultrasonic Corp.
acific Radionics
ioneer Industries Div., Almar-York Co. Inc.
ower Supplies Inc.
aytheon Mfg. Co.
angamo Electric Co.
argeant & Wilbur Heat Treating Corp.
heffield Corp., The, Sub.-Bendix Aviation Corp.
perry Products, Inc.
ransdyne Corp.
wenty-First Century Electronics, Inc.
estinghouse Electric Corp.
ye Industries
acharias Electronics Corp.

ULTRASONIC SOLDERING EQUIPMENT
See SOLDERING EQUIPMENT, ULTRASONIC

ULTRASONIC VIBRATORS
See VIBRATORS, ULTRASONIC

UNITS, PLUG-IN-CIRCUIT
See PLUG-IN-CIRCUIT UNITS

UNITS, PRESSURIZATION
See PRESSURIZATION UNITS

UNITS, REVERBERATION
See REVERBERATION UNITS

UPSET FORGINGS
See FORGINGS, UPSET

UPSET FORMS
See FORMS, UPSET

VACUUM ALUMINIZERS
onsolidated Electrodynamics Corp., Rochester Div.
isler Engrg. Co., Inc.
eneral Vacuum Corp.
een Rectifier Co.
igh Vacuum Equipment Corp.
ill Corp.
inney Mfg. Div., The New York Air Brake Co.
etaplast Corp.
RC Equipment Corp.
ational Research Corp.
ientific Engrg. Labs., Inc.
F. J. Stokes Corp.
yedlaw Inc.
emperature Engrg. Corp.
rian Associates
eeco Vacuum Corp.

VACUUM SYSTEMS & CONTROLS
fred Electronics
nerican Machine & Foundry Co., Greenwich
plied Radiation Corp.
o Equipment Corp.
ASSOCIATED TESTING LABS., INC.
travac Corp.
och-Russ Co.
istol Co., The
ntral Electronic Mfrs., Div.-Nuclear Corp. of America
noflow Corp.
nsolidated Controls Corp.
nsolidated Diesel Electric Corp.
nsolidated Electrodynamics Corp., Rochester Div.
rnelius Co., The, Aero Div.
oll-Reynolds Co. Inc.
neral Vacuum Corp.
annini Plasmadyne Corp.
een Rectifier Co.
ardite Co., Div. of American Marietta Co.
ul Hardeman, Inc.
gh Vacuum Equipment Corp.
ll Corp.
dramatics, Inc.
ernational Pump & Machine Works
ANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP.
nney Mfg. Div., The New York Air Brake Co.
ar, Inc.
tton Engrg. Labs.
etaplast Corp.
nneapolis-Honeywell Regulator Co., Industrial Div.
nneapolis-Honeywell Regulator Co., Industrial Product Group
hn Mohr & Sons
RC Equipment Corp.
ational Research Corp.
ygen Equipment & Service Co.
neu-Hydro Valve Corp.
ocess & Instruments
d Point Corp.
esearch Appliance Co.
ientific Engrg. Labs., Inc.
Skyline Electric & Mfg. Co.
Space Corp.
F. J. Stokes Corp.
Temperature Engrg. Corp.
United Electric Controls Co.
Vacuum Tube Products, Div.-Hughes Aircraft Co.
Varian Associates
Veeco Vacuum Corp.

VACUUM TUBE MEGOHMETERS
See MEGOHMETERS, VACUUM TUBE

VACUUM UNITS
Applied Radiation Corp.
Beach-Russ Co.
Central Electronic Mfrs., Div.-Nuclear Corp. of America
Consolidated Electrodynamics Corp., Rochester Div.
Cornelius Co., The, Aero Div.
Finnell System, Inc.
General Vacuum Corp.
Giannini Plasmadyne Corp.
Green Rectifier Co.
Guardite Co., Div. of American Marietta Co.
High Vacuum Equipment Corp.
Hull Corp.
International Radiant Corp.
Kinney Mfg. Div., The New York Air Brake Co.
Lear, Inc.
Lear Inc., Lear-Romec Div.
Leiman Brothers, Inc.
NRC Equipment Corp.
National Research Corp.
Red Point Corp.
Research Appliance Co.
Scientific Engrg. Labs., Inc.
F. J. Stokes Corp.
Temperature Engrg. Corp.
Veeco Vacuum Corp.

VALVE GUIDES
*ANNIN CO., THE
Capital City Mfg. Co.
Huppert, K. H., Co.

VALVE OPERATOR
*ANNIN CO., THE
Bristol Co., The
Conoflow Corp.
Fisher Governor Co.
Holex, Inc.
Hoover Electric Co.
Hydra-Power Corp.
Hydromatics, Inc.
Leslie Co.
Mason-Neilan
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Morse Instrument Co., The
Research Controls
Ronson Hydraulic Units Corp.
Sargent Engrg. Corp.
Skinner Electric Valve Div.
Talley Corp., The
Vacuum Research Co.

VALVE OPERATOR, ELECTRIC
*ANNIN CO., THE
Bart Mfg. Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Bristol Co., The
Conoflow Corp.
Hammel-Dahl Div.-General Controls Co.
Hoover Electric Co.
Hydra-Power Corp.
Mason-Neilan
Minneapolis-Honeywell Regulator Co., Industrial Product Group
Skinner Electric Valve Div.
Talley Corp., The
Valcor Engrg. Corp.
Walworth Co.

VALVE OPERATOR, HYDRAULIC
Adel Precision Products of California, Div.-General Metals Corp.
American Machine & Foundry Co., Government Products Group
American Measurement & Control, Inc.
*ANNIN CO., THE
Astronautics Engrg. Co.
Bendix-Pacific Div., Bendix Aviation Corp.
Bristol Co., The
Capital City Mfg. Co.
Fisher Governor Co.
Hammel-Dahl Div.-General Controls Co.
Hydra-Power Corp.
Hydromatics, Inc.
Kemp Aero Products
Ledeen Inc.
Leslie Co.
Mason-Neilan
Ozone Metal Products Corp.
Research Controls
Ronson Hydraulic Units Corp.
Sargent Engrg. Corp.
Sirvalco Systems Corp.
Walworth Co.
Weston Hydraulics Ltd.-Sub., Borg-Warner Corp.

VALVES
- o. Accumulotor Charging
- b. Acid
- c. Acid Resistont
- d. Air
- e. Anti-Gravity
- f. Automatic Shutoff
- g. Automotic Shutoff, Hydraulic
- h. Bleeder
- i. By-Poss
- j. Check & Check Relief
- k. Check-Hydroulic, Gas
- l. Control
- m. Diaphrogm
- n. Dump
- o. Electronic Solenoid
- p. Engine Inlet
- q. Exhaust
- r. Float
- s. Globe
- t. Helium
- u. High Pressure Gas
- v. Hydroulic System
- w. Hydrogen
- x. Motor Operated
- y. Needle
- z. Plug
- o1. Pneumatic
- b1. Power Control
- c1. Pressure Regulating
- d1. Relief & By-Pass
- e1. Restrictor
- f1. Rocket Fuel
- g1. Rotary
- h1. Sequence
- i1. Servo
- j1. Shuttle
- k1. Shuttle Solenoid
- l1. Solenoid
- m1. Strainer
- n1. Suction Reguloting
- o1. Surge
- p1. Thermostatic
- q1. Throttling
- r1. Tronsfer
- s1. Vocuum Selector & Check
- t1. Vopor Tight
- u1. Venturi Opening

ACF Industries Inc., b, c, j, k, m, o, u, v, y, a-1, c-1, d-1, k-1, l-1, p-1.
Accessory Products Co., Div.-Textron Inc., o, d, e, f, j thru o, s thru x, a-1, b-1, c-1, f-1 thru n-1, p-1, r-1, s-1, t-1.
Actuation Research Corp., d, t thru x, a-1, c-1.
Adel Precision Products of California, Div.-General Metals Corp., d, f, g, i thru l, n, o, u, v, a-1, b-1, d-1, g-1, h-1, j-1, l-1.
Aero Gasket Corp., m.
Aero Supply Mfg. Inc., b thru o, r, t thru x, b-1 thru r-1.
Aerojet-General Corp., b, d, f, g, n, u, v, w, z, a-1, c-1, f-1, i-1, q-1.
Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co., t.
Aerotec Corp., The, d, f, g, j, l, r, t thru x, a-1, c-1, d-1, j-1, k-1, l-1, n-1, t-1, u-1.
Airaterra, g, w. f-1.
Airborne Research & Development Corp., j, l, o, u, c-1, d-1, h-1, s-1.
*AIRESEARCH MFG. CO. OF ARIZ., c, d, f, h thru q, t, u, w, z, a-1 thru e-1, h-1, k-1, p-1, q-1, s-1, t-1, u-1.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., c, d, f thru o, u thru x, a-1, c-1, d-1, f-1, i-1, l-1, n-1 thru r-1.
Alco Valve Co., c, o, r, v, b-1, l-1.
All Specs Corp., h, i, j, s, y, z, e-1, j-1.
Allen Aircraft Products, Inc., d, i, j, k, n, r, v, a-1, d-1, f-1, a-1, s-1.
Allenair Corp., d, h, i, o-1, j-1, l-1.
Allied Control Co., Inc., l-1.
Allmetal Screw Products Co., Inc., s.
Alloy Steel Products Co., b, c, j, s, u, w thru z, f-1, g-1.
Altair, Inc. d, f, g, j, k, o, u, v, a-1, c-1, j-1, l-1, p-1 thru s-1, u-1.
American Aeroparts, o, f thru l, n, r, s, x, y, z, g-1 thru p-1, s-1.
American Brake Shoe Co., a-1.
American Brake Shoe Co., Kellogg Div., a-1.
American Felt Co., k, u, y.
American Instrument Co., Inc., h, j, o, s, u, y, a-1, d-1.
American Measurement & Control, Inc., l, o, v, x, b-1, i-1, r-1.
American Standard Products, Inc., a thru z, a-1 thru u-1.
Ampco Metal, Inc., c.
*ANDERSON, GREENWOOD & CO., c, d, j, l, n, s thru z, a-1, d-1, q-1.
*ANNIN CO., THE, g, j, l, m, s thru y, a-1, b-1, c-1, f-1, h-1, i-1, n-1, q-1, t-1.
Applied Dynamics Corp., j, m, c-1.
Arnav Aircraft Associates, Inc., h.
ARO Equipment Corp., d, e, f, j, u, a-1, c-1, d-1, e-1.
Astronautics Engrg. Co., o, e, f, g, i, n, v, c-1, d-1, i-1, j-1.
Automatic Switch Co., b, c, d, i, j, l thru q, s, t, u, w, x, y, a-1, b-1, d-1, f-1, l-1.
Auto-Valve Inc., h, j, n, e-1, l-1, m-1.
Barber-Colman Co., d, f, j, l, x, a-1.
Barksdale Valves, d, o, u, a-1, l-1.

Bart Mfg. Corp., o thru d, f, h, i, o, q, s thru w, o-1, d-1, f-1, l-1, o-1, s-1.
Bell Aircraft Corp., Niagara Frontier Div., i-1.
Benbow Mfg. Corp., d, h thru m, u, v, x, o-1, c-1, d-1, e-1, h-1, l-1.
*BENDIX AVIATION CORP., HAMILTON DIV., v, i-1.
Bendix Aviation Corp., Pioneer-Central Div., i, j, c-1, d-1.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., o, l-1.
Bendix-Pacific Div., Bendix Aviation Corp., o, d, f, g, i, l thru o, v, x, y, z, o-1 thru d-1, g-1 thru l-1, r-1.
Bendix Utica Div., Bendix Aviation Corp., d, f thru o, u, o-1 thru d-1, h-1, i-1, l-1, n-1, q-1.
Bobrick Mfg. Corp., c, d, g, i thru o, u, v, x, o-1, b-1, d-1, e-1, f-1, j-1, l-1, n-1, s-1.
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., f, g, j, k, o, v, o-1, l-1.
Bristol Co., The, f, l, m, q, x, o-1 thru d-1, p-1.
Burklyn Co., j, k, v, o-1.
CDC Control Services, Inc., v, i-1.
Cadillac Gage Co., u, o-1, b-1, i-1.
Caltron Products Co., o, k-1, l-1.
*CAMERON IRON WORKS, INC.
Capitol City Mfg. Co., d, j, y.
Captive Seal Corp., b, d, f thru l, n, o, t thru x, o-1, c-1 thru f-1, h-1, l-1, q-1, t-1.
Carleton Aviation Co., d, l, t, u, v, o-1, c-1, e-1, f-1, h-1.
Carmac Aviation
Carruthers & Fernandez, Inc., d, i, j, k, o, v, o-1, c-1, d-1, e-1, k-1, l-1.
J. C. Carter Co., The, f, i, l, n, r, x, c-1, d-1, f-1, n-1, r-1.
Carter Controls, Inc., o-1, l-1.
A. W. Cash Valve Mfg. Corp., l, m, o-1, c-1, d-1.
Chandler Evans Corp., d, f, i thru m, t, u, w, o-1 thru f-1, i-1, p-1, q-1, t-1.
Chase Brass & Copper Co., Inc., j, l, s, y.
Chrysler Corp., Defense Operations Div., f-1.
Clark Equipment Co., v.
Clary Dynamics, o thru l, n, o, q, t thru x, o-1 thru t-1.
Cleveland Pneumatic Industries, Inc., o, f thru l, n, q, z, h-1 thru l-1.
Clippard Instrument Lab., Inc., d, h, j, l, o, y, o-1, e-1, l-1.
Collins Engrg. Corp., e, h, j.
Com-Air Products, Div.-A S R Products Corp., d, f thru l, n, o, t thru y, o-1, c-1, d-1, i-1, l-1.
Commercial Shearing & Stamping Co., v.
Components Corp., o thru i, n, o, t thru x, z, o-1 thru g-1, i-1, l-1, n-1, q-1, r-1, t-1.
Conoflow Corp., b, c, d, l, m, s, x, o-1, c-1, q-1.
Consolidated Controls Corp., b, d, f, g, i thru l, o, p, r, v, x, o-1 thru d-1, f-1 thru l-1, n-1 thru q-1, s-1, t-1.
Consolidated Diesel Electric Corp., d, h thru m, s thru z, o-1, c-1, d-1, f-1, i-1, l-1, p-1.
Consolidated Diesel Electric Corp., Test Equip. Div., j, k, v.
Controls Co. of America, l, c-1, l-1, p-1.
Coppus Engrg. Corp., f, m, n, l-1.
Cornelius Co., The, Aero Div., d, e, f, h thru o, u, o-1, c-1, d-1, e-1, j-1, n-1.
Crane Co., b, c, j, m, s, u, x, y, z, f-1, q-1.
Crystal-X Corp., j.
Curtis Automotive Devices, Inc., d, h, n.
Curtiss-Wright Corp., Marquette Div., y.
Darling Valve & Mfg. Co., b, c, d, i, j, x.
Denison Engrg. Div., American Brake Shoe Co., g thru j, l, o, v, b-1, c-1, d-1, h-1, j-1, k-1, l-1, o-1, q-1.
Dukes Co., Inc., l, v.
Dumont Aircraft Fitting Co., b, f, g, j, k, m, o, q, s thru x, o-1, c-1, d-1, f-1 thru i-1, l-1, m-1, p-1, v-1.
Dynamic Controls Corp., c, d, l, n, o, r, u, v, o-1, c-1, f-1, i-1, l-1, p-1.
Dynamic Devices, Inc., f-1.
Eastern Industries Inc., v, i-1.
Eckel Valve Co., o thru d, f thru i, l, n, o, t thru w, e-1, f-1, l-1, n-1, t-1.
Electric Auto-Lite Co., The, o, i-1, l-1.
Electrol Inc., i, j, n, v, y, z, b-1, c-1, d-1, g-1, h-1, j-1, l-1, q-1.
Electro-Tech Equipment Co., l-1.
Emerson Electric Mfg. Co., The, Electronics & Avionics Div., v, i-1.
Engineered Products Co., The, j, y.
Essex Mfg., Co., Inc., d, g, i, j, o-1.
Fairbanks Co., The, d, j, s, y, q-1.
Firestone Tire & Rubber Co., The, Guided Missile Div., d.
Firewel Co., Inc., The, l, q, c-1.
Fischer & Porter Co., l, c-1.
Fisher Governor Co., f, l, m, r, u, x, o-1, c-1, d-1.
Flight Refueling, Inc., b, c, d, j, l, r, e-1, f-1.
Fluid Regulators Corp., h, i, k, v, y, c-1 thru f-1, h-1, l-1.
Frebank Co., o, d, i thru l, n, t thru w, o-1, c-1, d-1, h-1, l-1.
Fulton-Irgon Corp., The
Futurecraft Corp., c, d, f, g, i thru m, p, t, u, x, o-1, c-1 thru f-1, j-1, k-1, l-1, q-1, s-1.
GAR Precision Parts, Inc., k, v, o-1, c-1, e-1.
Galland-Henning Nopak Div., d, l, v, o-1, l-1.
General Electric Co., Apparatus Sales Div., i-1.
Greer Hydraulics, Inc., o, c, g, h, j, k, l, v, y, z, o-1, q-1.
Grinnell Co., b, c, d, f, g, i, l, m, n, t, v, w, x, o-1, b-1, c-1, f-1, q-1, t-1.
Grove Valve & Regulator Co., d, f, g, h, j, l, m, s thru y, o-1, c-1, d-1, f-1, l-1, q-1, v-1.
Guided Missile Div.- De Havilland Aircratt of Canada, Ltd., g, o-1, d-1, q-1.
B. H. Hadley, Inc., b thru p, r, t thru z, o-1 thru l-1, n-1, o-1, q-1 thru v-1.
Hagon Chemicals & Controls, Inc., l.
Hamer Valves, Inc., c, u, w, x, z, f-1, t-1, v-1.
Hamilton Standard, Div.-United Aircraft Corp., d, i, m, n, p, u, o-1, c-1, d-1, i-1.
Hammel-Dahl Div.-General Controls Co., b, c, d, f, g, j, l, m, s thru y, o-1, c-1, d-1, f-1, l-1, g-1, v-1.
Hannifin Co., Div.-Parker-Hannifin Corp., j, k, o, o-1, c-1, e-1, l-1.
Haskel Engrg. & Supply Co., a thru d, f thru o, s thru w, y, z, o-1 thru o-1, g-1, h-1, i-1, l-1.
Haveg Industries, Inc., b, c.
High Vacuum Equipment Corp., s-1.
Highland Rim Machine Works Inc., f-1.
Hills-Mc Canna Co., b, c, m.
Hoefner Corp., o thru d, f thru m, t thru w, o-1 thru f-1, i-1, p-1, q-1.
Hoke Inc., c, d, i, k, l, m, s, t, u, y, c-1, l-1, q-1.
Holex, Inc.
Hoot Products Co., g, j, k, n, v, x, c-1, j-1.
Hoover Electric Co., b, d, l, o, v, x, g-1, h-1, l-1, q-1, r-1.
Hughes Tool Co., Aircraft Div.
Walter J. Hyatt Co., The, b, d, g thru m, o, u, v, w, y, z, o-1, c-1 thru j-1, l-1, o-1, s-1, t-1.
Hydra-Power Corp., d, f thru l, n, o, u, v, x, o-1, b-1, d-1, g-1 thru l-1, r-1.
Hydraulic Press Mfg. Co., The, Div.-Koehring Co., v, d-1, l-1.
*HYDRO-AIRE CO., DIV.-CRANE CO., c, d, f thru o, r thru l-1.
Hydrodyne Corp., Skinner Seal Div., b, c, d, i, j, k, m thru q, t, u, v, x, o-1 thru d-1, f-1, j-1 thru m-1, t-1.
Hydromatics, Inc., b, c, d, f thru i, l, n, p, t thru x, z, o-1 thru d-1, f-1, g-1, h-1, n-1, o-1, q-1 thru v-1.
Imperial Brass Mfg. Co., The, l, m, v, y, z.
Industrial Engrg. Corp., v, c-1.
Integral Corp., o thru d, f thru o, u, v, y, o-1, c-1, d-1, e-1, i-1 thru m-1, s-1.
Interstate Engrg Corp., d thru j, l, n, r, t, u, v, x, o-1, c-1, d-1, g-1 thru l-1, q-1, r-1.
James, Pond & Clark, Inc., b, c, d, h, j, t thru w, z, o-1, d-1, e-1, f-1, j-1.
Jamesbury Corp., b, d, x, o-1, f-1, t-1.
*JANITROL AIRCRAFT DIV., SURFACE COMBUSTION CORP., d, f, h, i, j, l, m, n, o-1, c-1, d-1, h-1.
Jerguson Gage & Valve Co., s.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp., n.
*KEARFOTT CO., INC., i-1.
Kemp Aero Products, o thru o, s thru z, o-1 thru i-1, p-1, q-1, r-1.
Walter Kidde & Co., Inc., Aviation Div., j, u, o-1, c-1, d-1, h-1, i-1, l-1.
Kieley & Mueller, Inc., c, l, m, s, t, u, w, z, c-1, q-1.
Kinney Mfg. Div., The New York Air Brake Co., s-1.
Koehler Aircraft Products Co., d, f, l thru r, u, w thru z, o-1, b-1, d-1, f-1, h-1, i-1, l-1, m-1, o-1, q-1, r-1.
Kohler Co., d, f thru l, n, r, v, y, z, o-1, c-1, d-1, e-1.
*KOONTZ-WAGNER ELECTRIC CO., INC., o thru d, f, h, i, l, o, u, v, b-1, f-1, j-1, k-1, l-1.
Ladish Co., c, j, l, s, y, z, m-1.
Lear, Inc., l, u, v, x, o-1, i-1.
Lear, Inc., Grand Rapids Div., l, l-1.
Lear, Inc., Lear-Romec Div., v, o-1, c-1, i-1.
Ledeen Inc., l, o-1.
*WALLACE O. LEONARD, INC., d, f, g, i, k, l, n thru q, t thru w, o-1, c-1 thru f-1, h-1, i-1, l-1, o-1, h, j, s-1.
Leslie Co., c, d, f, g, l, m, o, u, v, x, o-1, c-1, d-1, f-1, i-1, l-1, n-1, p-1, q-1, r-1, t-1, v-1.
Linde Co., Div.-Union Carbide Corp., t, u, w.
G. W. Lisk Co. Inc., k-1, l-1.
Lundy Mfg. Corp., d, f, l, x.
Luzerne Rubber Co., c.
M. C. Mfg. Co., i, j, l, o, t thru w, o-1 thru e-1, g-1, h-1, j-1, l-1, r-1.
Marotta Valve Corp., b, c, d, f thru l, o, t thru w, o-1, c-1, d-1, f-1, h-1, j-1, k-1, l-1.
Jas. P. Marsh Corp., d, l, s, t, u, y, c-1, l-1, p-1.
Mason-Neilan, f, i, l, m, r, x, o-1, c-1, n-1.
Matheson Co., Inc., The, j, t, u, w, c-1.
Mechanical Air Controls, Inc., l, o, o-1, h-1, l-1, n-1, s-1.
Minneapolis-Honeywell Regulator Co., Industrial Product Group, b, c, d, f, i, l, m, n, u, x, o-1, c-1, f-1, q-1.
Minneapolis-Honeywell Regulator Co., Ordnance Div., v, o-1.
J. J. Monaghan Co., Inc., d.
Monogram Precision Industries
Moog Valve Co., Inc., g, v, i-1.
Mueller Brass Co., i, j, m, s, d-1, l-1, q-1.
NRC Equipment Corp., s, q-1, s-1.
National Airoil Burner Co., d, s, y, z.
National Pneumatic Co., Inc., Holtzer-Cabot Divs., o-1, l-1.
National Research Corp., s-1.
Natl. Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc., l, i-1.
National Welding Equipment Co., d, h, j, t, u, w, y.
OPW-Jordan, c, d, f, i, j, l, m, c-1, d-1, p-1.
Dil-Dyne, Inc., i, j, k, m, l-1.
Dliver Corp., The, v.
Owatonna Tool Co., v.
Ozone Metal Products Corp., o, g, h, j, k, l, v, y, o-1, d-1, e-1, i-1 thru l-1.
Pacific Scientific Co., l-1.
Pocific Valves, Inc., c, g, i, s, x, y.
Parker Aircraft Co., o thru p, r, t thru z, o-1 thru r-1.
Parker Hydraulics Div., Parker-Hannifin Corp., o, j, k, l, v.
Peerless Machine Co., c, d, h, j, k, t, u, v, g-1, t-1.
Pennsylvania Pump & Compressor Co., d.
Pesco Products Div.-Borg-Warner Corp., i-1.
Pneu-Hydro Valve Corp., o thru z, o-1 thru t-1.
Power-Tronic Systems Inc., i-1.
Precision Equipment Co., Inc., b, c, d, f, i, j, o, t thru w, y, o-1, d-1, e-1, f-1, l-1, m-1, q-1, t-1, v-1.
Puritan Compressed Gas Corp., Aviation Div., u.
Racine Hydraulics & Machinery Inc., g, v.
Randall Engrg. Corp., o thru d, f, g, j, k, m, n, t, u, v, z, o-1, c-1, d-1, l-1.
Reaction Motors Div., Thiokol Chem., Corp., f, i thru l, n, t, u, c-1, d-1, f-1, j-1, r-1.
Reinhold Engrg. & Plastics Co., o-1.
Republic Mfg. Co., o, c, d, f thru o, s thru z, o-1, c-1 thru h-1, j-1, l-1, m-1, q-1, s-1.
Research Controls, b, c, d, l, m, t, u, w, x, y, o-1, c-1, f-1, q-1, r-1, t-1.
Rivett Lathe & Grinder Inc., d, j, k, l, o, v, o-1, c-1, d-1, h-1, l-1.
Robbins Aviation, Inc., c, d, s thru y, o-1, q-1.
Rocketdyne Div.-North American Aviation, Inc.
Ronson Hydraulic Units Corp., o, d, f thru l, n, o, t thru w, o-1 thru e-1, g-1, h-1, j-1, k-1, l-1, o-1, r-1.
Rotex Punch Co., Inc., d, h, v, o-1, k-1, l-1.
Milton Roy Co., d-1.
Roylyn Inc., g, w, f-1.
Ryan Aeronautical Co., q.
S-P Mfg. Corp., The, o-1.
Sargent Engrg. Corp., d, f thru m, o, t thru x, o-1, thru e-1, g-1 thru l-1, o-1, q-1, r-1.
Schutte & Koerting Co., h, i, q, s.
Scientific Engrg. Labs., Inc., s-1.
Sealol Corp., j, k, n, v, d-1, f-1.
Servomechanisns, Inc., i-1.
Simmonds Aerocessories, Inc., b, c, d, f, g, l, m, s thru y, o-1, c-1, f-1.
Sinclair-Collins Valve Co., Div.-IBEC, o, d, k, l, m, o, q, s thru v, o-1, c-1, h-1, j-1, l-1, q-1 thru t-1.
Sirvalco Systems Corp., b, c, d, f, g k thru q, t thru x, o-1, c-1, e-1 thru i-1, l-1, q-1, t-1.
Skinner Electric Valve Div., c, d, f, g, l, o, t, u, w, o-1, f-1, l-1.
Skyvalve Inc., b, c, d, h, l thru o, s thru v, z, o-1, c-1, j-1, k-1, l-1, o-1, q-1.
Smith-Morris Corp., z.
Solar Aircraft Co., o, l, o-1, d-1.
Standard Controls, Inc., i-1.
Standard-Thomson Corp., Clifford Mfg. Co. Div., h, i, n, o-1, c-1, d-1, p-1, s-1.
F. J. Stokes Corp., s-1.
A. U. Stone & Co., Inc., b, c, d, f, g, h, j, k, l, u, v, w, o-1, c-1 thru f-1.
Stratos, Div.-Fairchild Engine & Airplane Corp., u thru e, h thru p, t thru x, o-1 thru l-1
Surface Combustion Corp., d, l, o, u.
Tactair Valve Div.-Aircraft Products Co., d, i thru l u, v, o-1, b-1, c-1, e-1, h-1, j-1, k-1, l-1.
Talley Corp., The, b, c, d, f, h, i, l, m, o, q, t, w, x, o-1, b-1, d-1, l-1.
Tapco Group, Thompson-Ramo-Wooldridge Inc., d, f, g, l, o, v, x, o-1, c-1, d-1, l-1.
Taylor Winfield Corp., d, o, o-1, l-1.
Technical Apparatus Builders, o.
Thermech Engrg. Corp., l, m, v.
Thiokol Chemical Corp., g, v, f-1, r-1.
Transco Products, Inc., d, h, i, j, n, p, x, c-1, d-1, l-1.
Turbo Products, Inc., d, f, g, i, l thru r, v, x, o-1, b-1, f-1, g-1, h-1, l-1, r-1.
Uniflow Valve Corp., c, d, k, l, m, s, u, v, w, y, z, o-1, k-1, p-1, s-1.
United Aircraft Products, Inc., b thru v-1.
United Control Corp., i, o-1, d-1, v-1.
United Electric Controls Co., l, c-1, p-1.
United States Rubber Co., m.
United Supply Co.
Vacuum Research Co.
Valcor Engrg. Corp., b, c, d, f, g, i, l thru o, q, t thru w, o-1, f-1, j-1, k-1, l-1, r-1, t-1.
Vap-Air Aeronautical Products Div., Vapor Heating Corp., o-1, c-1.
Veeco Vacuum Corp., s-1.
Vickers Inc., Div.-Sperry Rand, o, i, j, l, n, o, v, y, b-1, c-1, d-1, h-1, i-1, l-1.
Vickers Inc., Marine & Drdnance Dept., Machinery Hydraulics Div., j, l, o, v.
Vilter Mfg. Co., The, r, s, d-1.
Vinson Mfg. Co. Inc., o thru r, t thru z, o-1 thru h-1, j-1, k-1, l-1, n-1, o-1, r-1, s-1, t-1.

Valdorf Fluid Systems. Div.-F. C. Huyck & Sons, c, d, f thru r, t thru d-1, f-1, g-1, h-1, j-1, k-1, l-1, n-1, o-1, q thru u-1.
Vallace & Tiernan Inc., u, c-1, n-1.
Valworth Co., c, d, h thru l, s thru v, x, y, z, d-1, f-1.
Vatertown Div., The New York Air Brake Co., v.
WEATHERHEAD CO., THE, a, d, h, j, k, n.
Vestinghouse Air Brake Co., Industrial Products Div., j, u, o-1, c-1, j-1.
Vestinghouse Electric Corp., a, v, b-1, i-1.
Veston Hydraulics Ltd.-Sub., Borg-Warner Corp., c, l, o, t thru w, y, o-1 thru f-1, h-1 thru l-1, q-1, r-1, t-1.
Vhittaker Controls, Div.-Telecomputing Corp., b thru r, t thru x, z, o-1 thru h-1, j-1, k-1, l-1, n-1 thru u-1.

VAPOR PHASE CHROMATOGRAPHS
See CHROMATOGRAPHS, VAPOR PHASE

VAPORIZERS, LIQUID OXYGEN

AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Cambridge Co.-Div.-Carrier Corp.
Clary Dynamics
Dumont Aircraft Fitting Co.
Paul Hardeman, Inc.
Hoefner Corp.
Hofman Labs., Inc.
Hydromatics, Inc.
Linde Co., Div.-Union Carbide Corp.
Parts Engrg. Co., Inc.
Ronan & Kunzl, Inc.
Stearns-Roger Mfg. Co.
Superior Air Products Co.

VARIABLE INOUCTANCES
See INDUCTANCES, VARIABLE

VARNISH
Acme Wire Co.
Arco Co., The
Aries Laboratories, Inc.
Carl H. Biggs Co.
Borden Chemical Co.
DOW CORNING CORP.
Krylon, Inc.
Midland Industrial Finishes Co.
Penetone Co., The
United States Varnish Co.
Westinghouse Electric Corp.

VESSELS
American Machine & Foundry Co., Government Products Group
Anchor Metal Spinning Co., The
Basco Metal Products, Inc.
Brooks & Perkins, Inc.
Cambridge Co.-Div.-Carrier Corp.
Chicago Bridge & Iron Co.
Doyle & Roth Mfg. Co., Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
General American Transportation Corp.
Paul Hardeman, Inc.
Philip A. Hunt Co.
Industrial Engrg. Corp.
Intercontinental Mfg. Co., Inc.
Kahn & Co., Inc.
Kaiser Aircraft & Electronics, Div.-Kaiser Industries Corp.
Kaiser Metal Products, Inc.-Fleetwings Div.
L. W. Kellogg Co., The
Kelter Kidde & Co., Inc., Aviation Div.
Mercury Tool & Mfg. Corp.
MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER OIV.
Monogram Precision Industries
National Tube Div.-United States Steel Corp.
Newbrook Machine Corp.
Pater Corp.
Morris-Thermador Corp.
Pittsburgh-Des Moines Steel Co.
Precision Sheet Metal, Inc.
Pressed Steel Tank Co.
Reinhold Engrg. & Plastics Co.
Rdw. Renneburg & Sons Co.
Rohr Aircraft Corp.
Sailmobile Inc.
Salter Mfg. Co., The

VHF OMNIRANGE RECEIVING EQUIPMENT
See RECEIVING EQUIPMENT, VHF OMNIRANGE

VHF TRANSCEIVERS
See TRANSCEIVERS, VHF

VIBRATION ABSORBERS
American Felt Co.
American Latex Products Corp.
Anaconda Metal Hose Div., The American Brass Co.
Applied Design Co.
Barco Mfg. Co.
Barry Controls Inc.
Bushings, Inc.
Cleveland Pneumatic Industries, Inc.
Continental Rubber Works
DOW CORNING CORP.
Dow-Elco, Inc.
Federal Shock Mount Corp.-Div. The Korfund Co., Inc.
Finn Aeronautical Div., T. R. Finn & Co., Inc.
***HOUOAILLE INOUSTRIES, INC., BUFFALO HYORAULICS DIV.**
Johns-Manville
J. W. Johnson & Co., Inc.
Walter Kidde & Co., Inc., Aviation Div.
Lord Mfg. Co.
M B Mfg. Co.
Mc Dowell-Wellman Companies, The
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER OIV.**
Pacific Scientific Co.
Robinson Technical Products, Inc.
Rubbercraft Corp. of California
A. T. Stevens Co.
Taylor Devices, Inc.
Ucinite Co., The, Div.-United-Carr Fastener Corp.
United States Rubber Co.
Western Felt Works & Acadia Synthetic Products Div.

VIBRATION CONTROLS
American Machine & Foundry Co., Greenwich
Bushings, Inc.
Cleveland Pneumatic Industries, Inc.
Epic, Inc.
Genisco, Inc.
B. F. Goodrich Industrial Products Co.
Gulton Industries, Inc.
***HOUOAILLE INOUSTRIES, INC., BUFFALO HYORAULICS DIV.**
J. W. Johnson & Co., Inc.
Kahn & Co., Inc.
Ling Electronics, Inc.
Lord Mfg. Co.
M B Mfg. Co.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER OIV.**
Pacific Scientific Co.
Robinson Technical Products, Inc.
Solartron Inc.

VIBRATION MEASURING EQUIPMENT
See MEASURING EQUIPMENT, VIBRATION

VIBRATION & SHIMMY OAMPERS
See OAMPERS, VIBRATION & SHIMMY

VIBRATION & SHOCK MOUNTINGS
See MOUNTINGS, VIBRATION & SHOCK

VIBRATORS, INSTRUMENT PANEL
Cornell-Dubilier Electric Corp.
Globe Industries, Inc.
J. W. Johnson & Co., Inc.
Kahn & Co., Inc.
Solartron Inc.
Talley Corp., The

VIBRATORS, MULTIVIBRATORS
Aerolab Development Co.
Bendix Aviation Corp., York Div.
J. W. Johnson & Co., Inc.
Solartron Inc.
Talley Corp., The

VIBRATORS, ULTRASONIC
J. W. Johnson & Co., Inc.
Kin Tel Div.-Cohu Electronics, Inc.
Massa Div.-Cohu Electronics, Inc.

VICES
Aerotec Corp., The
Aircraft Tools, Inc.
Burklyn Co.
Covel Mfg. Co.
A. L. Dery & Sons Tool & Die Co.
Desmond-Stephan Mfg. Co., The
Emmett Mfg. Co.
Kenco Mfg. Co.
Richards-Wilcox Mfg. Co.
Snap-On-Tools Corp.
Swayne, Robinson & Co.

VIEW FINOERS
See FINOERS, VIEW

VISCOMETERS
Automation Products, Inc.
Bristol Co., The
Ferranti Electric Inc.
Fisher Scientific Co.
Fish-Schurman Corp.
Gardner Laboratory, Inc.
General Electric Co., Apparatus Sales Div.
Hagan Chemicals & Controls, Inc.
Hallikainen Instruments
Scientific Instrument Co.

VOLTAGE SUPPLIES, OECADE
American Aeroparts
Bendix Aviation Corp., York Div.
Beva Lab., Inc.
G. L. Collins Corp.
Davenport Mfg. Co.
John Fluke Mfg. Co., Inc.
Hevi-Duty Electric Co.
Julie Research Labs., Inc.
North Hills Electric Co., Inc.
Technical Apparatus Builders
Telectro Industries Corp.
Tel-Instrument Electronics Corp.

VOLTMETERS
American Aeroparts
American Machine & Foundry Co., Government Products Group
Assembly Products, Inc.
Avo Ltd.
Ballantine Labs., Inc.
Beckman Instruments, Inc., Berkeley Div.
Bristol Co., The
Burr-Brown Research Corp.
Burton-Rogers Co., Sales Div.-Hoyt Electrical Instruments.
Columbia Electric Mfg. Co.
Consolidated Electrodynamics Corp.
Cubic Corp.
Curtiss-Wright Corp., Electronics Div.
Daven Co., The
Daystrom Pacific Div.-Daystrom, Inc.
Dejur-Amsco Corp., Electronic Sales Div.
Donner Scientific Co.
Dresser Industries, Inc.
Electric Design & Mfg. Co.
Electro Instruments, Inc.
Electro-Tech Equipment Co.
Elsin Electronics Corp.
Epic, Inc.
Flow Corp.
John Fluke Mfg. Co., Inc.
General Electric Co., Apparatus Sales Div.
Greibach Instruments Corp.
Helipot Div.-Beckman Instruments Inc.
Hewlett-Packard Co.
Hoyt Electrical Instrument Works, Burton Rogers Co.
Kay Electric Co.
Keithley Instruments, Inc.
Kin Tel Div.-Cohu Electronics, Inc.
Marconi Instruments
Marion Instrument Div.
Meters Inc.
Metronix, Inc., Sub.-Assembly Products, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Product Group
F. L. Moseley Co.
National Electronics
New England Scientific Instruments Co.
Non-Linear Systems, Inc.
North Atlantic Industries, Inc.
Paul Nurches Co.
Pace Electrical Instruments Co., Inc.
Physics Research Laboratories, Inc.
Q. V. S. Inc.
Rawson Electrical Instrument Co.
Republic Aviation Corp.
Simpson Electric Co.
Sun Electric Corp., Aeronautical Div.
Systron Corp.
Technical Apparatus Builders
Technique Associates Div., Duncan Electric Co., Inc.
Technology Instrument Corp.
Wacline, Inc.
Waldom Electronics Inc.
Westinghouse Electric Corp.
Weston Instruments, Div.-Daystrom, Inc.

VOLUMETRIC FLOWMETERS
See FLOWMETERS, VOLUMETRIC

VSWR MEASURING EQUIPMENT
See MEASURING EQUIPMENT, VSWR

WALKING BEAM SYSTEMS
***NEWAY EQUIPMENT CO.**

WARNING UNITS, FUEL PRESSURE
ACF Industries Inc.
Aircraft Controls Co., Div., Gorn Electric Co., Inc.
Bendix Aviation Corp.-Montrose Div.
A. Biederman, Inc.
Cole-Hersee Co.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Frebank Co.
Simmonds Aerocessories, Inc.
United Aircraft Products, Inc.
United Electric Controls Co.

WARNING UNITS, TEMPERATURE
***ARNOUX CORP.**
Avien, Inc.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Fenwal Inc.
C. G. Hokanson Co., Inc.
Thermo Electric Co., Inc.
United Aircraft Products, Inc.
United Control Corp.
United Electric Controls Co.
West Instrument Corp.

WASHERS
a. Brass
b. Ceramic
c. Felt
d. Fibre
e. Insulating
f. Lock
g. Metal
h. Mica
i. Plastic
j. Rubber

Abbott Screw & Mfg. Co.,a, c, d, f, g.
Accurate Electronics Corp., Dept. D, a, d, e, g, i.
Acme Mfg. & Gasket Co., a, c thru g, i, j.
Aero Bolt & Screw Co., Inc., g, i.
Aero Gasket Corp., a, f, g, j.
All Specs Corp., a, d, f, g.
Allied Plastics Supply Corp., d, e, h, i, j.
Allmetal Screw Products Co., Inc., f.
Alloys Unlimited Inc., g, i.
Alpha Metals, Inc., g, i.
Alpitec, Inc., a, e, f, g.
Aluminum Co. of America, g.
Amatom Electronic Hardware Co. Inc., a, d, e.
American Aeroparts, a, c, d, g thru j.
American Agile Corp., i.
American Brass Co., The, a.
American Lava Corp., b.
American Standard Products, Inc., a thru g, i, j.
Amplex Div.-Chrysler Corp., g.
Anchor Packing Co., The, c, d, i, j.
Anti-Corrosive Metal Products Co., Inc.,e, f, g, i.
Aristacrat Plastics, Inc., i.
Armstrong Cork Co., j.
Atlas Screw & Specialty Co., a, f, g.
Auburn Mfg. Co., The, a thru e, g thru j.
W. L. Barrett Co., The, a, f, g.
W. A. Beauchaine & Sons Inc., i.
Belmont Smelting & Refining Works, Inc., g.
Bergen Carbide Co., b, g.
Best Aircraft Corp., a, f, g.
Birnbach Radio Co., Inc., a, e, f.
Bland Burner Co., The, a, g.
Bonny Mfg. Corp., e, i.
Booth Felt Co. Inc., c.
Boston Felt Co., c.
Calinoy-Div.-Illinois Tool Works, a, d thru g, i.
Capital City Mfg. Co., a, g.
Centralab, Div.-Globe-Union, b, e.
Century Fasteners Corp., a, d thru g, i, j.
Chase Brass & Copper Co., Inc., a, g.
Chemplast, Inc., e, i.
Chicago Gasket Co., i.
Cleveland Graphite Bronze, Div.-Clevite Corp., a, g.
Colonial Rubber Co., j.
Connecticut Hard Rubber Co., The, j.
Continental Diamond Fibre Corp., d, e, h, i.
Continental Rubber Works, j.
Cooper Industries, Inc., f, g, i, j.
Corbin Products Div., a, f, g.
Crystal-X Corp., i.
Diamonite Products Mfg. Co., b.
Division Lead Co., g.
Dixon Corp., i.
Dresser Mfg. Div., Dresser Industries, Inc., g.
Du-Co Ceramics Co., b, e.
R. C. Dudek & Co., f.
Eaton Mfg. Co., f.
Eaton Mfg. Co., Reliance Div., a, f, g.
Electrical Insulation Co., Inc., d, e, i.
Electrical Refractories Co., The, b.
Eljay Corp., i.
Emeloid Co., Inc., The, i.
Emerson Plastics Corp., d, e, h, i.
Emmco Plastic Fabricators-Div.-E. M. McCarthy Machine Co.,d, e, i.
Excelsior Leather Washer Mfg. Co., Inc., c, d, i, j.
Federal Screw Products Inc., a, d, f, g, j.
Felters Co., The, c.
Flexrock Co., i.
Fluorocarbon Co., The i.
Fluorulon Labs., Inc., i.
Ford Radio & Mica Corp., h.
Franklin Fibre-Lamitex Corp., d, e, i.
Frenchtown Porcelain Co., b.
George K. Garrett Co., Inc., a, e, f.
Gasket Mfg. Co. Inc., a, c, d, e, g thru j.
General Cement Mfg. Co., Div.-Textron, Inc., d, f, g.
General Gasket Inc., a, c, d, e, g, i, j.
Gladding, McBean & Co., b.
Goshen Rubber Co., Inc., j.
Greene, Tweed & Co., d, j.
Hampden Mfg. Co., Inc., d, i.
H. M. Harper Co., a.
Hays Mfg. Co., e, i.
Hobbs Mfg. Co., f.
Huntington Rubber Mills, j.
Integrated Mica Corp., e, h.
Joclin Mfg. Co., e, i.
Jodee Plastics Co., d, i.
Johns-Manville, d, e, i, j.
Kip Electronics Corp., b, e.
Kling Metal Spinning & Stamping Co., a, g.
Lamtex Industries, Inc., i.
Thomas J. Long, Inc., d, e, i.
Louthan Mfg. Co., The, Div.-Ferro Corp., b.
Lucas Aircraft Supply Co., a thru j.
M & Q Plastic Products, i.
Magnetic Shield Div. Perfection Mica Co., c, d, h, i.
Mercury Tool & Mfg. Corp., a, d, g.
Mica Fabricating Co., b, e, h, i.
Mica Insulator Div.-Minnesota Mining & Mfg., Co., e, h.
Minnesota Mining & Mfg. Co., b, h.
***MIRAX CHEMICAL PRODUCTS CORP., METAL CONTAINER DIV., i, j.**
Mitronics Inc., b.
Monogram Precision Industries
J. I. Morris Co., a, f, g.
National Beryllia Corp., b.
National Ceramic Co., b.
National Tel-Tronics Corp., d, i.
National Vulcanized Fibre Co., d, e, i.
New England Tape Co., Div.-United-Carr Fastener Corp., i.
Orchard Industries, Inc., Actionflex Div., e, i, j.
PIC Design Corp., Sub.-Benrus Watch Co., Inc., f, g.
Pacific Cut Washer Co., a, d thru i.
Peerless Products Industries, a, c, d, e, g thru j.
Penn Fibre & Specialty Co., Inc., a, c, d, e, g thru j.
Pilgrim Products Inc., e, i.
Plastic Age Sales, Inc., i.
Polymer Corp., The, e, i.
Positive Lock Washer Co., The, f.
R & R Engrg. Co., a, c, d, g, i, j.
Raybestos-Manhattan, Inc., j.
Raybestos-Manhattan, Inc., Pa., i, j.
Republic Steel Corp., f, g.
Rogers Corp., d, e, i, j.
Milton Ross Metals Co., The, e, i.
Rubber Teck Inc., i.
Rubbercraft Corp. of California, j.
Saginaw Bearing Co., a.
St. Regis Paper Co., Panelyte Div., e, i.
Sanford Plastics Corp., i.
Sealectric Switch & Relay Corp., d, e, j.
W. S. Shamban & Co., i.
Silicone Insulation, Inc., e, h, i.
Sinclair Mfg. Co., a, d, e, g, i.
Skinner Precision Products, d.
Slip Ring Co. of America, i.
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co., e, i.
Spruce Pine Mica Co., Inc., e, h.
Standard Locknut & Lockwasher Inc., f.
Stonley-Judd Div.-The Stonley Works, a, e, g
Star Stainless Screw Co., a, f.
Stover Co., Inc., The , a, c, d, e, g, i, j.
A. T. Stevens Co., j.
Stevens Products, Inc., e.
Superior Steatite & Cermamic Corp., b, e.
Teiner Engrg. Corp., a, g.
Thermal Refractories Corp., b.
Thompson-Bremer & Co., f.
Turbo Products, Inc., i.
United Mineral & Chemical Corp., h.
U. S. Fiber & Plastics Corp., i.
United States Rubber Co., j.
Variety Aircraft Corp., a, g.
Waterbury Companies, Inc., i.
Western Felt Works & Acadia Synthetic Products Div., c, j.
Westlake Plastics Co., i.
Wilmington Fibre Specialty Co., d, e, i.
Wrought Washer Mfg., Co., a, c thru i.

WATER INJECTION EQUIPMENT

Accessory Products Co., Div.-Textron Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Chandler Evans Corp.
Components Corp.
Curtiss-Wright Corp., Santa Barbara Div.
Eastern Industries Inc.
Hydra-Power Corp.
Lear, Inc.
Marquardt Aircraft Co.
Talley Corp., The
Tapco Group, Thompson-Ramo-Wooldridge Inc.
Turbo Products, Inc.
Washington Technological Associates Inc.
Western Gear Corp.

WATER INJECTION SYSTEMS
See INJECTION SYSTEMS, WATER

WAVE TRAPS

Dietz Design & Mfg. Co.
Meridian Metalcraft, Inc.
Radar Design Corp.

WAVEGUIDE STANDS
See STANDS, WAVEGUIDE

WAVEGUIDE WINDOWS
See WINDOWS, WAVEGUIDE

WAVEGUIDES

Ainslie Corp.
Aircom Inc.
Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
***AVCO MFG. CORP., CROSLEY DIV.**
Bart Mfg. Corp.
Budd Stanley Co. Inc.
Carmac Aviation
Central Electronic Mfrs., Div.-Nuclear Corp. of America
Chemalloy Electronics Corp.
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
Engelhard Industries Inc., D. E. Makepeace Div.
FXR, Inc.
Gabriel Co., The, Gabriel Electronics Div.
Gilfillan Bros. Inc.
John Gombos Co., Inc.
Highland Rim Machine Works Inc.
Hughes Tool Co., Aircraft Div.
Walter J. Hyatt Co., The
I-T-E Circuit Breaker Co.
ITT Labs.
Indusl. Prod.-Danbury Knudsen Div. Amphenol-Barg Electronics Corp.
J-V-M Microwave Co.
***KEARFOTT CO., INC.**
***KEARFOTT CO., INC., MICROWAVE DIV.**
Lieco, Inc.
Litton Industries, Inc.
Mercast Mfg. Corp.
Mercury Tool & Mfg. Corp.
Meridian Metalcraft, Inc.
Metal Fabricators Corp.
Microwave Associates, Inc.
Monogram Precision Industries
N. R. K. Mfg. & Engrg. Co.
Narda Microwave Corp., The
National Beryllia Corp.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Omega Labs., Inc.
Portchester Instrument Corp.
Radiatronics, Inc.
Ryan Aeronautical Co.
Savage-Rowe Plating Co., Inc.
Scientific-Atlanta, Inc.
Special Instruments Div., British Industries Corp.
Standard Metals Corp.
Telerad Mfg. Corp.
Thermal Refractories Corp.
Turbo Machine Co.
United Aircraft Products, Inc.
United Shoe Machinery Corp., Ordnance Dept.
Waltham Horological Corp.
Walworth Co. Electronics Div.
Washington Aluminum Co., Inc.
Waveline, Inc.
Western International Co.
Wilks Precision Instrument Co., Inc.

WAVEGUIDES, FLEXIBLE

Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Borker Sales Co,
Bendix Aviation Corp., York Div.
Budd Stanley Co. Inc.
Co-Operative Industries, Inc.
Gilfillan Bros. Inc.
Walter J. Hyatt Co., The
ITT Labs.
***KEARFOTT CO., INC.**
Lieco, Inc.
Litton Industries, Inc.
Narda Microwave Corp., The
Portchester Instrument Corp.
Savage-Rowe Plating Co., Inc.
Telerad Mfg. Corp.

WAVEGUIDES, RIGID

Ainslie Corp.
Aircom Inc.
Aircom Inc. of New Jersey
Airtron Inc., Div.-Litton Industries
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich
Bart Mfg. Corp.
Bendix Aviation Corp., York Div.
Budd Stanley Co. Inc.
Central Electronics Mfrs., Div.-Nuclear Corp. of America
Coaxial Connector Co. Inc.
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
FXR, Inc.
Federal Mfg. & Engrg. Corp.
Gilfillan Bros. Inc.
Walter J. Hyatt Co., The
I-T-E Circuit Breaker Co.
ITT Labs.
Indusl. Prod.-Danbury Knudsen Div. Amphenol-Barg Electronics Corp.
J-V-M Microwave Co.
***KEARFOTT CO., INC.**
D. S. Kennedy & Co.
Lieco, Inc.
Litton Industries, Inc.
Mercast Mfg. Corp.
Meridian Metalcraft, Inc.
Metal Fabricators Corp.
Metals & Controls Corp., General Plate Div.
Microwave Associates, Inc.
N. R. K. Mfg. & Engrg. Co.
Narda Microwave Corp., The
National Beryllia Corp.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Omega Labs., Inc.
Portchester Instrument Corp.
Radiatronics, Inc.
Ryan Aeronautical Co.
Savage-Rowe Plating Co., Inc.
Scientific-Atlanta, Inc.
Special Instruments Div., British Industries Corp.
Standard Metals Corp.
Telerad Mfg. Corp.
Thermal Refractories Corp.
Turbo Machine Co.

Victar R. F. & Microwave Co.
Waltham Horological Corp.
Walworth Co. Electronics Div.
Washington Technological Associates Inc.
Waveline, Inc.
Western International Co.
Wilks Precision Instrument Co., Inc.

ELDERS
a. Automotic
b. Electric Arc
c. Inert Gas
d. Manuol

***MOTOR GENERATOR CORP.**

LDERS, SPOT
Commercial Shearing & Stamping Co.
Eisler Engrg. Co., Inc.
Erdco Engrg. Corp.
Ewald Instruments
Federal Tool Engrg. Co.
Hardman Tool & Engrg. Co.
High Vacuum Equipment Corp.
Linde Co., Div.-Union Carbide Corp.
Littan Engrg. Labs.
Peer, Inc.
Pioneer Industries Div., Almar-York Co. Inc.
Raytheon Mfg. Co.
Republic Aviation Corp.
Sciaky Brothers, Inc.
Taylar Winfield Corp.
Vacuum Tube Products, Div.-Hughes Aircraft Co.
Weldmatic Div., Unitek Corp.
Westinghouse Electric Corp.

WHEELS
BALCRANK INC., MACHINE TOOL DIV.

WHEELS, TURBINE
See TURBINE WHEELS

WIND TUNNELS
Aero Research Instrument Co. Inc.
Aeralab Development Co.
Arde-Portland, Inc.
Astravac Corp.
Beaver Precision Products Inc.
Chicago Bridge & Iron Co.
Dynametrics Corp.
Giannini Plasmadyne Corp.
Griscam-Russell Co., The
Paul Hardeman, Inc.
International Radiant Corp.
McDowell-Wellman Companies, The
Monagram Precision Industries
NRC Equipment Corp.
Nordberg Mfg. Co.
Pacific Coast Engrg. Co.
Phillips & Davies Inc.
Pittsburgh-Des Maines Steel Co.
Portland Copper & Tank Works Inc.
Schlumberger Well Surveying Corp.
Schlumberger Well Surveying Corp.
Southern Calif. Cooperative Wind Tunnel-Calif. Inst. of Technology
Task Corp.
Tinsley Labs., Inc.
T. S. Science Corp., Div.-Topp Industries, Inc.
Washington Technological Associates Inc.
Westinghouse Electric Corp.

WINDINGS, TRANSFORMER
Advanced Electronics, Inc.
Aerosol Industries, Inc.
Eisler Engrg. Co., Inc.
Electronic Labs. Inc.
Green Rectifier Co.
International Wire & Coble Co.
Wind-Air Inc.
Unitran Corp.
Vitanol Coil Co.
New York Coil Co.
Douglas Randall Inc.
Universal Toroid Coil Winding, Inc.
Westbury Electronics Inc.
Westinghouse Electric Corp.

WINDOWS, WAVEGUIDE
Artron Inc., Div.-Litton Industries
A. Beauchaine & Sons Inc.
Bomoc Laboratories, Inc.
Central Electronic Mfrs., Div.-Nuclear Corp. of America
Ceramaseal, Inc.
Chromoney-Bonordi
Douglas Microwave Co., Inc.
Electro-Mechanical Products Co.
Emmohm Corp.
G-E Circuit Breaker Co.
G-M Microwave Co.
Heco, Inc.
Microwave Associates, Inc.
R. K. Mfg. & Engrg. Co.
National Beryllio Corp.
Page Labs., Inc.
Sylvania Electric Products Inc., Special Tube Operations
Uherad Mfg. Corp.
Thermal Refractories Corp.

WIRE
a. Aluminum
b. Annunciotor
c. Antenno
d. Asbestos Insuloted
e. Beryllium Copper
f. Ceramic Insuloted
g. Cut & Stripped
h. Enomeled
i. Filoment
j. Fine Wire Speciolties
k. Forms
l. Gloss Insulated
m. Gold Ploted
n. Guy
o. Harnesses
p. High Voltage
q. Hook-Up
r. Litz
s. Magnet
t. Marking Service
u. Mesh
v. Metol Ploted
w. Metol Shielded
x. Monel
y. Nickel Clod Copper
z. Phosphor Bronze
o1. Plostic Insuloted
b1. Plotinum
c1. Recording
d1. Reels
e1. Resistance & Filoment
f1. Shielded
g1. Silicon Bronze
h1. Silver Plated
i1. Stoinless Steel
j1. Strippers, Mechonicol
k1. Tantalum
l1. Teflon Insuloted
m1. Thermocouple
n1. Zirconium

Acme Wire Co., h, l, s.
Acramark Co., The, t.
Adam Metal Supply Inc., o.
Advanced Electronics, Inc., o.
Aero Research Instrument Co. Inc., f, m-1.
Alden Products Co., g, o.
All Boro Metal Products Co., Inc., i-1.
All Specs Corp., k.
Allegheny Ludlum Steel Corp., i-1.
Alloys Unlimited Inc., a, e, i, j, k, m, s, u, x, z, b-1, h-1, i-1, k-1.
All-State Welding Alloys Co., Inc., a.
Alpitec, Inc., k.
Aluminum Co. of America, o.
American Aeraparts, c.
American Brass Co., The, j, z, g-1.
American Brazing Allays Co., a, z, g-1.
American Electric Cable Co., b, c, g, j, l, o, p, q, w, z, o-1, f-1.
American Insulated Wire Corp., d, p, q, o-1, f-1.
American Silver Co., m, b-1, h-1, k-1, n-1.
American Super-Temperature Wires, Inc., g, h, j, l, p, q, s, w, o-1, f-1, l-1.
Amphenol Coble & Wire Div., Amphenol-Borg Electronics Corp., c, q, o-1, l-1.
Amphenol Connector Div., Amphenol-Borg Electronics Corp., o.
Anoconda Wire & Coble Co., o, b, c, d, h, l, p, q, s, w, z, o-1, f-1, g-1.
Anchor Metol Co. Inc., o, k.
Armco Steel Corp., i-1.
Art Wire & Stamping Co., j, k.
Associated American Winding Co., Inc., j.
Associated Engrg. & Mfg. Corp., i, j, y.
Semon Bache & Co., l.
Barker Sales Co., o thru e, h, j, l, m, n, p thru s, u, w, o-1, c-1, f-1.
W. L. Barrett Co., The, j, k.
Bart Mfg. Corp., m, u, y.
W. A. Beauchaine & Sons Inc., o.
Belden Mfg. Co., b, c, d, g, h, j, l, o thru s, o-1, f-1, l-1.
Bendix Aviation Corp., Scintillo Div., o.
Birnbach Radio Co., Inc., c, d, g, h, j, l, n thru q, s, t, z, o-1, f-1, g-1, h-1, l-1.
J. Bishop & Co., Platinum Works, m, u, v, x, y, b-1.
Whitney Blake Co., q, o-1, f-1.
Bliss Electronic Corp., o.
Blowers Inc., j, k.
Boston Insulated Wire & Cable Co., l, p, q, o-1, f-1, l-1, m-1.
Brom Metallurgical & Chemicol Co., e, h, j, m, r, v thru z, b-1, g-1, h-1, k-1, n-1.
William Brand & Co., Inc., g, l, o, p, q, t, w, o-1, f-1.
Bridgeport Brass Co., o, e, u, v, y, z, g-1, i-1, k-1, n-1.
Bristol Co., The, m-1.
Brush Beryllium Co., The, e.
Coble Electric Products Inc., b, l, o, q, o-1.
Connon-Muskegon Corp., j.
Carpenter Steel Co., The, j, i-1.
Chose Brass & Copper Co., Inc., a, h, l, s, u, z, g-1, i-1.
Chemplast, Inc., p, o-1, l-1.
Chester Coble Corp., l, p, q, w, o-1, f-1.
Clippord Instrument Lob., Inc., o.
Conox Corp., m-1.
Consolidated Wire & Associated Companies, o thru e, h, l, p thru s, z, o-1, f-1 thru i-1, l-1, m-1.
Continental Wire Soles Corp., d, g, l, p, q, w, o-1, f-1.
Copperweld Steel Co., Wire & Cable Div., o, c, e, j, m, n, p, q, u thru z, f-1, h-1, i-1.
Cornish Wire Co., Inc., b, g, l, o, q, o-1, f-1.
Crucible Steel Co. of America, s, x.
Crystal-X Corp., o-1, l-1.
Dalweld Co. Inc., a, z, g-1.
Dell Optics Co., Ltd., l.
Delta Chemical Works, Inc., e, f, j, l, m, v, w, y, z, b-1, g-1, h-1, i-1, k-1 thru n-1.
Deringer Metallurgical Corp., b-1.
Dielectric Materials Co., l, p, q, f-1.
Wilbur B. Driver Co., e, h, i, j, l, x, z, c-1, h-1, i-1, k-1, l-1, m-1.
Duralith Corp., t.
Eagle Electric Mfg. Co. Inc., b, q, o-1, d-1.
Eastern Smelting & Refining Corp., m, b-1, h-1.
Eaton Mfg. Co., Reliance Div., a, j, x, z, d-1, g-1, i-1.
Electric Auto-Lite Co., The, h, l, p, s, o-1, h-1, l-1.
Electric Cords & Supply Corp., g, o, t.
Electronic Applications, Inc., f-1.
Electronic Parts Mfg. Co., Inc., i, j, k, y, e-1.
Electra-Tech Equipment Co., m-1.
Elmet Div.-North American Philips Co., Inc., o, h, i, m, s, h-1.
Empire Electronics Co., Inc., a.
Empire State Aluminum Corp., o.
Engelhard Industries Inc., D. E. Makepeace Div., m, b-1, h-1.
Essex Mfg. Co., Inc., k.
Essex Wire Corp., o, b, d, e, h, l, o, p, q, s, f-1.
First Electronics Corp., The, o.
Fluoracarbon Co., The, l-1.
Fort Wayne Metals, Inc., i, u, x, c-1.
General Cable Corp., o thru d, f, g, h, j, l, o thru s, u, w, z, f-1.
General Cement Mfg. Co., Div.-Textran, Inc., j-1, l-1.
General Electric Co., Apparatus Sales Div., m-1.
General Electric Co., Lamp Metals & Components Dept., f, i.
General Insulated Wire Works, g, q, w, o-1, f-1.
Claud S. Gordan Co., f, l, o, w, o-1, m-1.
Gunnar Laboratories, k, o.
Hallett Mfg. Co., g, o, w, f-1.
Hamilton Watch Co.-Industrial Div., e, j.
Harco Labs., Inc., m-1.
Haveg Industries, Inc., f, q, s, o-1, l-1.
Haynes Stellite Co., Div.-Union Carbide Corp., k-1.
Hi-Lo Manufacturing Corp., g, o.
Hitemp Wires Inc., f, h, j, l, q, o-1, f-1.
Holyoke Wire & Cable Corp., c, j, l, o, p, q, w, o-1, f-1, l-1.
Haskins Mfg. Co., h, j, e-1, m-1.
T. J. Houlihan Co., o.
International Nickel Co., The, x, y, b-1, e-1.
International Wire & Cable Co., o thru d, g, k.
Jan Hardware Mfg. Co., Inc., w.
Jeffersan Electronic Products Corp., a.
Jefferson Wire & Cable Corp., l, p, q, o-1, f-1.
Jennings Machine Corp., l-1.
Kaiser Aluminum & Chemical Sales, Inc., a.
Kanthal Corp., The, d, h, j, e-1.
Leeds & Northrup Co., m-1.
Lenz Electric Mfg. Co., j, l, p, q, o-1, f-1, h-1, m-1.
***LEWIS ENGRG. CO., THE**, d, g, h, l, o, p, q, w, y, o-1, f-1, l-1, m-1.
Magnetic Shield Div. Perfection Mico Co., f-1.
P. R. Mallory & Co. Inc., e.
***MALLORY-SHARON METALS CORP.**, k-1, n-1.
Manger Electric Co., g, k, t.
J. E. Menough Co., o, f-1.
Metals & Controls Corp., General Plate Div., e, j, m, v, y, h-1, k-1, m-1, n-1.
Michigon Wire Cloth Co., u.
Minicord Corp. of America, c-1.
Minnesota Mining & Mfg. Co., k.
Mohawk Wire & Cable Corp., g, p, q, w, o-1, f-1.
Heinz Mueller Eng. Co. Inc., o.
Mutron Corp., o.
National Pneumotic Co., Inc., Haltzer-Cobat Divs., o.
National-Standard Co., c, i, j, n, u, v, x, i-1.
Nesor Allay Products Co., o, c, e, i, j, k, m, o, v thru z, b-1, e-1 thru i-1.
New England Electricol Works, Inc., b, c, h, j, l, q, r, s, w.
M. M. Newman Corp., o.
Okonite Co., The, Subsidiory of Kennecott Copper Corp., a, c, d, p, q, o-1, f-1, l-1, m-1.
Pacific Scientific Co., a, m-1.
Packard Electric Div.-General Motors Corp., o, p, q, w, o-1, h-1, l-1.
Paraplegics Mfg. Co., Inc., o.
Pholo Plostics Corp., g, o, p, q, o-1.
Phelps Dodge Copper Products Corp., c, h, j, l, p, s, v, w, y, o-1, f-1, h-1, l-1.
Philodelphia Insulated Wire Co., b, d, g, h, j, l, o, q, r, s, w, o-1, f-1, l-1, m-1.
Plastoid Corp., o thru d, p, q, o-1, f-1.
Joseph E. Podgor Co., Inc., u, z, i-1.
Precision Resistor Co. Inc., e-1.
Precision Tube Co., Inc., w, f-1.
Pyrometer Instrument Co., Inc., m-1.
Rodiaphone Co. Inc., o.
Reinhold Engrg. & Plastics Co., f, s, o-1.
Reliable Spring & Wire Forms Co., k.
Republic Steel Corp., i-1.
Revere Corp. of America, d, g, l, o, q, o-1, f-1, l-1, m-1.
Reynolds Metals Co., o.

Rex Corp., The, Sub.-American-Enko, o, b, c, q, w, f-1.
Rockbestos Products Corp., d, l, q, s, o-1, l-1.
John A. Roeblings Sons Corp., o, d, h, j, k, l, n, p, s, u, v, w, z, a-1, f-1.
Rolock Inc., u.
Rome Cable Corp., Sub.-Aluminum Co. of America, a, h, p, q, s, w, a-1, f-1.
Royal Electric Corp., b, d, g, o, p, w, a-1, f-1.
Joseph T. Ryerson & Son, Inc., a, i-1.
Sanders Associates, Inc., j, o, q, a-1.
Sequoia Wire & Cable Co.-Div.-Mondrel Industries, Inc., f, g, j, o, p, q, w, a-1, f-1, l-1, m-1.
Simplex Wire & Cable Co., p, q, w, a-1, f-1, l-1.
Southwire Co., o, g, n, q.
Spectra-Strip Wire & Cable Corp., b, g, j, o, p, q, s, t, w, a-1, f-1, l-1, m-1.
Standard Metals Corp., m, v.
Stanley-Judd Div.-The Stanley Works, k.
Superior Cable Corp., c, q, w, a-1, f-1.
Sylvania Electric Products Inc., Chemicol & Metallurgicol Div., i, j, m, v, e-1, h-1.
Sylvania Electric Products Inc., Ports Div., i, j, k, m, v, x, y, z, e-1, h-1, i-1.
TA Mfg. Corp., o.
Tape Cable Corp., q, a-1.
Tensolite Insulated Wire Co., Inc., c, g, h, j, l, q, s, v, w, y, a-1, f-1, h-1, i-1, l-1.
Thermal Wire of America, h, s, a-1.
Thermax Wire Corp., b, e, g, j, q, w, y, a-1, f-1, l-1.
Thermo Electric Co., Inc., m-1.
H. I. Thompson Fiber Glass Co., l.
Times Wire & Cable Co., Inc., c, l, p, q, w, a-1, f-1, h-1, l-1, m-1.
Topper Mfg. Co., Inc., f, g, r, l-1.
Tricraft Products Corp., g, o.
United Wire & Supply Corp., a.
Universal-Cyclops Steel Corp., i-1, k-1, n-1.
Virginia Electronics Co., Inc., o.
Warren Wire Co., o, c, f, h, j, l, p, q, s, v, w, y, a-1, e-1, f-1.
West Instrument Corp., m-1.
Western Internotional Co., b, c, g, l, n thru r, v, w, z, a-1, f-1, g-1, h-1, l-1.
Westinghouse Electric Corp., i, j, l.
Westline Products Div.-Western Lithograph Co., t.
Westwood Cable Corp., d, l, m, o thru s, w, y, a-1, f-1, g-1, h-1, l-1, m-1.
Whitaker Cable Corp., l, o, q, a-1, f-1.
Wildberg Bros. Smelting & Refining Co., b-1.
Wire Co. of America, Inc., o, b, a-1.
Wirecraft Products, Inc., g, j, l, o, q, f-1, l-1.
Woodworth Specialties Corp., k.
Zippertubing Co., The, w, a-1, f-1.

WIRE & CABLE TRANSMISSION LINE
See TRANSMISSION LINE, WIRE & CABLE

WIRE MARKING SERVICE

Acromark Co., The
Adept Industries Inc.
Artos Engrg. Co.
W. H. Brady Co.
William Brond & Co., Inc.
Electric Cords & Supply Corp.
Electro-Mechonicol Products Co.
First Electronics Corp., The
Duncon M. Gillies Co. Inc.
Gordon Enterprises
Monger Electric Co.
Sheltered Workshops
Spectra-Strip Wire & Cable Corp.
Westline Products Div.-Western Lithograph Co.
Zippertubing Co., The

WIRE STRIPPER CHEMICALS
See CHEMICALS, WIRE STRIPPER

WIRE STRIPPERS

AMP Inc.
Artos Engrg. Co.
Division Leod Co.
Electric Cords & Supply Corp.
First Electronics Corp., The
General Cement Mfg. Co., Div.-Textron, Inc.
Gordon Enterprises
Hoveg Industries, Inc.
Holub Industries, Inc.
Hunter Tool Co.
Ideol Industries, Inc.
Jennings Machine Corp.
Poul Nurches Co.
Paroplegics Mfg. Co., Inc.
Seolectric Switch & Relay Corp.

WIREWAYS, WATER-TIGHT

*ETS-HOKIN & GALVAN

WOOD SLOT WEDGES
See WEDGES, WOOD SLOT

WRENCHES

Allen Mfg. Co.
Billings & Spencer Co., The
Black & Decker Mfg. Co., The
Chicago Pneumatic Tool Co.
Gardner-Denver Co.
Hunter Tool Co.
Industrial Tools Mfg. Corp., Sub-Pendleton Tool Industries, Inc.
Jo-Line Tools, Inc.
Kramer Fabricating Co., The
Machinery Soles & Engrg. Co.
Moody Machine Products Co., Inc.
Owatonna Tool Co.
Snap-On-Tools Corp.
B. K. Sweeney Mfg., Co.
Torque Controls Inc.

X-RAY EQUIPMENT, INDUSTRIAL

Applied Radiation Corp.
Applied Research Labs., Inc.
Balteau Electric Corp.
Bar-Roy Products, Inc.
Bendix Aviation Corp., Friez Instrument Div.
Brocke-Seib X-Roy Co., Inc.
Curtiss-Wright Corp.-Princeton Div.
Deluxe Metal Products Co.
Fleetwood Labs., Inc.
General Electric Co., Apparatus Sales Div.
General Electric Co., X-Ray Dept.
Arnold Greene Testing Labs., Inc.
High Voltage Engrg. Corp.
Instruments Div.-Philips Electronics, Inc.
Land-Air Inc.
Philco Corp., Government & Industriol Div.
Radiation Dynamics, Inc.
St. John X-Ray Lab.
Sanborn Corp.
Smith-Morris Corp.
Television Utilities Corp.
Triplett & Barton, Inc.
Twenty-First Century Electronics, Inc.
Westinghouse Electric Corp.
Zenith Radio Corp.

X-RAY FILMS, PHOTOGRAPHIC MATERIALS
See PHOTOGRAPHIC MATERIALS, X-RAY FILMS

X-Y PLOTTERS
See PLOTTERS, X-Y

YOKES, DEFLECTION

Bendix Aviation Corp.-Montrose Div.
Celco (Constantine Engrg. Labs. Co.)
Coil Co. of America
Consolidated Productions, Inc.
Continental Technical Service, Inc.
Electricol Insulation Co., Inc.
Ferroxcube Corp. of America
Jet Electronics Corp.
Kanorr Corp.
Litton Industries, Inc.
Monogram Precision Industries
Penn-Tron Corp.
Redmond Co., Inc.
Triad Transformer Corp.
Zenith Radio Corp.

MODERN WEAPON SYSTEMS

Depend on Reliable Technical Manuals!

Reliability is the key factor stressed more and more in military equipment procurement, especially for components of modern weapon systems. Maintaining equipment reliability in the field requires Technical Manuals of exceptional quality. The thinking of the military on this point is clearly reflected in the following quotation from Specification MIL-M-005474B:

"Modern weapon systems and support equipment represent a vastly increased complexity in equipment, with the result that each manual MUST be, and shall be, engineered as carefully as the equipment which it covers; sufficient time, thought and energy shall be expended to make it so. In sharp contrast with any idea that technical manuals can be a "cheap and dirty" effort in a program involving design and production of costly and complex equipment, a new high standard shall be sought in the development of technical manuals produced to this specification. The cost of operation and maintenance can skyrocket when Service personnel fail to 'get the word,' that is, when they fail to get clearly understandable, well-written and well-illustrated manuals."

We are gratified to note this firm statement of policy since it defines a quality of service and product which is standard with Spruce Co. Each project, large or small, is directed by a publication engineer supported by quality control procedures and complete production facilities. With this approach we are able to consistently produce the accurate, readily understandable and well illustrated technical manuals demanded by the military.

For additional information about the many technical data services offered by R. Spruce Co., write today for the informative brochure "Technical Publications by Spruce."

R. SPRUCE COMPANY

Technical Publications Specialists

608 S. Dearborn Street **Chicago 5, Illinois**

An Affiliate of American Aviation Publications, Inc.

R. Spruce Company
608 S. Dearborn Street
Chicago 5, Illinois

Please send me a copy of your new brochure "Technical Publications by Spruce" at no cost or obligation.

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

Advertisers' Index

AC Spark Plug Div., General Motors Corp. 48
Agency—D. P. Brother & Co.
Ack Radio Supply Co. 66
Agency—Crim-Thomas Agency
AiResearch Mfg. Co., Div.-The Garrett Corp. 43
Agency—J. Walter Thompson Co.
Allied Chemical & Dye Corp., General Chemical Div. 45
Agency—Kastor, Hilton, Chesley, Clifford & Atherton, Inc.
American Potash & Chemical Corp. 38
Agency—The McCarty Co.
Anderson, Greenwod & Co. ... 62
Annin Co., The 52
Agency—The McCarty Co.
Arnoux Corp. 50, 82
Agency—Kay Christopher
Associated Testing Laboratories, Inc. 32
Agency—W. N. Hudson Adv.
Astromatic Div.,-The Electro-snap Corp. 67, 68
Agency—Don Kemper Co., Inc.
Avco Corp. ..... Cover 3
Agency—Benton & Bowles, Inc.
Balcrank, Inc. 71
Agency—Dinerman & Co., Inc.
Bausch & Lomb Optical Co. .. 95
Agency—Wolff Associates, Inc.
Beaton & Corbin Mfg. Co. ... 100
Agency—Post, Johnson & Livingston, Inc.
Behlman Engineering Co. 57
Agency—Jack Packard Adv.
Bendix Aviation Corp., Bendix Products Div. 47
Hamilton Div. 12
Agency—MacManus, John & Adams, Inc.
Cameron Iron Works, Inc. 34
Agency—Boone & Cummings
Cannon Electric Co. 27
Agency—Anderson-McConnel Adv. Agency, Inc.
Cherry Rivet Div., Townsend Co. 36
Agency—Bond & Starr, Inc.
Dow Corning Corp. 10
Agency—Church & Guisewite Adv., Inc.
Electrical Engineering & Mfg. Corp. 110
Agency—MacManus, John & Adams, Inc.
Engis Equipment Co. 4
Agency—Central Adv. Service
Ets-Hokin and Galvan 54
Filtors, Inc. 6
Agency—Burton Browne Adv.
Flexonics Corp., Aeronautical Div. 41
Agency—O'Grady-Anderson-Gray, Inc.
Harco Containers Div., Harbor Boat Bldg. Co. 55
Agency—Richard Pennington Adv.
Hartford Machine Screw Co., Div.-Standard Screw Co. 35, 46, 54, 76
Agency—The Charles Brunelle Co.
Haws Drinking Faucet Co. 70
Agency—Pacific Adv. Staff
A. W. Haydon Co., The 74
Agency—Cory Snow, Inc.
Houdaille Industries, Inc., Buffalo Hydraulics Div. 28
Agency—Comstock & Co.
Hydro-Aire, Inc. 3
Agency—Gaynor & Ducas, Inc.
Janitrol Aircraft Div., Surface Combustion Corp. 84
Agency—Odiorne Industrial Adv., Inc.
Kearfott Co., Inc. 7
Agency—Gaynor & Ducas, Inc.
Koontz Wagner Electric Co., Inc. 35
Laminated Shim Co., Inc. .. 58, 59
Agency—Wilson, Haight, Welsh & Grover, Inc.
Lavelle Aircraft Corp. 98
Agency—The Roland G. E. Ullman Organization
LaVezzi Machine Works 80
Agency—R. W. Sayre Co.
Wallace O. Leonard, Inc. 186
Agency—MacManus, John & Adams, Inc.
Lewis Engineering Co. 5
Agency—Neary Adv. Agency
Mallory-Sharon Metals Corp. 8
Agency—The Griswold-Eshleman Co.
McCormick Selph Associates ..... Cover 4
Agency—Aircraft & Missile Consultants
Mirax Chemical Products Corp. 79
Agency—Shaffer-Brennan-Margulis Adv. Co.
Motor Generator Corp. 90
Agency—Ralph Dalton & Associates
Nadella 33
Neway Equipment Co. 56
Agency—Creative Ad Art
Nord-Aviation 71
Packard Bell Electronics, Technical Products Div. 64
Agency—Robinson, Jensen, Fenwick & Haynes, Inc.
Pan American World Airways, Inc. 44
Propellex Chemical Corp 81
Agency—Al Maescher Adv., Inc.
Redel, Inc. 46
Agency—Richard Pennington Adv.
Rheem Mfg. Co., Defense & Technical Products Div. Cover 2
Agency—Getz & Sanborg, Inc.
Ultra-Violet Products, Inc. ... 79
Agency—Edward S. Kellogg Co.
Wall Colmonoy Corp., Stainless Processing Div. 72
Agency—A. Hemsing Adv.
Weatherhead Co., The, Aviation Div. 60
Agency—The Bayless-Kerr Co.
R. D. Werner Co., Inc. 78
Agency—Aubrey C. Bury, Inc.
White Diesel Engine Div., White Motor Co. 30
Agency—Weber, Geiger & Kalat, Inc.

POSTAGE WILL BE PAID BY ADDRESSEE

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
First Class Permit No. 2455-R, Washington, D. C.

MISSILES and ROCKETS

17 East 48th Street
New York 17, N. Y.

Subscriber Service Dept.

Name_____

Title/Position_____

Company_____

Product Mfg./Service Offered_____

Address_____

City_____ Zone____

State_____

1959
MISSILE MARKET AND PRODUCT GUIDE
Expires
Dec. 31, 1959

Card cannot be processed unless all information is given. Please limit requests to ten items.

Write in numbers below for more information on New Products or Advertisements.

NEW PRODUCTS

_____ _____
_____ _____
_____ _____

ADVERTISEMENTS

_____ _____
_____ _____
_____ _____

POSTAGE WILL BE PAID BY ADDRESSEE

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
First Class Permit No. 2455-R, Washington, D. C.

MISSILES and ROCKETS

17 East 48th Street
New York 17, N. Y.

Subscriber Service Dept.

Name_____

Title/Position_____

Company_____

Product Mfg./Service Offered_____

Address_____

City_____ Zone____

State_____

1959
MISSILE MARKET AND PRODUCT GUIDE
Expires
Dec. 31, 1959

Card cannot be processed unless all information is given. Please limit requests to ten items.

Write in numbers below for more information on New Products or Advertisements.

NEW PRODUCTS

ADVERTISEMENTS

Name_____

Title/Position_____

Company_____

Product Mfg./Service Offered_____

Address_____

City_____ Zone____

State_____

1959

MISSILE MARKET AND PRODUCT GUIDE

Expires
Dec. 31, 1959

Card cannot be processed unless all information is given. Please limit requests to ten items.

Write in numbers below for more information on New Products or Advertisements.

NEW PRODUCTS		ADVERTISEMENTS	
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

POSTAGE WILL BE PAID BY ADDRESSEE

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
First Class Permit No. 2455-R, Washington, D. C.

MISSILES and ROCKETS
17 East 48th Street
New York 17, N. Y.

Subscriber Service Dept.

Name_____

Title/Position_____

Company_____

Product Mfg./Service Offered_____

Address_____

City_____ Zone____

State_____

1959

MISSILE MARKET AND PRODUCT GUIDE

Expires
Dec. 31, 1959

Card cannot be processed unless all information is given. Please limit requests to ten items.

Write in numbers below for more information on New Products or Advertisements.

NEW PRODUCTS ADVERTISEMENTS

POSTAGE WILL BE PAID BY ADDRESSEE

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
First Class Permit No. 2455-R, Washington, D. C.

MISSILES and ROCKETS
17 East 48th Street
New York 17, N. Y.

Subscriber Service Dept.



Avco and a Modern Minuteman—Recent work at Avco led to a solution of the missile reentry problem, and to production of the nose cone for the Air Force Titan ICBM. Now the Air Force announces a development program for Minuteman, a solid fuel missile that will be capable of instantaneous firing with no preparatory fueling delays. Its nose cone, too, will come from Avco's Research and Advanced Development and Lycoming Divisions . . . implementing this modern Minuteman's vigilant defense of our shores.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY.

Avco

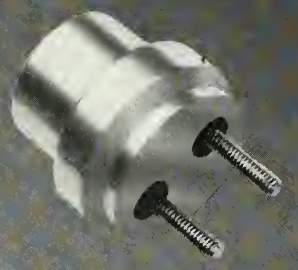
CO MAKES THINGS BETTER FOR AMERICA / AVCO CORPORATION / 750 THIRD AVENUE, NEW YORK 17, N.Y.

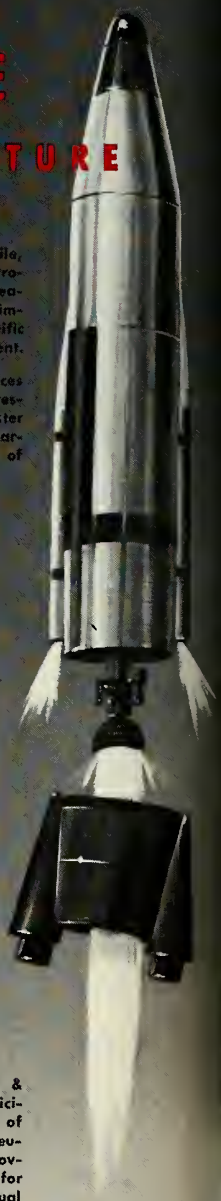
Mc/S/A EXPLOSIVE ORDNANCE

IN STEP WITH THE FUTURE

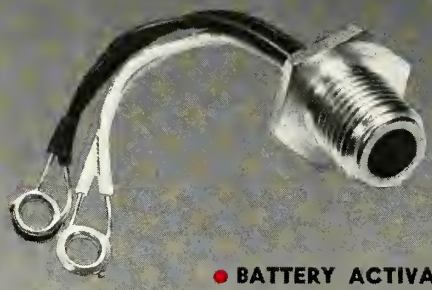
The powerful ATLAS Intercontinental Ballistic Missile, built for the United States Air Force by Convair-Astronautics, has proven its reliability as a military weapons system. In addition, it will soon lift man himself into interplanetary space in search of scientific knowledge of our solar system and its environment.

McCormick Selph Associates explosive ordnance devices play a major role in the ATLAS system — M-92 pressure cartridges actuate the twin-chambered booster engine separation system, and battery actuation cartridges allow power to be generated for operation of systems within the *missile nose cone.





● M-92 PRESSURE CARTRIDGES



● BATTERY ACTIVATION CARTRIDGES



Mc/S/A devices such as M-92 pressure cartridges & battery activation cartridges will operate with efficiency and reliability at all altitudes and any extreme of temperature; can be mechanically, electrically or pneumatically initiated and will meet the most rigid government, industry or other specifications. Write for detailed technical data applicable to your individual problems.

*Nose cone supplied by General Electric, Missile and Space Division

EXPLOSIVE ORDNANCE

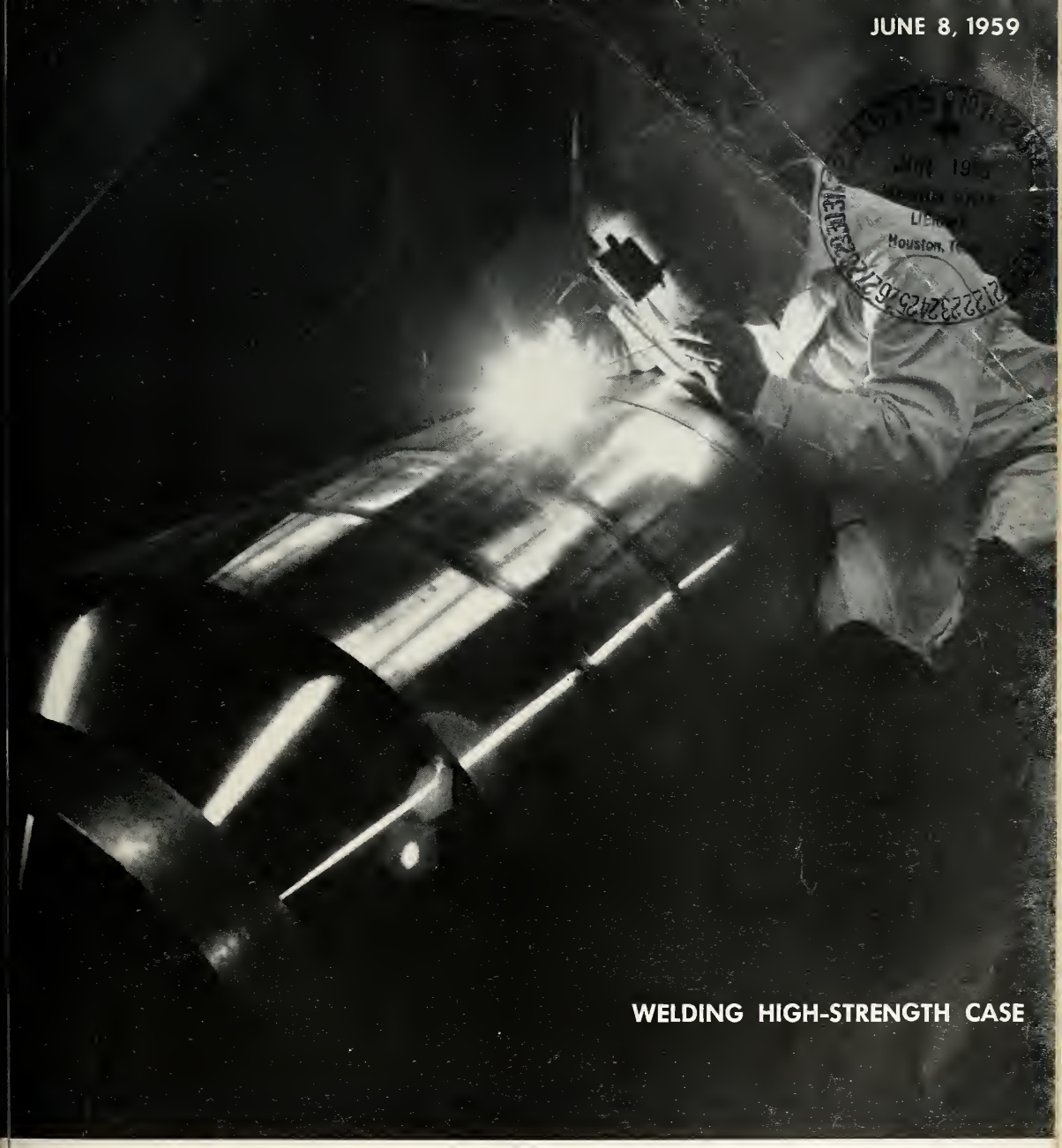
McCormick Selph Associates

HOLLISTER AIRPORT/HOLLISTER, CALIFORNIA

Physical Chemists, Engineering Physicists and Chemical Engineers are invited to submit resumes to Frank LaHaye, Vice President, Engineering for position openings in all phases of explosive ordnance.

Fill in No. 39 on Subscriber Service Card.

JUNE 8, 1959



WELDING HIGH-STRENGTH CASE

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

h Case for Heat Sink 16
h Case for Ablation 19
ew Barrier for Solids 23

AN AMERICAN AVIATION PUBLICATION



for Communications

on the Missile Base Complex..

come to the experts!

DuKane electronic communication systems provide the vital network of instant voice communication which literally ties together such installations as Fort Churchill, Patrick AFB, and White Sands. DuKane offers the broadest, most flexible, most versatile line of custom-installed communication systems in the industry. For an installation involving a few persons, or hundreds, DuKane's experts can help you design and specify a communication system which will fill your needs. Why not ask for their help? *Write or wire DuKane Corporation, Dept.MR-3, St. Charles, Illinois*

If you specify electronic equipment, ask also for DuKane's chart of electronic equipment symbols.

DuKane Products are installed and serviced by a nationwide network of factory-trained experts

DuKane CORPORATION
St. Charles, Illinois

Job-engineered sound installations . . . Flexifone intercom systems . . . Private automatic telephone systems . . . Hosp
communications systems . . . Ionovac hi-fi tweeters and ultrasonic generators . . . Sound slidefilm projectors for educa
and industry . . . Electronic production facilities for industry and for defense.



The Pentadome structure, developed by an industrial team in cooperation with the U. S. Army Quartermaster Corps, was designed to meet Ordnance Corps requirements for a missile maintenance shelter.

NEW BIRDAIR STRUCTURE
to guard our nation's defenses

COOPERATING MANUFACTURERS

Nylon Base Fabric by
WELLINGTON SEARS CO.
11 WEST 40th STREET • NEW YORK 18, NEW YORK

pecial fabric construction for the Pentadome was supplied by Wellington Sears, manufacturers of famous Welkote" nylon fabric specially engineered for vinyl nd neoprene coating.

Coated Fabric by
THE H. M. SAWYER DIVISION
SAWYER-TOWER, INC.
WATERTOWN 72, MASSACHUSETTS

pecial vinyl coating compounds and their application meet rigid military specifications were provided y Sawyer for the Pentadome. Sawyer's "Tuff-Tarp" world renowned for its excellent properties and igh quality.

Inflation Equipment by
HE PEERLESS ELECTRIC CO.
1401 W. MARKET STREET • WARREN, OHIO

he "heart" of the Pentadome, its inflation and its ressurization blowers, were provided by Peerless, uilders of a complete line of high quality air moving uipment ... fans, blowers, and electric motors.

This is Pentadome, the largest air-supported structure ever built for military use. It is made up of five — one large, and four small — domes which can be used either in combination, or individually.

The main dome is 150 feet in diameter and 85 feet high; the smaller domes, 100 feet in diameter and 50 feet high. A total ground area of 50,000 sq. ft. and volume of over 2,000,000 cu. ft. are protected.

With vinyl-coated nylon fabric as the basic construction material, shape and stability are attained (and maintained) through constant low-pressure, high-volume, air supplied by electric powered blowers.

Thus, *no* rigid supports, poles or frames are needed. There are no obstructions to hinder the free movement of missiles or other large pieces of equipment.

The Pentadome is held in place by anchors driven into the ground around its perimeter. It is designed to withstand a constant wind load of 70 miles per hour and gust loads of greater velocity.

Ten men, during a single working day, can erect the Pentadome, after proper anchorage installations have been made. A deflated Pentadome can be transported on standard military vehicles.

Although developed as missile inspection and maintenance shelter, the Pentadome configuration appears to have many other military and commercial applications. For example, experts have suggested its use as a storage enclosure, as a protection for construction activities, and as an exhibit enclosure.

If you have a problem that might be solved with this new approach to space enclosure, we will be glad to send complete specifications, or to arrange a conference at your convenience. Address inquiries to:

BIRDAIR STRUCTURES, INC.
Dept. MR-1, 290 Larkin St., Buffalo 10, N. Y.
Originators of Modern Air Supported Structures

foremost designers and manufacturers of telemetry receivers



NEMS • CLARKE

hos been designing ond monufocturing precision electronic equipment since 1909 when it first produced communications devices for the United Stotes Government. This holf-century of experience is recognized by government and industry alike. *Today more than 95% of the telemetry receivers in use ot United States missile test stations and ronges were designed and built by Nems-Clarke.* Among mony installotions now using this equipment are:

PATRICK AIR FORCE BASE

VANDENBERG AIR FORCE BASE

WHITE SANDS MISSILE RANGE

EGLIN AIR FORCE BASE

ARMY BALLISTIC MISSILE AGENCY

We welcome inquiries on problems in the telemetry field

NEMS CLARKE COMPANY

A DIVISION OF VITRO CORPORATION OF AMERICA

919 JESUP-BLAIR DRIVE • SILVER SPRING, MARYLAND • JUNIPER 5-1000

Executive Editor .....CLARKE NE
Managing Editor ....DONALD E. P

EDITORIAL STAFF

News Editor .....REED
Military & Defense .....BETTY C
JAME
Electronics/Support Equipment ..HAL GE
Electronics Engineering ....CHARLES D. L
Missile Manufacturing .....WILLIAM E. H
Missile Business .....ERICA M
NASA .....PAUL
Los Angeles .....FRED B
RICHARD VAN
FRANK M
London .....G. V. E. THO
Paris .....JEAN-MARIE
Geneva .....ANTHONY V
Art Director .....WILLIAM M
Ass't Art Director .....BACIL C

CONTRIBUTORS

Propulsion Engineering .....MICHAEL L
Industry .....JAMES J. HAGGERT
Soviet Affairs .....DR. ALBERT
Space Medicine .....DR. HUBERTUS STR
Astrophysics .....DR. I. M.
Research .....HEYWARD CANNI

ADVISORY BOARD

DR. WERNHER VON BRAUN ROBERT P. HA
DR. PETER CASTRUCCIO DR. ARTHUR KANTI
KRAFFT EHRICKE DR. EUGEN S
R. F. GOMPERTZ ALEXANDER

BUSINESS STAFF

Assistant Publisher .....E. D. MU
Advertising Sales Manager .....W. E.
Circulation Director .....L. L. BR
Promotion Manager .....J. E. M
Advtg. Service Manager ..MRS. GLADYS B
Production Manager .....J. F.
Ass't Production Mgr. .....ELSIE
New York .....17 East 48
Eastern Advtg. Mgr. .....P. B. K
P. N. AN
A. B. SCH
Detroit .....201 Stephenson
K. J.
Chicago .....139 N. Cla
G. E.
Los Angeles .....8929 Wilshire
J. W.
C. R. MAR
Miami .....208 Almeria A
R. D.
Toronto .....12 Richmond
ALLIN ASSO
London .....28 Brut
NORALL &
Paris .....11 Rue Con
Geneva .....10 Rue C

Missiles and Rockets Volume 5 Numbe

Published each Monday by American Av Publications, Inc., 1001 Vermont Ave., Washington 5, D.C.

WAYNE W. PARRISH .....*President & Pul*
LEONARD A. EISERER ...*Executive Vice Pre & General M*
A. H. STACKPOLE .....*Vice Pre*
FRED HUNTER .....*Vice Pre*
ERIC BRAMLEY .....*Vice Pre*
ROBERT R. PARRISH .....*Vice Pre*

Printed at the Telegraph Press, Harrisbur Second class postage paid at Washington and at additional mailing offices. Cop 1959, American Aviation Publications, I

Subscription rates: U.S., Canada and P Union Nations—1 year, $8.00; 2 years, $1 3 years, $14.00. Foreign—1 year, $10.0 years, $18.00; 3 years, $26.00. Single rate—$.75. Subscriptions are solicited from persons with identifiable comme or professional interests in missiles rockets. Subscription orders and change address should be referred to Circula Fulfillment Mgr., M/R, 1001 Vermont Washington 5, D.C. Please allow 4 w for change to become effective and en recent address label if possible.

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

JUNE 8 HEADLINES

Army Expanding 'Breakout' Policy
Congress sees increased opportunities for small business with Army taking standardized components away from primes and buying under bidding 13

Cell Produces Power Directly from Gas
GE development appears promising for military and space vehicle power sources 18

The Pioneering Monkeys and Mice 28

Details on Saturn Gantry 33

Martin Fabricates Beryllium Structure 41

ASTRONAUTICS ENGINEERING

NOSE CONES: Case for Heat Sink 16

NOSE CONES: Case for Ablation 19

Notch Sensitivity—Barrier to Solid Rockets
Challenge is to increase large motor case strength without cost in weight and reliability (special M/R report) 23

Welding *Redstone* 29

MISSILE SUPPORT

FBM Sub Provides New Market
With 45 missile-launching boats possible, lion's share of some $4.5 billion should go for support equipment 31

MISSILE ELECTRONICS

Plasma Engine Delivers Nearly 2-lbs.
Republic's experimental 'magnetic pinch' engine produces over 4000-lbs. at peak with 1700 second I_{sp} 34

Radiation Effects on Components: What's Being Done? 37

Miniaturization—A Swelling Tide
Chain reaction of new breakthroughs could lead to microscopically small parts before trend runs its course 39

THE MISSILE WEEK

Washington Countdown 9

Industry Countdown 11

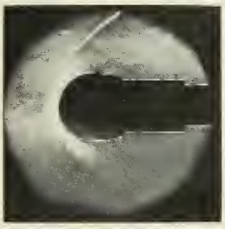
More About the Missile Week 44

DEPARTMENTS

Editorial 7
Reviews 42
Moscow Briefs 43
Propulsion Engineering ... 45
Missile Business 46
People 47
Letters 48
Contract Awards 49
When and Where 50



COVER: For what happened to Diversey Engineering's near 'perfect' rocket case, read the story on p. 23.



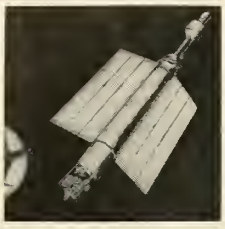
NOSE CONES, both heat sink and ablation, are discussed by GE engineers beginning on p. 16.



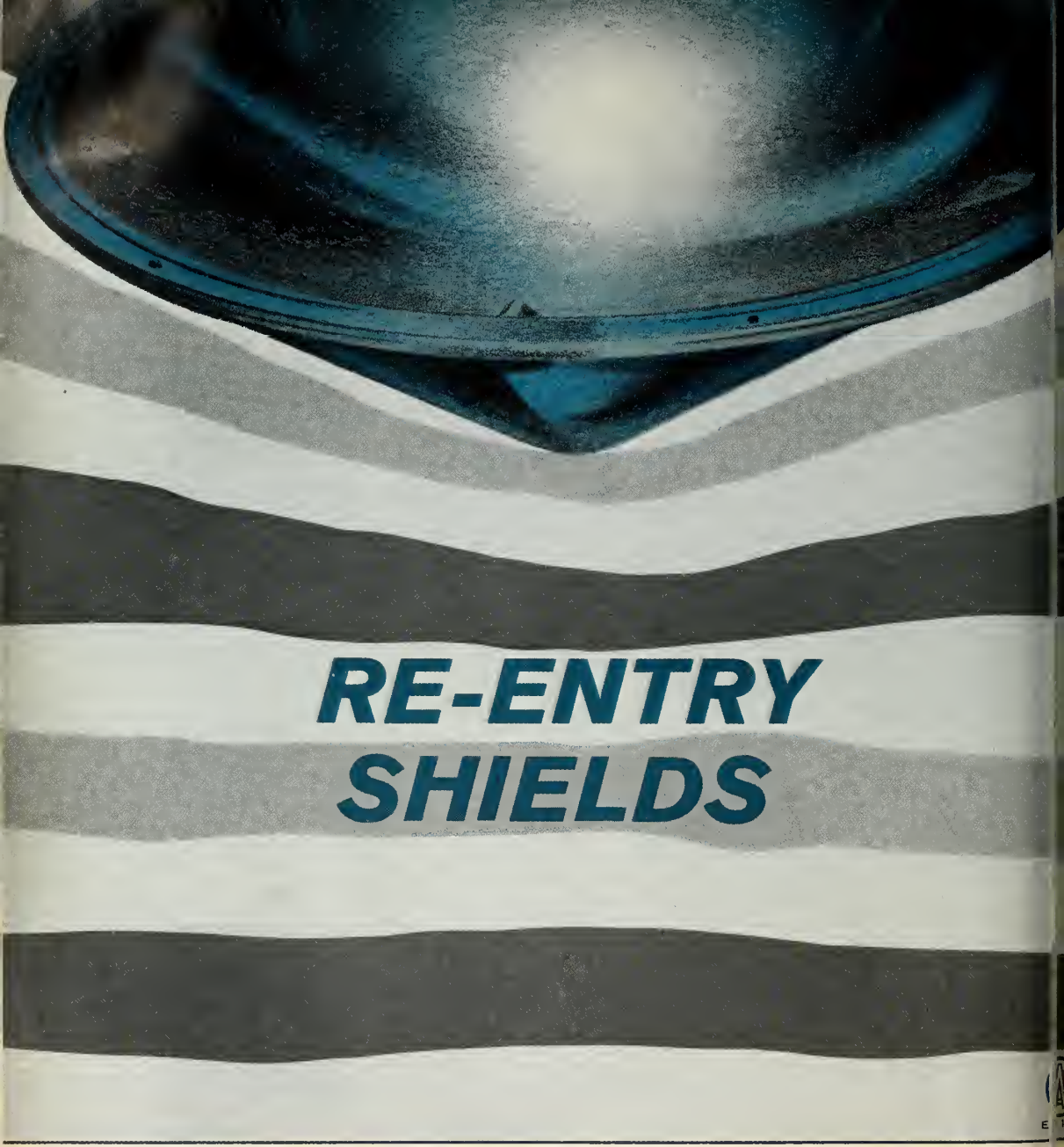
HIGHEST standards are required for welding the Army's *Redstone* missile. See p. 29.



NEW MARKET for missile support equipment is opening with the Navy's FBM submarine. See p. 31.



MARS vehicle could use new plasma engine under development by Republic. See p. 34.



RE-ENTRY SHIELDS

WYMAN-GORDON IS FORGING RE-ENTRY SHIELDS

- Copper in production
- Beryllium in limited production
- Reinforced plastics in development

WYMAN-GORDON

FORGING

ALUMINUM MAGNESIUM STEEL TITANIUM BERYLLIUM MOLYBDENUM COLUMBIUM
AND OTHER UNCOMMON MATERIALS

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS
DETROIT, MICHIGAN
GRAFTON, MASSACHUSETTS
FORT WORTH, TEXAS
FRANKLIN PARK, ILLINOIS
LOS ANGELES, CALIFORNIA

A Long Look at Renegotiation

Congress this week is considering legislation of tremendous significance to our space efforts and to our national security. This is legislation to extend the Renegotiation Act of 1951.

The House has passed HR 7086, which extends the Renegotiation Act for a period of four years, and the bill is now under consideration by the Senate Finance Committee.

The purpose of renegotiation is to provide for an after-the-fact review of all defense and applicable contracts to assure that the contractors do not make excessive profits. The Act itself is unique in that for all practical purposes it gives one agency of the government the power to overrule decisions of another government department.

In recent hearings before the House Ways and Means Committee, all of the testimony submitted by industry—both large and small—recommended against extension of the Act or called for its substantial modification to provide for precise definition of excessive profits.

Representatives of the Department of Defense, the Air Force and the Renegotiation Board itself—Robert Dechert, DOD general counsel; Max Golden, USAF general counsel, and Renegotiation Board Chairman Thomas Coggeshall—recommended to the committee a continuation of the Act for a period of two years and three months, or until Sept. 1, 1961.

Chief proponent of permanency for the Renegotiation Act was Congressman Carl Vinson, Chairman of the House Armed Services Committee.

The proposal for a long extension of the Act—and the recommendation that it be made permanent—obviously imply that the aircraft/missile/space industry is and has been making excessive profits. This assumption is not substantiated by the available facts and may be due to the hypnotic affect of large figures.

Boeing, for instance, earned in 1958 a profit of $29 million. That's a huge sum. But it was only 1.72% of net sales. A smaller company making a profit of $29 thousand at 1.72% wouldn't attract anybody's attention.

Actually, the earnings of the aircraft/missile/space industry historically have been substantially less than those of other manufacturers. Since 1951, when the Act was first passed, they have been less than half the average earnings recorded by all manufacturing companies in the U.S.

Lockheed Aircraft Corporation in 1958 devoted 40% of its effort to missile and space work and in so doing faced a tremendous expansion program. Robert E. Gross, chairman of the board, told the committee:

"In the last three years . . . we have spent $56 million of our own funds on plant additions, and the dollar value of company-owned facilities has increased 64%. I might point out that in these same three years our total earnings after taxes amounted to just $50 million."

In a comprehensive study of the same companies whose profits in many cases the Renegotiation Board is now finding excessive, the Investigating Subcommittee (Chairmanned by Congressman Hébert) of the House Armed Services Committee, on July 13, 1956, reported:

"The Subcommittee concludes on the evidence that there has been no showing that on the average the profits allowed are excessive."

This report, incidentally, was signed by Carl Vinson, then as now chairman of the House Armed Services Committee, and now leading the proponents of permanent re-enactment or lengthy extension of the Renegotiation Act.

Since the 1956 report, both the Hébert Subcommittee and the House Committee on Ways and Means, which has actual jurisdiction, have recommended that studies and a review of the entire renegotiation process, including the Act and its administration, be undertaken. No such review has been made or attempted.

We are in complete agreement that management of our public funds is a matter for the closest official scrutiny. We believe that it is of the utmost importance to our national security and our economy that proper and adequate measures be established to insure that no industry makes excessive profits from government contracts.

Equally, we are concerned with the health and welfare of the aircraft/missile/space industry, which has the primary responsibility for providing the vehicles essential to our national security—and national prestige. Industry will not maintain its responsibility if it does not equally maintain a healthy financial condition.

We would therefore urge the Senate, which has the immediate action in the matter, to extend the Renegotiation Act—but only for one year.

We would further urge that Congress institute during that year the studies recommended by the two committees—studies not of the principle of recovering excessive profits, but of establishing an equitable formula for this recovery.

This seems to us the only fair way to resolve the wide divergencies of opinion which exist between government and industry and within government itself.

Clarke Newlon

engine power
BY CATERPILLAR

THEY DEPEND ON CAT DIESEL POWER T
KEEP AIR FORCE ATLAS MISSILE ON TARGE

Calibration of the delicate electronic system of an Atlas missile requires a portable power source with unusually accurate control of voltage.

Down-range tracking stations need a power supply that can be depended upon in *any* emergency.

Both requirements are met by Caterpillar Diesel Electric Sets. Caterpillar Diesel Engines in these sets are extremely efficient 4-cycle engines which operate on any fuel from JP-4 through No. 2 furnace oil. They start easily, pick up load quickly and can be maintained and operated by unskilled personnel. Parts—and service—are available all over the Free World.

These are some of the reasons why you will see so many Caterpillar Electric Sets used for primary and standby power at our missile bases and other military establishments. They are used to supply power for testing, for starting jet engines, for radar warning systems, for lighting, heating and other base living facilities.

Free booklet. Get the full story on the advantages of Caterpillar Diesel Electric Sets. Write to Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

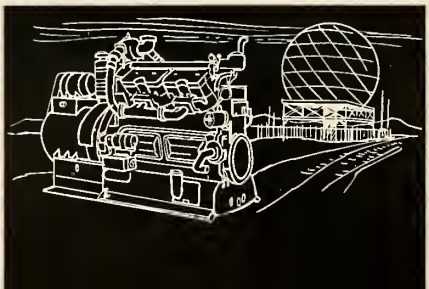


At Edwards Air Force Base in California, power for testing th precision electronic control circuits of the Atlas missile is supplie by two Cat D375 Diesel Electric Sets. They meet the triple r quirement of portability, dependability and accurate contro

JET ASSIST. Caterpillar Portable Electric Sets supply dependable power for starting jet engines and for calibrating control systems.



ALONE. Without benefit of people to look after them, Cat Electric Sets furnish power for gap filler sites in our aircraft warning system. They are used at larger bases, too.



ENDURANCE. At Air Force Bases in t Atlantic, Cat Electric Sets have run o 20,000 hours without overhaul, wh supplying 68,000 kwh a month.



washington countdown

The Air Force successfully launched ARPA's *Discoverer III* June 3. The satellite carried four two-month old male mice—each wearing a small instrumented saddle. (See page 28)

IN THE PENTAGON

The budget-minded Administration appears to have no intention of buying an extra eight Convair *Atlas* squadrons as recommended by the House Appropriations Committee. They would cost about $800 million—a long way from the $85 million "downpayment" added to the defense appropriations bill by the committee.

• • •

The Martin *Mace-B*—also considered for use by European NATO troops—has substantially greater range than the more than 750-mile *Mace-A* and operates on a new inertial guidance system. In fact, the much extended range of the *Mace-B* is reported to be forcing the Air Force to transfer testing from Holloman AFB, New Mexico, to Cape Canaveral.

• • •

The $127,500,000 slashed by the House Appropriations Committee from the Air Force's *Mace* program would virtually strangle production of the *Mace-B*. But the cut would not halt the flow of *Mace-A's* to U.S. troops in Europe where they are taking the place of the *Matador*.

• • •

One of the big problems facing scientists working on feasibility studies for ARPA's Project *Orion* is radiation and fallout. *Orion*—a proposed multi-kiloton space platform—would be launched by a series of controlled nuclear explosions. General Atomic Division of General Dynamics is conducting the studies.

• • •

One of the main arguments being used by some top Pentagon scientists against the Western Electric *Nike-Zeus* is that it cannot cope with the vastly complicated ICBM threat expected by the mid-1960's. They argue that defense against a small number of ICBM's and radar decoys is one thing. But the attack they foresee, involving hundreds of warheads, jammers and decoys, is quite another.

A major reorganization of the Air Force Weapons Board involves establishment of advisory and review panels based on complete weapon systems. These include not only the weapon and related facilities but also personnel, training, maintenance and supply.

ON CAPITOL HILL

The House's deep cuts in the Boeing *Bomarc* program and the Senate's deep cuts in the Western Electric *Nike-Hercules* program are seen more as pressure plays than economy. Congressmen are tired of pumping billions into both the Air Force and Army programs. Now they are putting it to the Pentagon at point blank range: Make up your mind.

• • •

The flight of Baker and the late Able has stirred up a new congressional secrecy investigation. The House Information Subcommittee will soon be asking Pentagon and NASA officials to explain why space monkey business is secret some days and not on others.

AT NASA

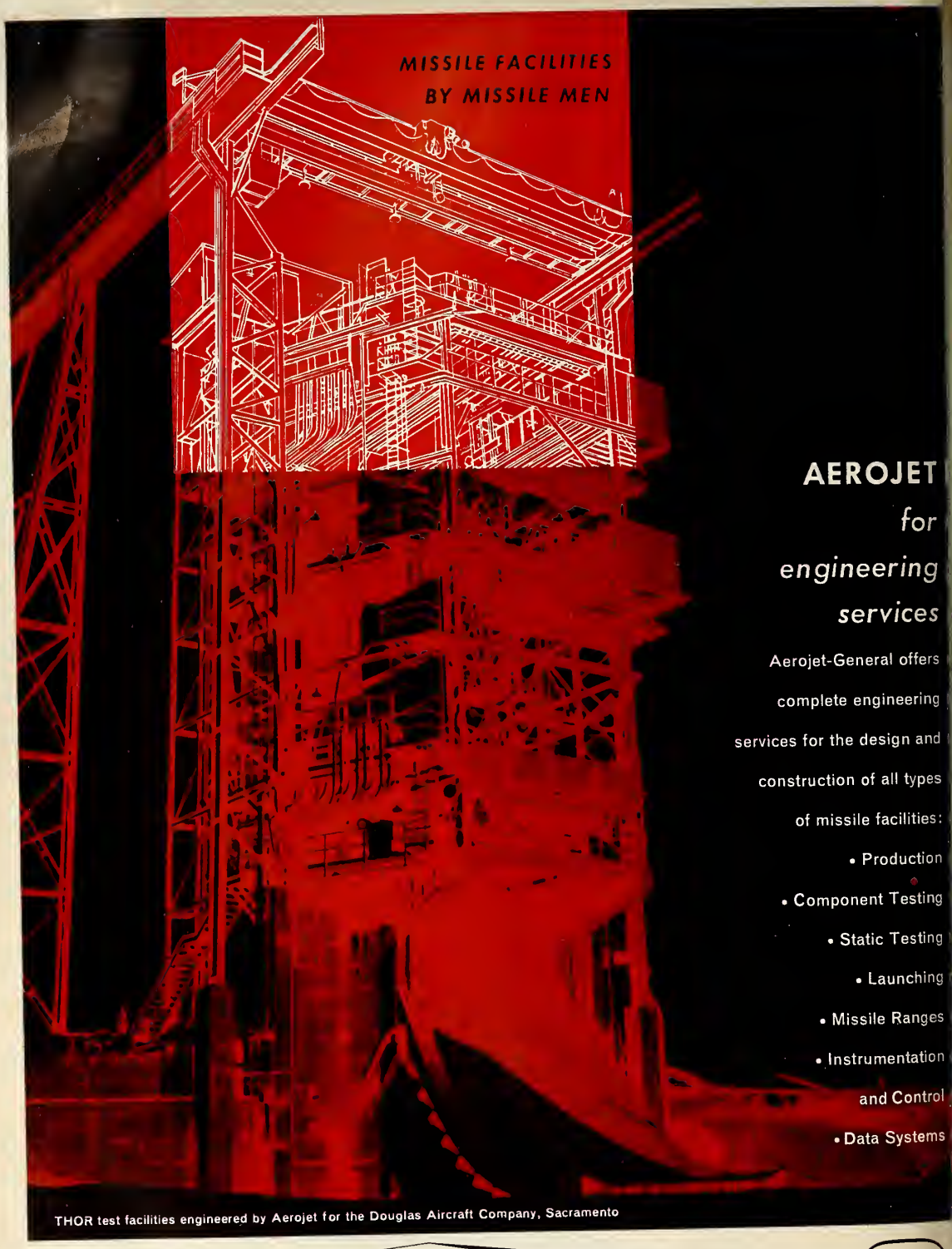
Scientists at NASA have scheduled a satellite launching a week for three weeks beginning with one about mid-June. First will be a new attempt to launch *Vanguard III* with its extra proton-free precession magnetometer carrying an extra-sensitive magnetometer and an inflatable 30-inch balloon. Second will be *Explorer VI*. Third will be *Thor-Able III*—a space probe.

• • •

Two deep space probes—*Thor-Able IV* and *Atlas-Able IV*—are scheduled for later in July and August. Both are expected to follow *Mechta* and *Pioneer IV* into solar orbits. Scientists expect to be able to track them farther than either of the first two solar-powered satellites because they will be powered by greatly improved solar cells.

AROUND TOWN

U.S. officials say privately that Russian Premier Khrushchev's threat to establish missile bases in Albania is 100-proof Soviet hogwash. Reason: Russia already has submarine bases in Albania, and the Red subs are capable of launching missiles.



AEROJET
for
engineering
services

Aerojet-General offers complete engineering services for the design and construction of all types of missile facilities:

- Production
- Component Testing
- Static Testing
- Launching
- Missile Ranges
- Instrumentation and Control
- Data Systems

THOR test facilities engineered by Aerojet for the Douglas Aircraft Company, Sacramento

AEROJET-GENERAL CORP.®

THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)

industry countdown

Cash position of missile/aircraft manufacturers will improve substantially under Air Force decision to ease requirements for liquidation of progress payments. Order has been forwarded from USAF headquarters to Air Materiel Command requiring that the rate at which advances must be liquidated will be subject to negotiation. Order is effective July 1 and covers both new contracts and deliveries made after that date. During 1957 drive to stay under national debt ceiling, progress payments were limited to 70% of incurred cost. As a result, 70% of the delivery price (on fixed price contracts) was withheld until progress payments previously made were fully liquidated by the company. New AF Procurement Instruction will spell out the new rules, which seemingly would allow contractors to retain up to 85% of earned profit on deliveries without running afoul liquidation of progress payment rules.

STRUCTURES

Team that actually wins *Dyna-Soar* development contract, insiders say, probably will be a "mixture" of members of the two teams in the contest. One team is headed by Boeing and the other by Martin and Bell Aircraft. Air Force scramble conceivably could split Martin and Bell; would be aimed at putting together best combination of subsystems contractors. One high Pentagon official says concepts for the rocket-boosted manned glider are so similar "you could put 'em all out on a table and not be able to tell them apart." Announcement of the contract is due shortly.

• • •

Wage demands for forthcoming bargaining talks with missile/aircraft and electronic employers will be hammered out at the first joint conference of the International Association of Machinists and United Auto Workers Unions starting Aug. 5 at Kansas City. Both UAW's Walter P. Reuther and IAM president Al Hayes will address conference delegates representing 600,000 missile industry employes. Joint action of the two unions follows six years of individual, but coordinated collective bargaining under a mutual assistance pact.

• • •

Industry observers are wondering if the naming of retired AF procurement chief Lt. Gen. C. S. (Bill) Irvine as a v.p. and planning director of Avco means the company will expand on the West Coast. Irvine has indicated he will headquarter in California and friends believe he hasn't switched plans.

PROPULSION

Look for E. I. duPont to get into solid fuel development race. Military officials have been wondering why the big chemical concern hasn't moved sooner . . . Meantime, Astrodyne Corp., McGregor, Texas, has won a $2 million AF contract for solid propellants.

ARPA is investing about $14 million in solid fuel research during fiscal 1959. Biggest percentage of the funds will be spent with private industry.

ELECTRONICS

Lockheed is the Air Force contractor on *Midas* and *Sentry* projects. Funding amounts to $10.8 million for *Midas* and $98.6 million for *Sentry* during 1959 FY. Air Force is executive agent for ARPA on the projects.

• • •

Answer to frequency spectrum and bandwidth saturation problem are new devices under development for analyzing data before transmission. STL's Dr. George C. Mueller says these new telemetry techniques would reduce bandwidth requirements by 1000 to 1.

• • •

Near perpetual motion temperature-operated clock went to W. J. (Jim) Mayo-Wells of the National Bureau of Standards—winner of the first annual telemetering award of the National Telemetering Conference. He initiated the first industry-military telemetering conference back in 1948.

ASTROPHYSICS

Analysis of photographic plates exposed to radiation 770 miles in space indicates inner Van Allen belt consists of masses of protons with a level of 1 roentgen per hour. University of California Radiation Laboratory physicists Dr. R. Stephen White and Dr. Stanley C. Freden found most of the protons had energies around 75 mev; 10% were in 300 mev range and about 1% were 700 mev or greater.

• • •

White and Freden calculate at 2000 miles radiation intensity rises to 100 roentgens per hour. This would yield in four hours a fatal exposure to an unshielded space traveler. Ten photographic plates measuring slightly less than two inches square were rocketed into space aboard a *Thor-Able* launched from Cape Canaveral in April. They were recovered along with the nose cone.

Reach the heart of the missile market throughout the entire year.

missiles and rockets

3rd ANNUAL engineering progress issue

featuring the Guided Missile Encyclopedia

JULY 20, 1959



Your guarantee to high readership and constant reference . . . in the $7 billion missile market.

Here is the most exciting and popular issue of the year. Authoritative articles by recognized experts — from Astrometry to Ion Propulsion — PLUS the new and expanded Guided Missile Encyclopedia. Now you can reach the market in depth and quality as never before. Write, call or wire your *missile and rockets* representative today, and find out how you can put your sales message where it will reach the heart of the missile market throughout the entire year.

NEW YORK CITY: 17 East 48th Street PLaza 3-1100 • DETROIT: 201 Stephenson Bldg. TRinity 5-2555 • CHICAGO 139 N. Clark Street CEntral 6-5804 • LOS ANGELES: 8929 Wilshire Blvd. OLeander 5-9161 • MIAMI: 208 Almeria Avenue HIghland 4-8326 • TORONTO: 12 Richmond Street E. EMpire 4-2001 • LONDON: 28 Bruton Street GRosvenor 835 • PARIS: 11 Rue Condorcet Tru 15-39 • GENEVA: 10 Rue Grenus 34 66 73

M/R

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

UNE 8, 1959—VOL. 5, NO. 24

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Army Expanding 'Breakout' Policy

Congress sees increased opportunities for small business with Army taking 'standardized' components away from primes and buying under competitive bidding

by Erica M. Karr

WASHINGTON—The Army's greatly epped-up "breakout" policy, recently vealed in hearings before the House efense Appropriations Subcommittee, bound to jostle to some extent the tire structure of its missile procure- ent pyramid.

Breakout is the process through hich missile components, as they be- me stabilized are taken away om the prime contractor and con- cted for directly by the Army. Esti- ated savings, the Army says, will n to hundreds of millions of dollars en its hoped-for goal of 50% break- ct on missile systems is reached.

Affected is the prime, his subcon- ctors, the Army's own procurement s up and, Congress hopes, the tax- p er.

Prodded last year by a Congress hich felt that the primes were get- ti too much, the Army, which had b n making small motions in the d ection of breakout, went all-out u ler an August, 1958, directive from th Deputy Chief of Staff for Logistics. T e directive stresses early identifica- ti n of components "susceptible to b akout," and the encouragement of p ne contractors to "identify items a components which can be pro- c d on a competitive basis in order to broaden the subcontracting struc- tu ."

Latest Army procurement policies ar spelled out in a directive dated M ch 23, 1959 (#145-715). It will re ain in effect for two years.

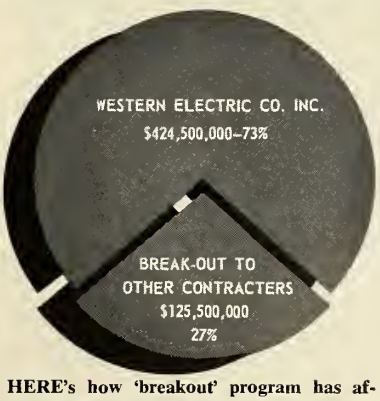
• **Shopping around**—With or with- ou his help, the prime contractor who wa given the whole pie in the be- gi ing is likely to find pieces nibbled aw y. If he or his subcontractor have de loped a piece of missile-related ha ware to the proven-out stage, he may well find it missing from the renewal contract next time around, because the Army has shopped around and found itself a better deal.

He may also find his proprietary items designed out of the system. Despite the fact that he will have no control over many important components in the system, he will be charged with responsibility for overall system reliability.

Moneywise, he stands to lose the approximate 3 to 6% profit he was making by riding herd on the subcontractor—about 10% if it was an "in-house" item.

Does the subcontractor make more profit if he deals directly with the Government? Possibly less, says the Army, since it is likely to scout the market more carefully to get the best possible price.

• **Savings touted**—The Army procurement staff will have to be stepped up to administer its increasing responsibility as that of the primes decrease. But the Army claims that the added administrative costs will be a drop in the bucket, compared to the savings.



HERE's how 'breakout' program has affected Western Electric's *Nike-Hercules* program.

The Army points out that breakout of *Nike-Hercules* components from prime Western Electric has so far resulted in a savings of about $4.7 million despite the increase in Government's administrative costs. Estimate on total savings for *Nike-Hercules* runs to $20 million and, Army points out, this does not include savings through competition. Western Electric, which started with 84% of the program, is now down to 73%.

Another example is *Sergeant*, scheduled for a final breakout within two years which will cut down Sperry Utah Engineering Lab, awarded 91% of the $40 million funded in Fiscal 1959, to 71%.

In addition, the Army anticipates a 30% dollar breakout from prime contractors on *Hawk* (Raytheon Manufacturing Co.) and *Lacrosse* (Martin Co. and Thiokol Chemical Corp.). Breakout is now in the works for *Nike-Zeus* (Western Electric) and *Pershing* (Martin Co.).

In addition to major item breakout, procurement of replenishment repair parts will be sought outside the prime.

Carrying this process one step further, the Army is now working on breakout from breakout—taking away from the new "sub-prime" contractor additional items which have stabilized if potential cost savings warrant it.

Under scrutiny is a direct contract with Douglas Aircraft Corp., originally subcontracted by Western Electric for launching area items of *Nike-Hercules*. Douglas may well find a big chunk of this taken away under "sub-breakout."

• **The process**—Breakout during the various phases of an Army missile program shapes up this way:

1) Development, Test and Pre-Production—Because major engineering at this point requires numerous

changes breakout is generally not desirable. The Army, however, may and frequently does procure directly items which will not substantially affect engineering compatibility with prime-supplied items. These would include nose cones, adaption kits, booster motors and fuzes.

2) First Production Order—Beginning of item stabilization gets breakout into gear. Easy marks for breakout are supports units such as fueling and power equipment and electric and hydraulic cables.

3) Placement of Follow-on First Repeat Order—At this phase the system prime contractor's end product is usually stabilized. System components which no longer require close control for compatibility and which are not part of the prime contractor's end products will be broken out and procured directly. This could include launchers, support equipment and certain missile metal parts. At this point repair parts will be procured directly through competition. It is at this point, too, that the system prime contractor's fee is negotiated downward in relation to the reduction in subcontracting.

4) Additional Repeat Orders—The government now analyzes major assemblies and important elements of the prime's end items to see whether these should be directly procured and furnished to the prime or if the prime should continue procuring them competitively if other sources are available. During this stage the government takes over direct control of engineering changes. Breakout possibilities here are guidance packages, sustainer motors, frames. Additional repeat orders are placed through fixed-price contracts "whenever possible."

• **Background**—In a statement prepared for the House Appropriations Subcommittee, Gen. John B. Medaris, commander of the Army Ordnance Missile Command, describing evolution of the original "system prime contractor" to the present "system prime contractor with breakout", said the concept was years in development.

He reported:

"When originally approached on this breakout concept, the prime contractors refused to accept it, contending that they were production industries and that they would not maintain a staff of engineers for the production of equipment by others. However, three major advances in missile system contracting helped pave the way toward a 'breakout' philosophy acceptable to the Government and the contractors."

First of these advances, said Medaris, came about through competitive negotiation on the *Honest John* reaffirming the Army's interpretation of the patent and proprietary rights and data clauses in missile development contracts. In general, this held that the reproduction rights of any item de veloped under government funds wer property of the government.

Next step was inclusion in produc tion contracts of a clause requiring th contractor to report to the governmen before production, any proprietar items in the system. "When the impa is major, and reproduction rights ca not be obtained economically, a d velopment program is established whe ever feasible to design the item out the system. Restriction of procureme to a selected few is reduced to a min mum."

Through what he calls "the late major advance" in Army contractir concepts, Medaris pointed out that t systems contractor is charged wi maintaining "system engineering r sponsibility throughout the life of t system no matter how, where or fro whom the parts of the system are pr cured."

Of the total Army missile expend tures, 81% is expended by priva industry.

Rep. Gerald R. Ford (R-Mich.), member of the House Defense Appr priations Subcommittee and a breako booster, says the committee is inte ested in the fact that breakout increas opportunities for small business in t defense picture.

"Anything legitimate that hel smaller companies, is on the rig track," Ford said recently. "The b are getting bigger to the exclusion the small companies who can make great contribution to the defense effo I certainly feel the Army breako system is right."

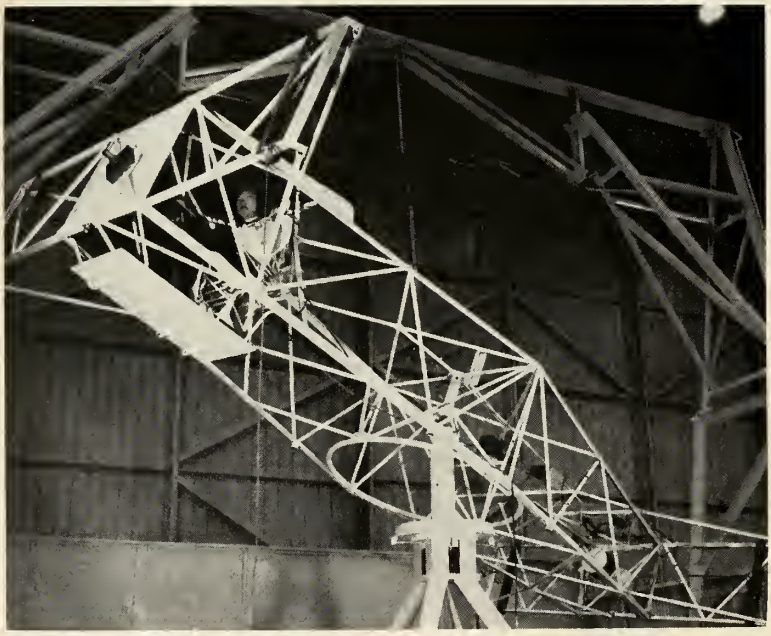
More emphatically, he told Br Gen. J. E. Engler, Army's Director Procurement-Logistics, at the rece appropriations hearings that if breako was not pushed as far as possib Congress might write it into law:

"I think your program is good a is a good illustration of response Congressional interest, but if the pr sure is not kept on it could well that legislative provisions might be i cluded in an appropriation bill otherwise which would take flexibil away from the services . . . arbitra restrictions . . . which would be mu more difficult as far as they (the pri contractors) are concerned, and a gr deal more difficult as far as the Arm the Navy and the Air Force are co cerned.

"It is not impossible to write leg lation which would make their p blems as prime contractors very di cult . . . So let us get them to go alo with you in what you are trying to d

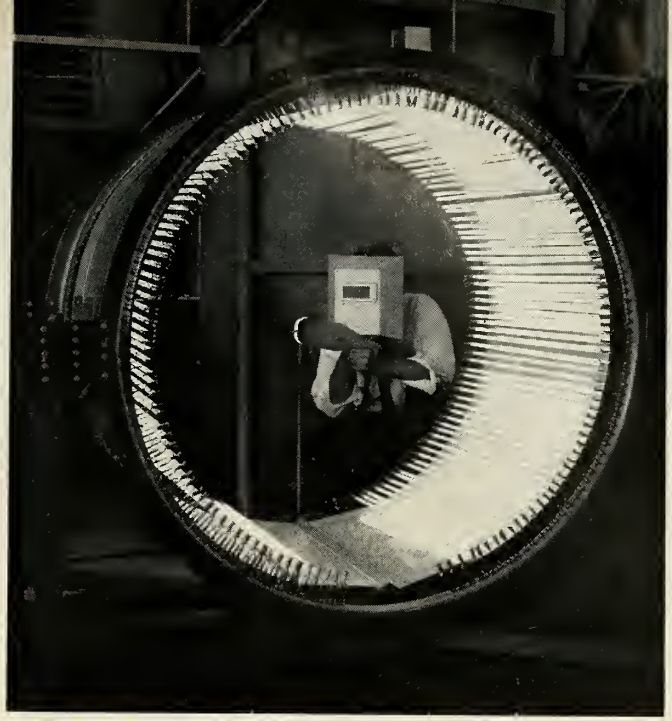
Ford told M/R later Congr would check progress to make s there would be no "dragging of feet."

Space Vehicle Simulator

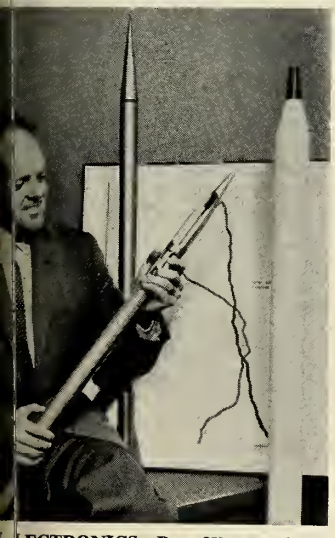


BOEING SIMULATOR, which rides atop a near-frictionless air-bearing, is being used as a test-bed for trying out various methods of controlling position. Compressed gas gives various attitudes for pitch, roll and yaw.

Industry Does It This Way



THIS OVEN—capable of testing components at 3000°F—is part of Convair's recently-opened High Temperature Structures Research Lab.



LECTRONICS, Borg-Warner Corp. s leveloped the *Owl* meteorological ck for ARDC to provide wind direc- n nd velocity information at altitudes hh as 240,000 ft.



FIRST released photograph of Boeing's *Bomarc* production line. These IM-99A missiles will be installed at Northeast air defense bases.



STANDARD STEEL Corp. is delivering vacuum-jacked LOX tanks for *Thor*. Holding 13,500 gallons, the 52′ tanks have a high-strength aluminum outer jacket and a stainless steel inner shell.

NOSE CONES: *The Case for Heat Sink*

Designs are limited to relatively low values of the ballistic parameter and require considerable attention to manufacturing tolerances

by Dr. J. D. Stewart

PHILADELPHIA—As nose cones using the ablation system for thermal design have gained more and more prominence in recent days, the question is naturally raised, "Why did General Electric select a heat sink design for the thermal protection of the ballistic missile re-entry nose cone in the first place?"

Before attempting to answer that question, let us consider a few of the characteristics of a ballistic missile. Basically it is composed of two separate systems, the nose cone and the booster system. The nose cone is accelerated by the booster system to a given velocity and altitude in space. At this point, it separates from the booster, follows a ballistic trajectory through space and re-enters the earth's atmosphere. The velocity and angle at which it re-enters are dependent on range and trajectory.

The design of the nose cone depends almost entirely on conditions encountered during the re-entry phase, when it is subjected simultaneously to large decelerations and large thermal loads. The decelerations which result from aerodynamic pressure-drag reach peak values around 50 g's. Depending on the configuration of the nose cone, the peak thermal loads are measured in 1000's of BTU/ft²-sec.

Heat is transferred to the re-entry body by several means. During re-entry, the blunt-nosed body is surrounded by high-temperature air. This air will be partly dissociated and, to a lesser extent, ionized, and it will be at temperatures of the order of 15,000°F at ICBM ranges. This hot gas can transfer heat to the body by convection and by radiation. The former mechanism is the prime contributor of heat, which the body can dissipate by conduction and radiation. For heat sink designs which have low melting temperatures, conduction is the more important.

The heat transferred to the body by convection or friction is approximately equal to the product of the thermal conductivity of the air and the difference between the temperature of the hot gas and the temperature of the wall divided by the boundary layer thickness. The boundary layer near the nose of a blunt body is a few thousandths of an inch thick.

The peak heat flux to a ballistic re-entry vehicle is a function of the ballistic parameter, defined as the ratio of the weight of the vehicle per unit frontal area divided by the aerodynamic drag coefficient. For given re-entry conditions, the lower the ballistic parameter, the lower the peak flux.

The heat flux to the stagnation point of a blunt body is inversely proportional to the square root of the radius. Thus, the smaller the nose radius, the higher the convective flux

• **Requirements**—Transcending other considerations, the primary pose of the ballistic nose cone i provide thermal protection for the load. Since internal components ar stricted to relatively low temperat insulation requirements are of ext importance in selecting nose cone terial.

The nose cone, in spite of its se environment, must maintain struc integrity during re-entry, and strength characteristics of many r rials are seriously reduced at high peratures. Moreover, the design o vehicle must be adequate to withs high deceleration loads as well as sure loads, particularly at high peratures.

By 1955 the ballistic missile gram had reached the stage whe decision was needed on selectio material to protect the payload o *Atlas* re-entry nose cone at I ranges. The Missile and Space Ve Department of the General Ele Company was given this responsi by the Air Force.

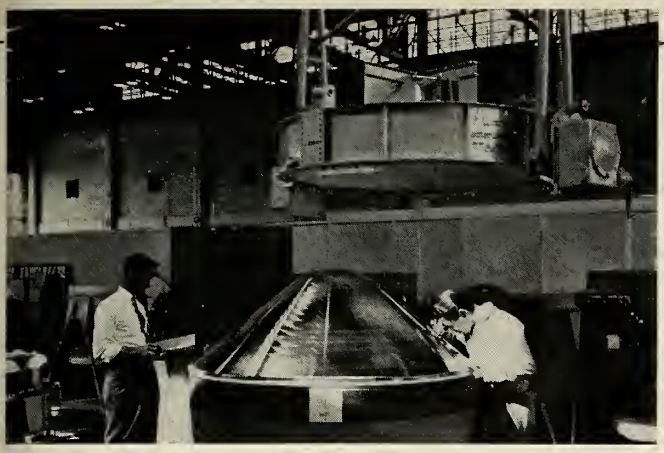
• **Sketchy data**—Very little available to aid in choosing mate There was practically no test dat an aerodynamic environment c sponding to that which would be countered by a re-entering bal missile. Some aerodynamic and the dynamic test data had been obtain low supersonic speeds in wind tu and shock tubes, but informatio the blunt shapes required for bal vehicles was lacking.

Furthermore, theoretical cal tions for blunt bodies in hyper flows were in the early develop stage. Lees, of the California Ins



ABOUT DR. J. D. STEWART

Dr. Stewart was awarded a B.A. Sc. in aeronautical engineering in 1949, an M.A. Sc. in 1950, and a Ph.D. in 1952, all from the University of Toronto. In 1952-53, he conducted airframe studies for the National Research Council of Canada. During the next four years, he carried out supersonic airframe structure and missile structure feasibility studies for Convair. He has been with GE's Missile and Space Vehicle Department since 1957, specializing in hypersonic missile structure design.



OVERALL surface finish of GE's copper heat sink cone severely restricts pits and scratches, placing heavy responsibility on quality control.

echnology, had derived for a blunt
in high Mach number flows, a
lution for the stagnation point heat-
g rates and for laminar flow away
o the stagnation point; but his the-
y had not been checked experimen-
ll. Opinions varied as to whether the
ndary layer on the nose cone would
n in laminar or whether it would be-
on turbulent, resulting in higher heat
ux).

n the field of materials, a consid-
ble amount of information was
ilable on properties of such metallic
terials as copper, aluminum, and
ckel at elevated temperatures. The
rmal, as well as the structural, char-
teristics were known to some degree
function of temperature. There
as some data on more exotic mate-
ials such as graphite and beryllium.
er, little was known about the char-
teristics of plastic materials, partic-
ar under the extremes to which
ey would be subjected during a re-
try trajectory.

Another consideration was the
eight of the re-entry vehicle. Since
is would be limited by booster sys-
m capabilities, an upper limit was
aced on the heat protection system,
miting the insulation requirements.

In addition to the technical consid-
rations of strength and heat protec-
on, there were other factors of equal
portance. Was the selected material
vailable in the quantities required for
oduction? What would be the manu-
turing problems? What about relia-
ility of the heat protection system?
ould local melting be tolerated?

To answer some of these questions, cer-
tain ground rules were specified. The
heat protection system must have high
reliability. No surface melting should
occur. The nose cone must be delivered
on a given schedule.

• **Decisions**—After weighing all factors, GE decided to use a solid heat sink nose cone on the re-entry vehicle. There still remained the question of material. A few of the thermal characteristics of some of the more probable materials are listed in the table below.

Settling on the heat sink for thermal protection meant that the aerodynamic configuration was, of necessity, one with a relatively low ballistic parameter. To provide some thermal margin, use of aluminum, iron, or nickel was not possible because, at ICBM ranges, the surface temperature during re-entry would exceed the melting point of these materials.

Because of the low heat capacity of silver per unit weight, it, too, was eliminated from consideration. The nose cone would have been too heavy.

Beryllium would provide a small thermal margin for the vehicle being considered. However, at the time, it was not available in the quantities required. Beryllium manufacturing problems had not been overcome when the material selection was required.

Tungsten gave an adequate thermal margin but was in short supply and had been placed on the critical materials list. It also had the disadvantage of operating at a surface temperature high enough to put a severe design requirement on insulation needs.

Graphite introduced manufacturing problems. And it also operates at high temperature, creating insulation problems.

Molybdenum suffers severe oxidation at high temperatures. Manufacturing solutions had to be found before it could be used in the nose cone design. Here again, the high surface temperature creates an insulation problem.

The remaining material, copper, met the requirements for no surface melting at ICBM ranges for the configuration being considered. Copper was in plentiful supply and presented no major manufacturing difficulties. Hence it was decided to construct the heat sink nose cone from copper.

• **Smooth design**—The GE 3.1 configuration is basically a blunt, sphere-cone forebody with a relatively low ballistic parameter. The flow over the forebody behind the detached shock wave is subsonic at all flight speeds.

If the boundary layer on the heat sink transits from laminar to turbulent flow, heat flux will be considerably higher. Since very little test data was available on effects of surface finish on transition, it was decided to make the surface of the shield as smooth as possible. In addition, plans were made to flight-test scale models of the GE 3.1 configuration on a research rocket vehicle which would fly at hypersonic velocities. These models were designed with surface finishes of the order of 2 microinches. Controlled roughness patches were placed on the models, and both the smooth and rough surfaces were instrumented with thermocouples, from which heat fluxes could be determined.

The copper heat sink was plated with a thin film of nickel, used to reduce the heat absorbed by the body from the radiating hot gas which surrounded the nose cones.

The overall surface finish of the copper heat sink severely restricts the number of pits and scratches permitted on the surfaces. These requirements on the surface finish of the nose cone placed a heavy responsibility on the quality control for the heat shield.

Thermal Properties of Ablative Materials

MATERIAL	MELTING POINT °R	DENSITY lb/ft³	SPECIFIC HEAT BTU/lb°R	THERMAL CONDUCTIVITY BTU/ft-sec-°R	THERMAL DIFFUSIVITY ft²/sec
Aluminum	1680	169	0.215	0.0366	0.00101
Beryllium	2800	114	0.52	0.0255	0.00043
Copper	2440	559	0.092	0.0632	0.00123
Graphite	6790	137	0.39	0.0051	0.000095
Iron	3260	492	0.11	0.0121	0.000224
Molybdenum	5220	637	0.061	0.0235	0.00060
Nickel	3110	556	0.105	0.0148	0.00025
Silver	2210	655	0.056	0.0672	0.00183
Tungsten	6630	1206	0.032	0.0323	0.00084

It can be seen that the use of the heat sink design for long-range ballistic missiles is limited to relatively low values of the ballistic parameter and requires considerable attention to manufacturing tolerances.

• **Testing**—To verify the theoretical design techniques developed during the design phase of the nose cone, an extensive flight test program was prepared for the full-scale vehicle.

The nose cone and afterbody of the re-entry vehicle were extensively instrumented with pressure and temperature sensors. The measured pressure data would be used to verify data obtained in such ground-based test facilities as the Jet Propulsion Laboratory supersonic wind tunnel and the AEDC "hot-shot" hypersonic tunnel. The pressures would also be used to check out a theoretical, real-gas, blunt body, flow field solution which was developed by MSVD personnel.

The thermocouples are located a few thousandths of an inch below the surface of the heat shield. The measured temperature rises at various stations on the nose cone are used to calculate the fluxes to the surface of the vehicle at various times during the re-entry trajectory.

Accelerometers and vibration sensors are among the other measuring devices which are used during each flight.

To determine the effect of surface finish on the heat fluxes to the body, controlled roughness patches were installed along one meridian line of temperature sensors. These patches had roughnesses of 62 and 100 microinches. The former roughness is characteristic of a good machine finish, whereas the latter is representative of the roughness which would be caused by micrometeorites impacting on the surface. If these roughness patches did not result in transition, the nose cone manufacturing problem would be eased considerably.

• **Getting data**—Three methods of getting the measured flight test data back to the engineer are used. The first and primary source of data return is by direct telemetry to nearby receiving stations. This method has one severe drawback: during a portion of the hypersonic re-entry trajectory, the ionized sheath of hot gases which surrounds the body attenuates the transmitted signal, resulting in "blackout."

In order to obtain data during this "blacked-out" portion of the trajectory, the measured data is stored on a tape. When direct telemetry is again possible, this playback data is transmitted to the receiving antenna. This will, naturally, result in a loss of recorded data during playback, but this is not serious since the major portion of the heat pulse has been completed.

The final method of obtaining data is to record the measured data on tape later stored in a data capsule. During the late stages of the re-entry trajectory, the data capsule is ejected from the nose cone. A recovery system has been developed by MSVD engineers for locating the data capsule in the ocean. No allowance has been made for attempting the recovery of the heat sink nose cone itself.

• **High success**—The copper heat sink re-entry vehicle has been successfully flight tested over a wide range of re-entry conditions. Direct telemetry and playback telemetry data have been obtained on all successful firings to date. The data capsule has survived water impact and has been recovered intact from a large number of flights.

Because a heat sink nose cone is used, the measured temperature data received on all the flights is excellent for comparison with the various theories used in thermal design. To date, a large amount of extremely useful data has been obtained. Stagnation point, laminar, turbulent, and separated flow heating rates have been measured.

The temperature rise at the stagnation point of the copper heat sink has agreed to within less than 5% [illegible] predicted temperature rise. The [illegible] over the forebody has remained [illegible] nar for longer periods of time [illegible] were originally estimated. Afte[illegible] heating rates are lower than pre[illegible] The copper heat sink design ha[illegible] vided the necessary thermal prot[illegible] for internal systems. The aerody[illegible] performance of the re-entry vehic[illegible] been good. And the nose cone ha[illegible] vived ballistic re-entry conditic[illegible] predicted.

The development of the [illegible] heat sink nose cone has been ju[illegible] by flight tests and has met [illegible] ground rules laid down. Local s[illegible] melting has not occurred. I[illegible] components receive the require[illegible] mal protection. The cone was de[illegible] on schedule.

Data from actual flight tes[illegible] proved invaluable, because it ha[illegible] vided the necessary verification [illegible] theoretical methods used in th[illegible] sink design. Moreover, the des[illegible] the more advanced nose cones, [illegible] use ablation materials, is more [illegible] because of the heat sink work.

The use of the heat sink nos[illegible] as designed by the Missile and [illegible] Vehicle Department of the [illegible] Elctric Company for the first I[illegible] and ICBM's has been justified b[illegible] tests. Furthermore, it is in pro[illegible] as an IOC weapon until more ad[illegible] cones become available.

Cell Produces Power Directly from Gas

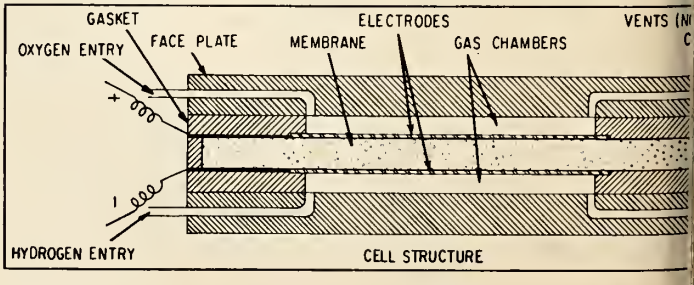
SCHENECTADY, N.Y.—A practical "fuel cell" that generates electricity directly from hydrogen and oxygen in the air has been developed by the General Electric Research Laboratory.

Such a device, under study by scientists for more than a century, promises much more efficient power generation than by conventional methods. Thermal efficiencies of over 60% have been obtained which compare with approximately 40% from present steam turbines. The device operates at room temperature and normal atmospheric pressure.

The cell uses an ion exchange membrane as an electrolyte. Hydrog[illegible] oxygen are introduced on o[illegible] sides of this membrane which [illegible] electrode in contact with each s[illegible]

At one electrode, the hy[illegible] molecules divide into electro[illegible] positive ions. The electrons esta[illegible] negative charge on this electro[illegible] the positive ions pass through th[illegible] brane to the other electrod[illegible] electrical current is thus crea[illegible] tween the two.

A number of experimenta[illegible] have been operating for mo[illegible] 100 days. One producing 9/[illegible] furnishes power to a small fan.



NOSE CONES: *The Case for Ablation*

GE engineers report that proper ablating materials have been found and re-entry tests prove the system enhances protection

by Henry G. Lew, Sinclaire M. Scala and George W. Sutton

PHILADELPHIA—The design of ballis missiles and re-entry satellite cap- us for hypersonic flight requires the co ideration of heat protection against th high-temperature environment en- co ntered by these vehicles during re- en y into the earth's atmosphere.

For ballistic missiles, typical speeds of 4 times the velocity of sound lead to quilibrium gaseous temperatures in he order of 13,000°F in the shock ay . The heat transfer rate to ballis- ic missiles is therefore very large, with pe values of about 2000 BTU/ft²-sec ec at the stagnation region. For re- en satellite vehicles, the heat rate is nu lower (peak values of 70 to 100 BTU/ft²-sec), but the time of exposure up ards to 300 seconds) leads to a ar total heat pulse.

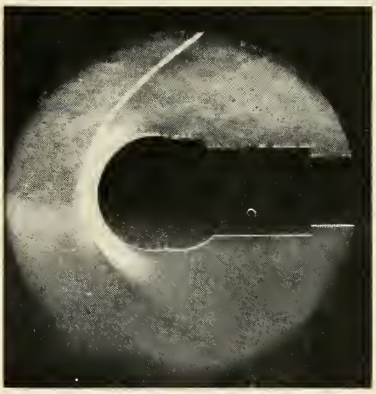
The use of heat sinks, which ab- or the aerodynamic heating by tem- er ure rise, has a limitation imposed by e thermal conductivity of the heat in material. For the larger peak heat flu associated with ballistic missiles, he heat cannot be conducted away ro the exposed face of the heat sink to the interior rapidly enough, and at trophic melting occurs. This is xa ly what happens to metallic ete rs, since metallic meteorites gen- ra exhibit large cavities after entry to the atmosphere.

Calculations indicate that the recov- red fragments represent only a frac- on of their original size. Stony iet rs generally fare somewhat bet- ir uring re-entry, since part of the ol n stone absorbs heat by vaporiz- ng. This process of melting during re- atr is called ablation, and is actually a type of self-regulating mass transfer process.

• **Plastics researched**—Stone, of course, is not an acceptable structural material, and hence a search was initiated to find suitable ablation materials for hypersonic re-entry. The discovery of appropriate materials actually started from tests on rocket motor materials. In the course of searching for better nozzle and jet vane materials for the *Hermes* Project, (1950-1954), plastics reinforced with glass fibers were investigated. Although these materials eroded badly in these initial tests, they did not erode completely. This was surprising because this type of plastic was generally used for service below 500°F.

Since one may regard these materials as being part ceramic and part plastic, at first it was felt that this was simply a convenient method of fabricating inorganic oxides into a structure which is not susceptible to thermal shock. This ability to withstand thermal shock stems both from the high strength of glass fibers—up to 500,000 psi—and from the certain amount of flexibility that the fibrous construction gives to the structure. After considerable development, glass-reinforced plastics were perfected to the point where they became suitable for use as rocket motor parts exposed to environmental temperatures up to 5000°F.

• **Nose cones**—The arrival of the ballistic nose cone program and its attendant high temperature environmental problems brought the problem of thermal protection into focus again. It was not obvious immediately that the type of material used in rocket motors would be suitable also for hypersonic re-entry, where environmental temperatures are of the order of



HOT GAS gap generated at high speeds created with 2500 kw AC air-stabilized free jet, proved out models.



ABLATED QUARTZ model. Up to 100% pure silica has been tested successfully, but shielding value drops in re-entry.

13,000°F, and the air is highly oxidizing. (Generally, rocket engine flames are reducing).

The possibility existed that the resin would burn exothermically with air, and the reinforced plastic would fail catastrophically. Therefore, research programs leading to the development of ablation materials for hypersonic flight were initiated by the Aerosciences Laboratory of the Missile and Space Vehicle Department of the General Electric Company, under contract with the Ballistic Missile Division of the Air Force and by the Army Ballistic Missile Agency, which was developing the *Jupiter* missile.

The Air Force required a method of obtaining flight data from nose cones. This called for the use of a data capsule which could be ejected from the nose cone at high speed, survive re-entry, and then impact the water at 400 ft./sec. and still remain functioning. On the basis of strength and weight requirements, it appeared imperative to use reinforced plastics as the outside material. To determine the hypersonic ablation characteristics of the reinforced plastic, models were tested in a rocket motor exhaust jet which simulated flight velocities up to 13,000 ft/sec. and yielded stagnation temperatures of approximately 5400°F, stagnation pressures between 200 and 300 psi, and heat transfer rates of 800 to 1800 BTU/ft²-sec.

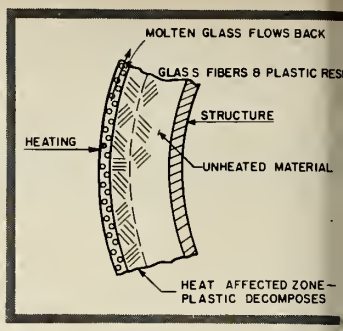
• **Reinforced plastics**—Using this facility, the discovery was made that "E" fiberglass reinforced plastics could absorb up to 2000 BTU for each pound of material which ablated. As the plastic ablated, the resin pyrolized into a carbonaceous structure and a gas flowed into the gaseous boundary layer, while the glass melted and flowed back along the surface.

The low thermal conductivity of this plastic kept the heat-damaged region close to the surface. If the aerodynamic skin friction and pressure gradient were sufficiently low, the glass usually vaporized, leaving a carbon surface.

A second discovery was made at this point: if the "E" glass, which is a low melting point glass, is replaced by the H. I. Thompson Co.'s Refrasil (96% silica), the plastic then absorbed 6000 BTU for each pound ablated in rocket exhaust tests.

This is 40 times better than a copper heat sink, on a weight basis. This property is due to the higher viscosity of molten silica, which allows it to partially vaporize before the melt flows downstream.

On the basis of these experiments, GE's data capsule was placed in production in the summer of 1957, and



REINFORCED plastic protects struct

was the first production vehicle to made from an ablating material thermal protection during hypersc re-entry.

The Army Ballistic Missile Age also stimulated by early experim on rocket motor parts, started sim research for *Jupiter* nose cones. In t program, hundreds of ablation terials were tested in rocket engine hausts at the Redstone Arsenal. results of the two programs were s lar and an ablating nose cone demonstrated and recovered on IRBM trajectory by a *Jupiter 'C* October, 1957.

• **Plasma jet development**—though the rocket exhaust was us the temperature simulation was lim to IRBM re-entry conditions. Th fore a more severe environmental which would simulate ICBM co tions was needed with temperature the order of 13,000°F. A water st ized plasma arc, on which ori work was conducted in Germany Maecker in 1951 and Weiss in 1 was selected for test and evaluatio

Constructed by the Chicago way Laboratories under GE sub tract, the water stabilized arc bec test operational late in 1956. facility produces a flow of dissoc steam at a temperature of app mately 23,000°F at subsonic flow cities, resulting in heat fluxes of order of 400 to 3000 BTU/ft²-sec

Using the water stabilized arc important discovery was made tha organic "E" glass fibers could b placed with nylon, with an increa performance to about 10,000 BTU in this test facility. This was expl in part by the evolution of a molecular weight gas as the r pyrolized. This gas thickened boundary layer and absorbed en considerably reducing the heat flu the surface.

Although the stagnation entl of the water stabilized arc was p for re-entry studies, its chemica vironment did not simulate flight ditions. This led to the developme

ABOUT THE AUTHORS



Dr. Henry G. Lew, *Manager, Gas Dynamics, has been associated with GE's Aerosciences Laboratory since 1957. Previously he was Professor of Aeronautical Engineering at the Pennsylvania State University. He received his Ph.D. from the Polytechnic Institute of Brooklyn. His fields of interest and publications have been in the boundary layer and heat transfer theories, with emphasis on control and mass transfer and plate and shell theory. His recent interest has been in the two phase boundary layer problem.*



Dr. Sinclaire M. Scala, *Consulting Research Engineer, High Altitude Gas Dynamics, has been associated with the Aerosciences Laboratory since 1956. He had previously been employed at New York University Westinghouse Electric Corporation and Princeton University where he received his Ph.D. His special field of interest is hypersonic aerodynamics, and he has published many technical articles dealing with mass transfer in chemically reacting hypersonic boundary layers and ablation, as well as other aspects of hypersonic molecular interaction problems.*



Dr. George W. Sutton, *Consultant Research Engineer, Energy Transfer, joined the Aerosciences Laboratory in 1956. He received his Ph.D. at the California Institute of Technology and had been with the Lockheed Missiles Systems Division Research Laboratory prior to joining the General Electric Company.*

His main field of interest for the past three years has been in the analysis of the response of ablation materials to aerodynamic heating and he has published several papers on heat sink analysis, melting ablation, mass transfer cooling with combustible gases, and the ablation of reinforced plastics.

small gas stabilized plasma arc, which ally culminated in the development the large 2500 kw AC air stabilized e jet. The latter facility was avail- le for testing in 1958. About 2500 was added to an air stream and nperatures of the order of 12,000°F re obtained. Using the air arc, it s discovered that the combustion of plastic would degrade its ablation rformance only slightly, but catas- phic burning would not occur.

• **Ablation theories**—Since experi- nts are best complemented by the- y, it was clear at the outset that re than an order of magnitude type analysis would be required if the gineering designer was to have con- ence in this radically new type of tem for the thermal protection of entry vehicles.

This was particularly true when it s understood that the conditions en- ountered during hypersonic re-entry, nely stagnation enthalpy levels of order of 13,000 BTU/lb., tempera- es of approximately 13,000°R and ssures up to 100 atmospheres, could be successfully simulated on the und for times of the order of one ute (ca 1956). Theories were there- e required which would predict the ormance of ablation materials over ide range of hypersonic flight con- ions.

It is clear that the theoretical de- ination of the rate of ablation of skin of hypersonic re-entry vehicles res an understanding of the mole- r interactions between a surface its environment. As is usual in sics, such problems are described y system of conservation laws, and ist of the conservation of mass, the ervation of momentum and the ervation of energy.

n addition, chemistry is involved, the thermal degradation of a ma- l may involve pyrolysis, depoly- zation, melting, vaporization, and bustion, all resulting in interphase transfer.

n comparison with the voluminous ture dealing with design for ordin- convective heat transfer, knowledge e beginning of this program was er regarding the art of design of aterial which degrades thermally yet does not fail as a structural d.

hus, it was clear that the theore- analysis of the complex ablation em required a sophisticated effort. act, the first rigorous theoretical on to the problem of determining ate of ablation of a ballistic nose required the use of high speed onic computers, including the 704 and the Reeves REAC.

his solution was presented in the er of 1957 at the Mass Transfer Cooling for Hypersonic Flight Conference sponsored by the Air Force Office of Scientific Research and the Rand Corporation. The solution showed that the heat blocking and heat absorption of a reinforced plastic could be of the order of thousands of BTU/lb. It has also been calculated that the magnitude of the "effective heat of ablation" of a material is not a constant, but depends critically on the environmental conditions to which the material is exposed.

The theory indicated quantitatively the magnitude of the separate contributions of the following to the heat of ablation:

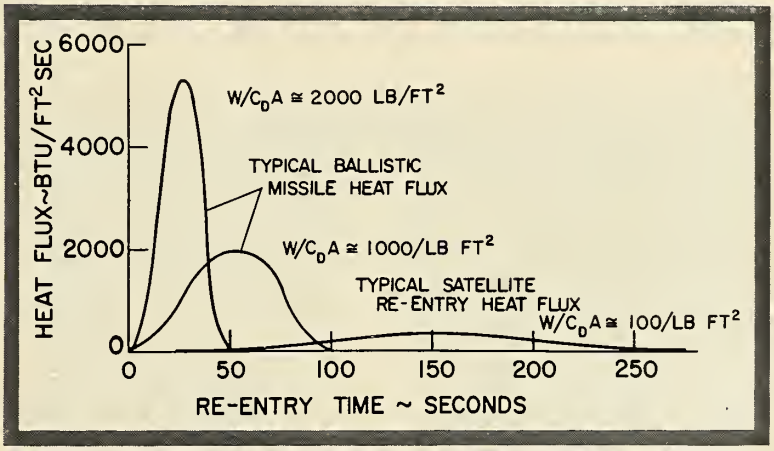
a) the heat blocking due to mass transfer (as a consequence of the thickening of the boundary layer),
b) the heat absorbed or released due to phase changes and combustion during the gasification of the solid,
c) the heat blocked by convection in the liquid phase.

The dependence of the blocking term (a) on enthalpy has been experimentally verified in water arc plasma jets, rocket motor exhaust jets, and air arc plasma jets and tunnels. It was found that tests conducted in rocket motor exhausts, which have a considerably lower enthalpy than high energy plasma jets, in general will result in an underestimate of the potential of an all plastic ablating material.

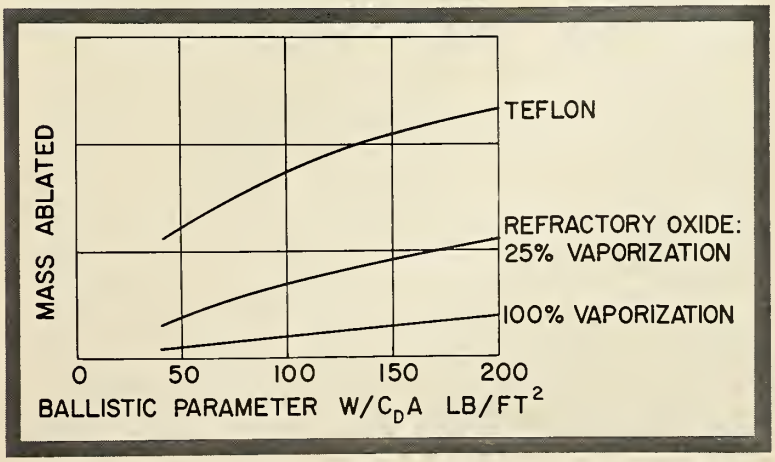
• **Ablation theories**—Since experi- ablating materials fall into the follow- ing categories:

1. Pure plastics
2. Plastics, reinforced with organic or inorganic fibers
3. Silica or other oxides
4. Carbon or graphite

Ablation theories have been developed for each of these classes, although the main line of development was directed toward reinforced plastics. When the reinforcement is "E" glass fiber, the percentage of glass is usually taken as that which gives the highest strength. The same is true when the reinforcement is nylon. When refrasil



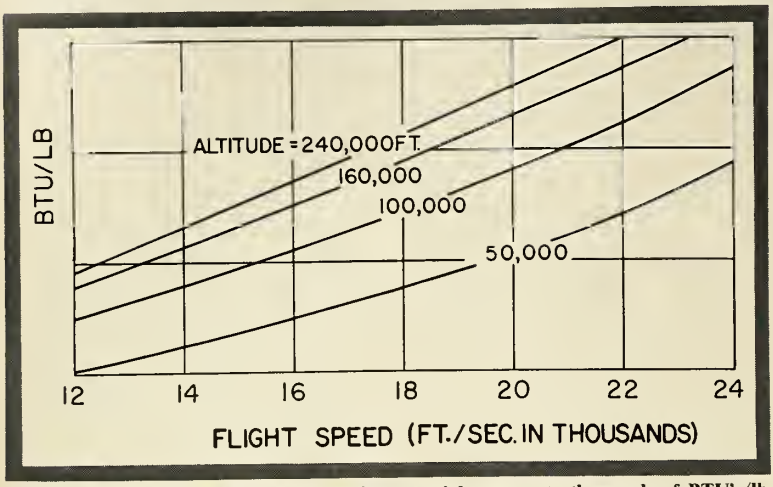
HEATING GRAPH shows typical ballistic missile and satellite re-entry heat fluxes.



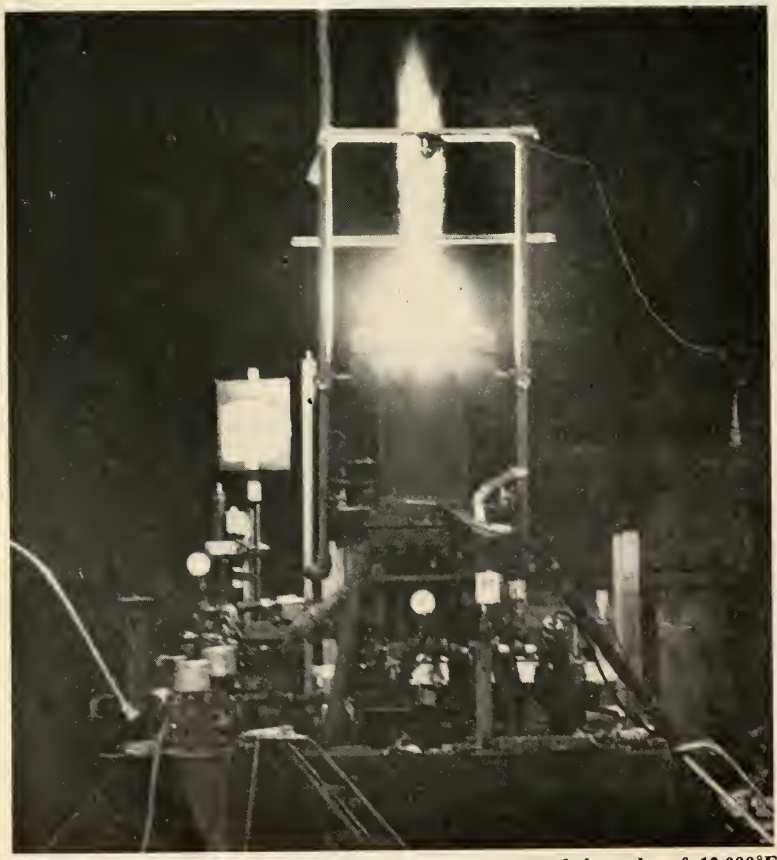
TOTAL MASS which is ablated at the stagnation point of the re-entry satellite.

or fused silica fibers are used, successful tests have been obtained with as little as 10% silica, and as much as 100% silica. Of course, the latter type of material with 100% silica is really not a reinforced plastic.

For pure fused silica, a theoretical prediction which has been verified experimentally: i. e., that liquid layers, which flow downstream under the influence of pressure gradients and aerodynamic skin friction tend to not vaporize as the environmental pressure rises.



EFFECTIVE HEAT absorption of ablating material runs up to thousands of BTU's/lb.



STABILIZED 2500 kw AC air arc obtaining temperatures of the order of 12,000°F was developed to provide chemical environment simulating flight conditions.

Thus, the peak stagnation pressur encountered during hypersonic re-ent retard the gasification of the materi minimizing the contributions of he blocking and heat absorption, and r sulting in a reduced "effective heat ablation." During re-entry the stagn tion enthalpy drops and the stagnati pressure rises. Hence one finds that t effectiveness of fused silica as a therm shield decreases all along the re-ent path.

The ability of plastics to ablate a satisfactory manner has focused tention on thermo-plastics which, wh heated, depolymerize to the monom The monomer usually has sufficien high vapor pressure so that it vapo izes immediately, giving the requir mass transfer into the boundary lay A polymer typical of this class Teflon.

These thermo-plastics are dist guished from the resins of reinforc plastics in that no carbon char is l

Another class of ablating materi is one which combusts only at the s face. This surface combustion usually diffusion controlled, and resu in ablation rates which are less th any of the other usual ablation m terials. Graphite is typical of this cl of materials. Aside from the us problems of fabricating suitable la parts from graphite, common grades graphite have a large thermal cond tivity and hence are not selfinsulat as are other ablation materials.

• **Application to design**—In ap cation to design, the designer n merely divide the aerodynamic h transfer by the effective heat of al tion to determine the amount of m terial erosion. In addition, a heat c duction calculation, allowing for moving boundary, predicts the pe tration of heat within the undama substructure.

It has been shown theoretically t for slow satellite re-entry, additio insulating material usually is requi behind the ablating skin to keep backface temperature within the lir which can be tolerated by the paylo

On the other hand, during the listic re-entry of a nose cone, wh involves much more severe heat tra fer rates than satellite re-entry, the face of the ablating material recede the same rate that the heat penetr into the interior.

These developments and disco ies have been verified by the Air Fo General Electric Company *Thor-A* flights, where several ablating n cones have successfully re-entered earth's atmosphere at hypersonic v cities after a 5000 mile ballistic tra tory. Thus, the task of finding proper types of ablating materials been completed.





'NEAR PERFECT' case on cover looked like this after hydro-static test.

Notch Sensitivity — Barrier to Solid Rockets

Challenge is to increase large motor case strength without cost in weight and reliability

WASHINGTON—Despite all the glamour in storybook and stock market, and despite the exotic nature of their missions and technological challenges, rockets usually work or don't for some pretty grubby reasons. One of the grubbiest is the motor case—the pressure vessel that contains and directs the hot, high-velocity gases of the burning propellant.

In fact, the failure of large motor case know-how to keep up with other states-of-the-art makes this the limiting factor today in solid rocket motor development. And, as a result, the unglamorous manufacturing end of the business has suddenly become the site of one of rocketry's more exciting scientific challenges—one for which a great many millions of dollars have been earmarked and in which a large number of companies and missile projects have a large and important stake.

Take the "desired" performance figures of such projects as *Minuteman, Polaris, Eagle, Pershing, Subroc, Mercury*, etc., for example. Ultimately their range, payload and reliability hang heavily on how fast large motor case technology advances.

The basic challenge is to increase large motor case strength without incurring any more cost in weight or any reduction in reliability. In order, this means finding out why materials that exhibit high strengths in the testing laboratory fail at fractional stresses when fabricated into a motor case; and —having found out why—determining what to do about it.

• **Answer coming?**—Only recently have the first hints of an answer begun to emerge. But even at this early stage, R&D results point to some important do's and don't's for large motor case designers and fabricators. Some appear pretty contradictory at first glance, such as for example this admonition: To get a high-strength case, heat treat to a lower strength than you want. The reason: Notch sensitivity, a peculiarity of high-strength materials that may provide the means of breaking through the solid rocket motor case strength barrier—if we can but understand it well enough.

The problem is one of vital national importance. In the fancier areas of solid rocket technology, like propellant chemistry, interior ballistics, etc., the big challenges have been met and won.

Propellant mixes and burning patterns have been developed which are capable of producing solid rocket motors with specific impulses that nudge the 300 mark; with burning pressures graduating from as low as 100 pounds per square inch up to the thousands of psi of pure detonation; with accelerations as low as one or two g's and as high as you please; with burning times from a fraction of a second to many minutes; and with a tolerance to environmental conditions ranging from the near-0° Kelvin temperatures of interstellar space, to the 1000°F and up of supersonic aerodynamic heating.

• **The trouble:** There are no motor cases capable of reliably putting this know-how into air or space. And no matter how advanced a solid propellant grain may be, it's still just a costly glob of highly dangerous chemicals with a fancy geometry until someone puts a suitable can around it—a can light enough to meet mass ratio requirements, strong enough to produce in volume and at a cost commensurate with national need.

Today's motor case requirements include wall thicknesses down to 0.020" and less, materials strengths in excess of 290,000 psi for steel and 100,000 psi for aluminum, strength at temperatures up to at least 1000°F—all this and reliability too. Briefly it boils down to a high-modulus motor case with a strength-to-weight ratio of at least 1,000,000 inches, compared to the 760,000 we're struggling to obtain now. It is a problem that encompasses

This is the first of a two part series prepared by the technical staff of M/R on the problems of high-strength, thin-wall solid rocket motor cases. Part one covers the newly discovered phenomenon, notch sensitivity. Part two, in the issue of June 22, will deal with biaxial stress, motor case test procedures, manufacturing techniques and some of the new materials.

Hydro-static tests wrecks havoc . . .

materials, manfacturing techniques, test methods and more thorough approaches to stress analysis.

On M/R's cover this week is the best of one state-of-the-art approach to making high-strength, thin-wall solid rocket motor cases. "A gem of the craftsman's art," the project manager said when he first saw it. "The best of the whole program!" On these pages you see how it looked after hydro-static test! The question that has plagued and continues to plague rocketry is: Why?

• **Case history**—The rocket case on the cover was fabricated from machined forged rings of 5%-chrome hot-worked die steel girth-welded together. This is still thought to be a very promising basic approach to high-performance solid rocket motor case manufacture.

Case diameter was 31 inches; length, 11 feet; wall thickness, 0.098 inches. Tolerance on the wall was held to ± 0.002". Ovality and banana were negligible, and the maximum TIR (total indicator reading) was 0.080"! All welds were X-rayed before and after heat treatment. No weld repairs were necessary. The as-machined finish on the case was less than 64 microinches.

Test of both welded and unwelded coupon samples that accompanied the case through heat treatment showed the processed material to have a minimum yield strength of 241,000 psi, a hardness of $R_c = 53$ and an elongation in the transverse and longitudinal directions of 6% and 11% respectively. Numerous pull tests showed an ultimate tensile of 270,000 psi and 100% strength in the weld and heat-effected areas. There was no decarburization. A perfect case—or so it seemed.

Upon delivery to the customer, the case was subjected to 10 "low-pressure" hydrostatic cycles at 500 psi each "to check out strain gaging and instrumentation." Then, during the first of two full pressure static and one dynamic hydro-test, it failed at a pressure of 875 psi. Its design minimum was 1175 psi, or a hoop stress in the wall of 210,000 psi. Again the question: Why did it burst at such a low stress when every pre-test check indicated a minimum yield of 240,000 psi and a burst of 270,000 psi? And why, when it did fail, did it shatter as though it had been heat treated into the blue-brittle $R_c = 74$ range?

The answer to question number one is: Notch sensitivity. The answer to the second question is a recently appreciated peculiarity of the kind of biaxial loading you get in a cylindrical pressure vessel.

This case history is typical of the kind of frustration rocket motor case makers have run into ever since first efforts were made to achieve a steel case with a minimum yield strength in excess of 180,000 psi.

You get an idea of how important this problem is when you realize that Aerojet-General is buying *Polaris* motor cases from no fewer than seven different suppliers, in addition to its own in-house development work; and that Navy's Special Projects Branch and Aerojet together are conducting 30 different *Polaris* case development programs. Most are aimed basically at overcoming notch sensitivity in high-strength motor cases.

• **Notch sensitivity**—Like many other principles now beginning to be applied to rocket motor case manufacture, notch sensitivity has been known in laboratory research work in one form or another for many years. Rarely, however, has it been necessary to apply it to large pieces of production hardware. Now, all preliminary indications are that it *must* be taken into account in designing any motor case with a minimum yield strength-to-weight ratio in excess of 730,000 inches.

Technically, notch sensitivity is the ratio of the notch strength of a material to its smooth (unnotched) strength. Notch sensitivity increases as the ratio decreases. For all practical purposes the maximum value the ratio achieves is 1.05, where the notched specimen is stronger than one that is flawless. The ratio may get as low as 0.20. What this all means is that a flaw—even one too small to be detected by any currently available means—may radically change the strength characteristics of any given material.

Flaws, or notches, include: cracks in the material, inclusions (as in a weldment), occlusions, local brittle spots—any discontinuity in the structure of the material.

Essentially, these small flaws act as stress raisers, causing local increases in stress equal to many times the calculated case stress. Under these circumstances the flaw propagates as a fast-growing crack—usually with catastrophic results. This is the same thing that caused Britain's Comet jetliners to blow up a few years back, and, apparently this is what happened to the case on M/R's cover—though the company doing the hydrotest was taking movies at 24 frames a second (compared to 1000 frames used by most rocket motor companies) whi made it impossible to determine t initial failure and its subsequent pro gation.

• **Notch ductility**—The opposite notch sensitivity is notch ductility. T is a measure of the ability of a n terial to permit local plastic deforn tion to relieve high notch-induc stresses. This means that small volun of the parent material actually mc in such a direction as to relieve t stress without increasing the size the flaw—and thus starting a r crack.

Notch sensitivity—its causes a characteristics—is the object of a la amount of research and testing by st interested agencies as Naval Resea Center, Naval Gun Factory, Spec Projects Branch, Bureau of Ordnan ARDC, Redstone Arsenal, NASA, Materials being tested run the ga ut—X-200, 4130, 4340, 12 Mo S.S. 410, S.S. 301, S.S. 304, 64 AM-350, Vascojet 1000, etc.

Virtually all show that at the h strengths demanded today—220,0 to-240,000 minimum-yield—nearly materials tested show a high no sensitivity when heat-treated to th optimum unnotched tensile streng Results also indicate that a hig notch strength can be assured by h treating to a somewhat lower notched strength level. See the cur accompanying this article for U Steel's air-quenched missile boo material, X-200, and for the 5 chrome hot-worked die steel, Vasco 1000.

These figures don't mean that h strength cases can't and won't be m —every now and then. Indeed t have. What it does mean is that conventional fabrication methods, th can be no guarantee of repeatib on the assembly line—or of reliab in flight—not until materials can delivered and fabricated in a gua teed flawless condition; until inspec methods can be developed to spot such flaws (once spotted they can repaired); or until materials and fa cation methods are developed that not subject to notch sensitivity. three approaches are currently u exploration.

• **Random failures**—Notch s tive materials give the highest stren ever achieved—if there is no nc But if one case goes to 270,000 the next one may fail at 145,000; next at 230,000; others at 170, 255,000, 200,000, 150,000, 260, etc., even though materials and cessing may be identical in each All failures are random. There is pattern from which to predict fu performance, and thus no reliabilit the finished product.

This is why you read about claims burst strengths up to 300,000 psi on one hand, but on the other, you've to read about repeatable flight rdware in excess of 200,000 psi.

Some of the characteristics of notch sitivity discovered to date are sur-sing. For example, it bears no ob-us relationship to:

• **Elongation**—Notch sensitivity, nerally speaking, is independent of per cent of elongation—except in very low percentage range (just a v percent), where most materials are y notch sensitive.

• **Yield-tensile strength ratio**—This the ratio of min-yield strength to imate tensile strength. With some ket motor case alloys it is a high ure; with others, quite low. This ead between first plastic deforma-n and failure seems to bear no con-ent relationship to notch sensitivity. a material is notch ductile, it will eve stress concentrations. If it isn't, von't.

Those physical properties which ear to affect notch sensitivity in-de:

• **Ductility**—The greater the ductility, the less the notch sensitivity, but also, unfortunately, the lower the material's minimum yield strength.

• **Decarburization**—Convention frowns on decarburization during heat treatment, since it usually defeats the purpose of the alloying effort. Recent work, however, shows that for high-strength motor cases a modicum of decarburization (to a depth not exceeding four per cent of wall thickness) reduces notch sensitivity—particularly to surface flaws.

• **Grain direction**—Often, but not always, notch sensitivity is worse in the transverse grain direction.

• **Temperature**—Generally, the higher the environmental temperature the lower the notch sensitivity. Thus, some of the reported 240,000 psi min-yield motor cases have been hydro-tested at a temperature of over 300°F. At this temperature the material is notch ductile, whereas at room temperature it is notch sensitive.

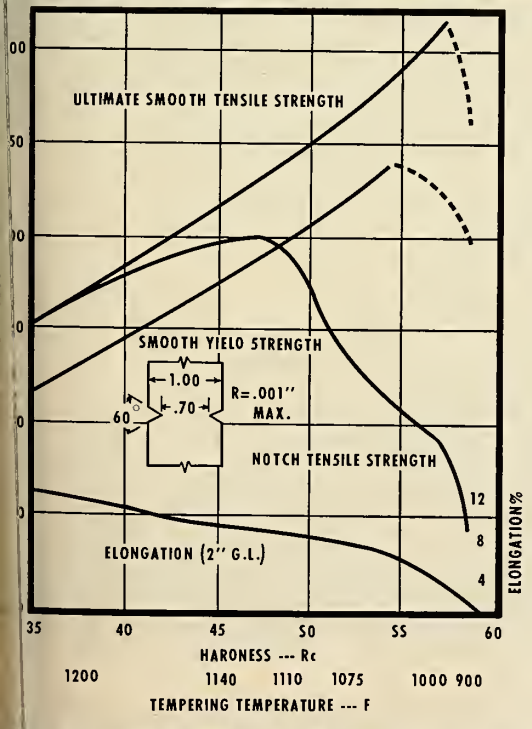
• **Wall thickness**—Very thin sheets (wall thickness below 0.010") show a much lower notch sensitivity than thicker sheets of the same material. Why? No one knows. It is only an empirical conclusion, as a result of tests.

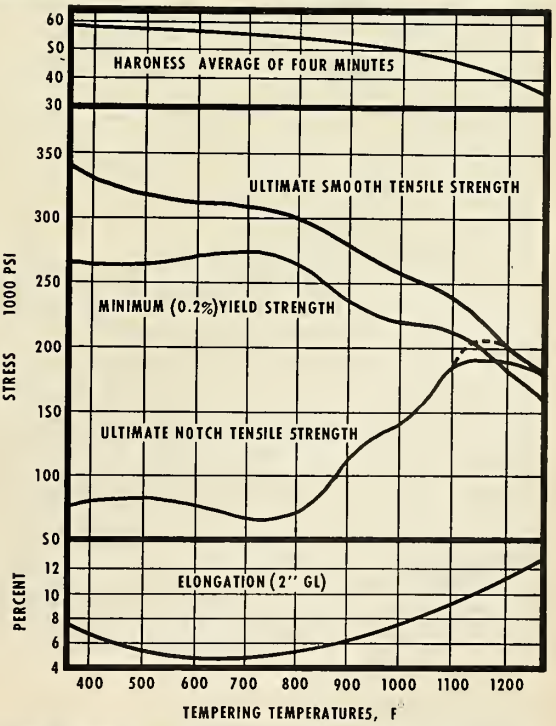
• **Alloy concentrations**—Notch sensitivity is usually less with alloys that have a lower carbon concentration (0.35-to-0.45% C), such as SAE 4340 types of steels.

All of this technical talk may sound like so much who-struck-John, but it is deadly serious business—one that has cost the American tax-payer literally hundreds of millions of dollars. It can't help but be a major factor in the *Polaris*' and *Minuteman* programs.

• **Size**—Higher strengths have been repeatedly achieved in small-scale model motor cases, say, six inches in diameter. However, results in these small test cases do not scale up to the larger size with any usable degree of reliability.

This is a highly competitive market and the company that first cracks the "notch barrier" effectively, repetitively and reliably and achieves a 1,000,000-inch strength-to-weight ratio in a high modulus (metal—and almost certainly steel) motor case stands to profit much thereby—to say nothing of what it will mean to the country's missile and space flight programs.





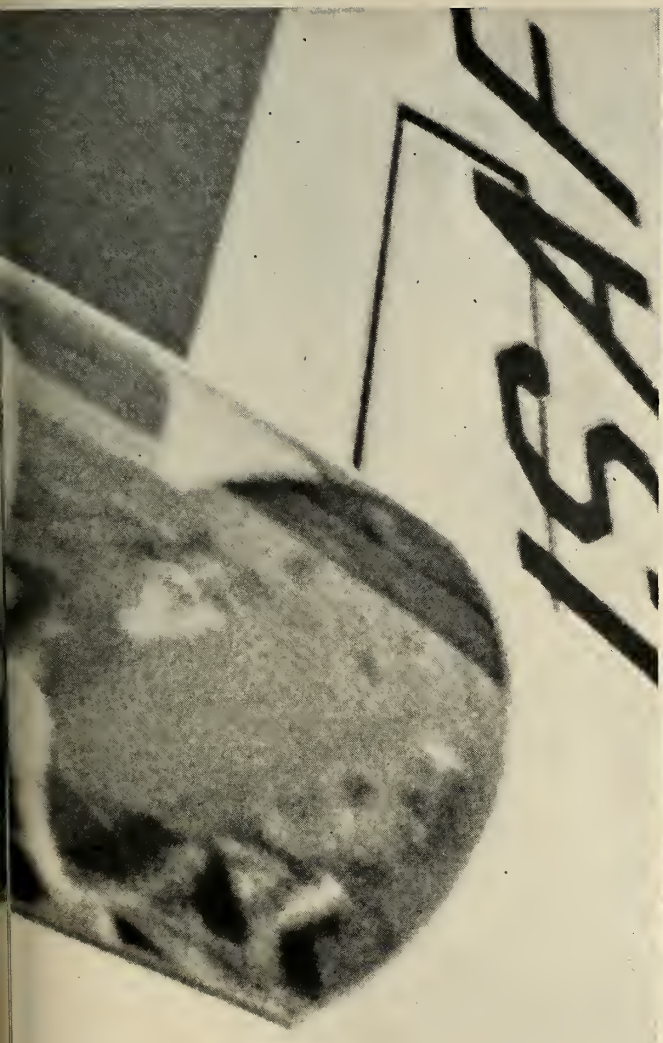
RO LEMS of notch sensitivity in large solid rocket motor ase were largely unsuspected until a few months ago. Left is -2(0.063 sheet (1750°F, quarter hour (Argon), oil tempera-ure, hour air) at room temperature tests. Right is Vascojet 1000 .063 sheet (850°F (Argon), ½ hour; air triple temper, 3 hour total) at room temperature tests. (Graphs courtesy Lewis Lab, NASA.)



AIRBORNE! FIRST LOW-COST SPACE AGE AIRCR

USAF-NORTHROP T-38 TALON ANSWERS AIR TRAINING COMMAND NEED FOR A SAFE, ECONOMICAL TRAINER FOR SPACE AGE AIRMEN

missiles and rockets, June 8,



NORTHROP'S T-38 achieves successful initial flight test at Edwards Air Force Base – offers USAF space age airmen supersonic training with twin-jet safety.

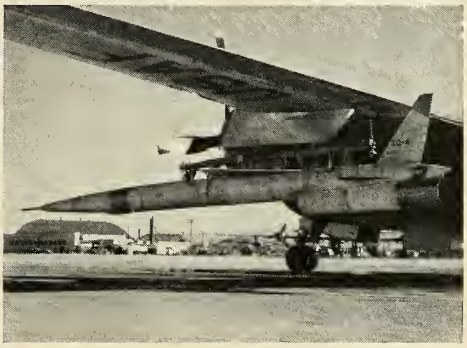
NORTRONICS

For U.S. Army's Hawk, Nortronics designs, produces airframe and all mechanical ground support as major subcontractor to Raytheon Co.



RADIOPLANE

Latest Radioplane answer to U.S. Armed Forces' drone needs is the supersonic, sophisticated USAF XQ-4 type target drone.



INTERNATIONAL

Northrop's N-156F multi-purpose fighter, a high-performance weapon system at minimum cost, now being developed under USAF contract.



NORAIR

The T-38 pioneers a new Northrop family of lightweight, low-cost manned aircraft. It is a breakthrough reflecting Northrop's constant use of all the tools of scientific management in finding lower-cost solutions to the problems of present and future defense. Latest tool: the Norair-ead Performance And Cost Evaluation Program called PACE.

NORTHROP CORPORATION

Beverly Hills, California

Pioneering Monkeys and Mice

Two monkeys came back strong from *Jupiter* flight, though one dies later; *Discoverer III* tests will be US' most elaborate effort

by James Baar

WASHINGTON—This year may be remembered as the year of the space animals. The U.S. Army entry: Rhesus Monkey Able and Spider Monkey Baker. The U.S. Air Force entry: Four black mice.

Other future entries: A variety of animals including larger primates.

The Army's monkeys lodged in the nose cone of a Chrysler *Jupiter* scored ahead of the Air Force when bad weather and technical difficulties delayed launching of *Discoverer III*.

Able died four days later when Army surgeons attempted to remove an electrode placed in her body before the historic launching. However, Army officials said death was caused by convulsive heart movement during the operation and was not a result of the space flight.

Until Able and Baker soared down the Atlantic Missile Range May 28, Russia held most of the records in the space animal derby.

Russia's *Sputnik II* carried the dog, Laika, into a 140-1038 mile orbit Nov. 3, 1957. Laika survived more than a week.

The Russians also have announced successful recovery of two small dogs after they traveled 281 miles straight up in a rocket.

The Army last December sent a monkey named Old Reliable down the Atlantic Missile Range in a *Jupiter*. He never was recovered, but telemetered data showed that he survived re-entry.

The *Discoverer III* satellite—the most advanced U.S. biomedical space experiment to date—was originally scheduled for May 21 at the Pacific Missile Test Range. The shot was postponed because of bad weather. Technical difficulties forced postponement again May 23 and again May 25.

The Air Force provided the same type missile for *Discoverer III* as it had for the first two *Discoverers:* A Douglas *Thor* topped with a Lockheed-Bell second stage.

Other key *Discoverer III* statistics —all similar to *Discoverer II:*

- A 1600-pound second stage that goes into orbit.
- A 440-pound payload including a 195-pound re-entry vehicle.
- Equipment designed to stabilize and adjust the attitude of the satellite in orbit.
- A recovery system designed to eject the re-entry vehicle at a determined point so that C-119's cc be waiting to snag it after it re-ente the atmosphere.

But the all-important difference the presence of the four mice. T recovery would mean the first succ ful return of an animal after it orb the earth.

The mice were placed in a Gen Electric life capsule equipped with conditioning and food.

The pop bottle-size air conditic was designed to keep the tempera at about 75 and eliminate muggir The food—a mixture of orange ju oatmeal and gelatin—fits into a cer feeding station. Instruments mor the mice's reactions.

Results from the Able-Baker lau ing are still being analyzed—part larly the effects on the flight on n spores, sea urchin eggs, human bl onion tissue, seeds and fruit fly pu that were carried in the *Jupiter* cone.

The sea urchin egg experiment cluded fertilized eggs, unfertilized and eggs that were fertilized during 1700-mile flight. Scientists sought check the reaction of both weight ness and cosmic rays on fertiliza

Scientists have expressed cor erable doubt that some species customed to a 1 g environment carry out their life cycles in a diffe one.

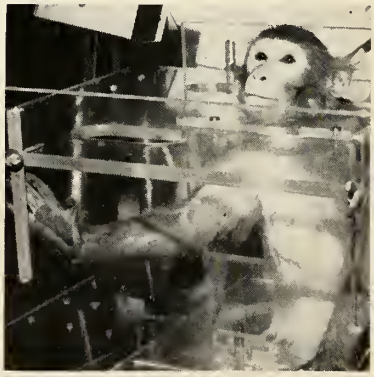
First results showed that se pound Able and one-pound Baker perienced no "undue alterations" their basal physiology.

This was particularly encoura since the two monkeys experience to 15 g's during takeoff and 38 for less than a second during re-e The most that the first man in spa expected to experience is 12.

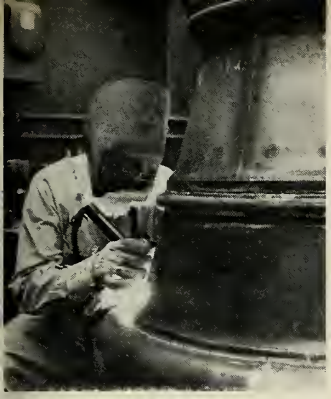
Army and Navy scientists stre the risk in extrapolating data animals to men. But the indica were that men would be able to d well as monkeys.



THIS MOUSE was one of a group of 60 candidates for *Discoverer III* ride.



MONKEY ABLE, who survived space flight but died later in operation.



HELIARC welding the exterior of a double-walled thrust chamber for Rocketdyne's *Redstone* engine.

Welding *Redstone*

Extreme care exercised at Reynolds plant precludes faulty welds

SHEFFIELD, ALA.—Weld strength played an important part in the reliability—about 99%—of the y's *Redstone*.

More than 1000 feet of welds go the construction of the aluminum g used for the *Jupiter-C* rocket the *Redstone* ballistic missile. The gs are fabricated at the Reynolds ls Company missile plant at ield, Alabama. Performance rec- show that because of precision ing, constant research, and in- ve inspection, no *Redstone* or *er-C* has failed due to faulty welds.

luminum outer wall of the 75,000 hrust *Redstone* engine's heat ex- ger is manually Heliarc welded t, an HW-9 torch. The finishing el, on the engine's critical thrust a ber are also made manually with Heliarc WH-12 torch. The engine's r ide tank, constructed of 17-7 ph i ess steel, is joined by a Heliarc W 3 torch mounted on an Oxweld M 7 carriage.

Provides versatility—The main as n for the use of inert-gas shielded- c elding on the *Redstone* engine is ersatility, according to Linde o cts. It can be used on many dif- re metals and thicknesses, deliver- g e same results on each.

l Heliarc welds undergo strict ra inspection before the engine is se bled and tested on a static test an After final factory approval, the gi is ready for shipment to ir ler Corporation in Detroit.

o insure quality, Reynolds em- oy an inspector for every four tech- cia s who work on the casings. The um um sheet and incoming parts e ecked for blemishes and tested th electronic devices to detect po- nti weak spots which might fail flight. Samples of each lot are with- aw from chemical analysis and a om te record is made of every part lec d to go into the missile. The sheet is then covered with protective paper tape to reduce the chance of being scratched during fabrication.

• **Fast speeds**—Each 20-foot sheet of type 5086 alloy is trimmed to size to form a shell meeting a .015-inch O.D. tolerance. After the sheets are rolled into a cylinder, the edges are cleaned, scraped and Sigma welded (inert-gas consumable-electrode) at speeds up to 100 inches per minute.

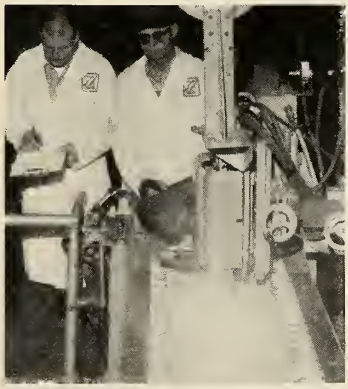
This longitudinal weld is made on an automatic Sigma SWM-3 machine, equipped with an HW-16 torch which is mounted on a Linde OM-48 side-beam carriage and controlled by a Linde SCC-1 control. The shell is then trimmed in length to a .020-inch tolerance and aluminum "Z" rings are spot-welded inside to support the shell.

Eight shells of varying lengths are joined to form the center section, or fuel tank, of the *Redstone*. These shells contain the bulkheads of the tank. The shells are assembled on another automatic Sigma SWM-3 machine and girth welded at speeds up to 55 inches per minute.

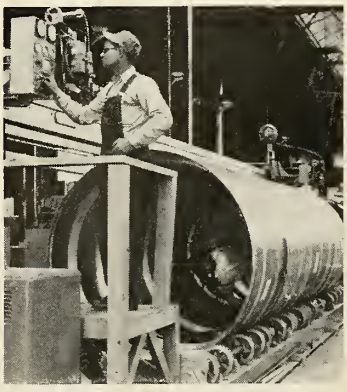
Power settings are usually 160-250 amp., 20-22 volts. Average welding time is only 4 to 10 minutes, but preparation takes the major part of time due to the extreme care required. First, the weld area is scrubbed with trichlorethylene, then the edges of the sheet are scraped with a special power scraper to remove oxide. Several power interlocks are provided to prevent machines with heavy electrical-current drains from starting during the critical weld cycle.

Prior to welding, a sample weld is x-rayed and checked for physical properties. After welding, each weld is x-rayed to doublecheck weld quality. When the center section meets radiographic and dimensional inspection, a series of aluminum pipes—which carry liquid oxygen, alcohol, or other fuel—are welded in place. The completed section is then ready for hydrostatic test, calibration, chemical cleaning, final assembly and finishing.

When the center and tail sections get final factory approval, the casing is forwarded to Chrysler Corporation in Detroit where the engine and instrumentation system are added to the ballistic shell to form a completed *Jupiter-C* or *Redstone* missile.



SIGMA welding is used by Reynolds Metals to make longitudinal weld on *Redstone's* center section.



ANOTHER Sigma machine makes a girth weld on *Redstone* fuel tank.

BRITISH ASTRONAUTICS

Government evasive on how much will be spent for space flight program; planetary probes and manned flight ruled out already

by G. V. E. Thompson

LONDON—British effort in the field of space research has so far been confined to the vertical sounding of the upper atmosphere with a few *Skylark* rockets, the tracking of U.S. and U.S.S.R. satellites and the analysis of the data obtained. Now government approval has been given for the establishment of a British spaceflight programme.

Government spokesmen have been evasive as to the expenditure involved, saying only that the sum spent would be hundreds of thousands of pounds, rather than millions, and that Parliament would not be committed to large or unlimited sum of money. A steering committee under the chairmanship of Sir Edward Bullard, F.R.S., has been appointed to advise on the allocation of money to the various projects.

At the moment no precise programme has been agreed upon, though it has been decided not to build planetary probes, not to undertake manned flight, and not to include animals in any launchings. Design studies have been put in hand for adaption of the *Blue Streak* and *Black Knight* rockets for launching satellites weighing 1000 lb. into orbits some hundreds of miles above the earth. It is expected that these studies will take about six months; the first satellite vehicle will probably be ready for firing in about two years' time. The likely design is a three-stage vehicle. The first stage would be *Blue Streak* (as yet unfired), the second would be *Black Knight*, and the third would be some solid-fueled rocket.

The R.A.F. teams at present being taught to fire *Thor* rockets will probably be responsible for the launching of the British satellites. It is too early for launching sites to be known—the most likely choice is the Woomera rocket range in Australia. If other Commonwealth countries participate in the programme, Kenya would be very suitable for launching satellites into equatorial orbits, but lacks the necessary ground facilities. The money to be allocated to the programme is not intended to cover the cost of constructing launching sites, but only design of the vehicle, adaption of military rockets and development of satellite instrumentation.

The greatest effort will be in the field of instrumentation; the series of experiments at satellite altitudes which scientists consider desirable would take over 40 years to carry out, even for a country with a space research budget as large as those of U.S.A. or U.S.S.R. Britain cannot hope to cover all that might be done, so a selection will have to be made.

The initial experiments will be an extension of the present *Skylark* sounding rocket programme, and will include use of an improved *Langmuir* probe for measuring atmospheric composition and temperature, magnetic field measurements, mass spectrometry, and meteorological studies. Ultra-violet and X-ray astronomy are other potential lines of research.

The instrumentation will be available before the launching vehicles, so advantage will be taken of the U.S. offer to COSPAR to fly other countries' equipment in American satellites. Professor H. S. W. Massey, Chairman of the British National Committee on Space Research, is shortly to lead a team of experts who will visit Washington to discover how much help can be expected, when, and on what basis. Following questions in Parliament, the possibility of joint action with the U.S.S.R. is also to be studied.

• **Transatlantic radio via moon**—Britain and the U.S. have cooperated in carrying out tests of the moon as a mirror for transatlantic radio communication. The experiments have been successful and have commercial and military potentialities.

Studies of radar echoes from the moon have been made since 1946, and Dr. John Evans of the Jodrell Bank radio telescope research station in Cheshire, England, advanced the theory that these echoes returned from quite a small area of the moon's disk. The absence of scattering indicated that it should be possible to bounce back signals carrying messages wit loss of intelligibility. This was de strated last year at Jodrell Bank signals transmitted and received a same spot.

Pye Telecommunications Ltd Cambridge, England, became inter and provided a standard 1 kw., mc transmitter for the transatl experiments, in which the 2 diameter Jodrell Bank radio teles sent messages to the moon. The flected signal was received at the 84-ft. diameter dish of the U.S. at Sagamore Hill, Hamilton, M which has only just become o tional and can only receive at pre A message in Morse sent from Eng read: "We will have no trouble fishing boats on this circuit," allu to the Russian trawlers susp recently of tampering with Atl cables. This was followed by transmissions.

Pye's are to produce a diameter radio telescope with power and higher frequency for f experiments. These will include si tests with the planet Venus (which be at its nearest to the earth in tember), and later with large inf artificial satellites. Use of the is limited to the time when it view of both transmitter and rece However, the method is not aff by ionospheric disturbances.

• **Cryogenic propellants**—The r engineer's approach to the handlin cryogenic liquids used as propel (ammonia, methane, hydrogen, oxy oxygen difluoride, and fluorine) discussed by D. Hurden of the Havilland Engine Co. Ltd. in a p read in London at a joint meetin the Institute of Refrigeration and Low Temperature Group of the P cal Society. Particular reference made to the *Snarler* and *Scre* rocket engines developed by strong-Siddeley Motors Ltd. for r aircraft (later abandoned). For mis delivery to launching sites by insu pipeline from central storage are preferred to the road tankers with the rocket aircraft. If nitr gas is used to pressurize liquid ox tanks, to prevent it dissolving in contaminating the LOX, the two be separated by a hollow piston; phragms of goatskin or kangaroo have been suggested, but the q of the material is variable.

The *Screamer* LOX pump wa signed to deliver 25 lb./sec. at 80 It ran at 20,000 rpm. and abso about 120 H.P. It was mainly structed in stainless steel, the ox seal being an optically flat stai steel ring soldered to a bellows bearing on a rotating sintered br disk.

FBM Sub Provides New Market

With 45 missile-launching boats possible, lion's share of some $4.5 billion should go for support equipment

by Donald E. Perry

ROTON, CONN.—More than $2
n has already been provided for
olaris Fleet Ballistic Missile pro-
r and the next five years may see
er $4.5 billion expended for this
ent weapon system.
mazingly enough, the lion's share
e funds will go for support equip-
r in this gigantic program which
be marked by the launching of
rst of possibly 45 fleet ballistic
e submarines this week at Electric
a Division of General Dynamics
r here.
ne $100 million George Wash-
t (380' and 5400 tons), which will
s first Lockheed *Polaris* missile
year, slides down the launching
une 9. Five more boats now under
uction will follow the GW once
three months.
timately, within the next five
r the Navy figures that some 45
submarines will be an adequate
er to keep at sea constantly and
ation, allowing for their upkeep
ew training.

Funding swells—Whether the
will get that many FBM sub-
es or not is another matter, but
ogram has vital implications for
e and shipbuilding suppliers who
furnish the tons of support equip-
Let's look at it:
Congress appropriated funds for the
ree FBM submarines even before
easibility of launching ballistic
s from beneath the ocean had
demonstrated in full-scale tests.
eorge Washington is expected to
s next year.
But in the meantime, further Con-
nal and administrative faith in
ogram has been shown by plac-
submarines under construction
very early development of the
This in turn has pushed the
t of money appropriated for
hardware beyond the amounts
d in development.
This will give the nation, by the
next year, three *Polaris* sub-

Fifth of a Series on Missile Support

marines with nine expected to be under construction. Cost? Well, $2.063 billion has been provided to date for the FBM program, bringing into being a vast program which includes:

- The USS Compass Island, a navigation development ship which has been testing instrumentation for more than two years.
- Another ship, the USS Observation Island, which soon will conduct a missile firing at sea; and other auxiliary support vessels.
- Six FBM submarines, with keels for three more subs to be laid this year, bringing total construction to nine.
- A tender especially converted to maintain *Polaris* submarines on station outside the continental United States.

The money which has been appropriated through FY 1959 will buy missiles for the first five boats and will continue the missile's flight development and testing program.

- **Six in '60?**—How about FY 1960? The Navy is requesting $611.7 million for continuation of the program and there appears a distinct possibility



WORKMEN put the finishing touches on the George Washington, the nation's first FBM submarine to be launched at Electric Boat Co. June 9.

that a *Polaris*-minded Congress may authorize additional millions for possibly six more submarines.

This was brought out in hearings before a Congressional appropriations subcommittee earlier this year when Rear Adm. W. F. Raborn, director Special Projects office, Bureau of Ordnance, was questioned on the add-on cost of a six-boat program for FY 1960. For the six submarines a $600-million figure was given along with $51 million for additional support.

FY 1960 funds for the *Polaris* program will do several things:

1. Permit construction of a second FBM tender designed from the keel up for its missile role, rather than conversion of some existing ship.

2. Provide advance procurement of long leadtime components for three FBM submarines, bringing the total number of boats to 12.

3. Provide additional *Polaris* tactical missiles.

4. Continue an extensive flight test and evaluation program, and maintain R&D effort on reliability.

Here's how the amounts break down:

Operation and maintenance, $19,-275,000 (This would provide continuous support of test vessels and facilities, give upkeep and repair capability; give ship and ashore type training equipment; provide some $1.3 million in communication equipment and another $3 million in a "service-wide operations" activity).

Shipbuilding and conversion, $54,-042,000 (New tender construction would be $61 million, principally from previously appropriated funds); long time lead items for three boats; basic reactor components, cores, and the ships' SINS inertial navigation equipment.

Procurement of ordnance and ammunition, $314 million (of this $84.5 million would go for tactical missiles; $107.2 million for missile components for development test; $13.4 million for operation of flight test program; $77.2 million for production facilities and other missile system support; and $31.6 million for training, logistics and weapon system support).

• **Participation**—And how are suppliers participating in the FBM program? Electric Boat Co. points out that through January 55% of direct purchase orders under the FBM program went to small business firms. In the same period, small business got 38% of the dollar volume of stock inventory and 58% went into plant maintenance.

Actually, however, EB has only added perhaps 50 more suppliers under the FBM program. It acts more as an assembly participant in the gigantic jigsaw program with many items regarded as GFE (government-furnished equipment) under separate contracts by BuShips, BuOrd and Special Projects Office.

While Congress has almost overwhelmingly endorsed the *Polaris* FBM program, obsolescence of the FBM submarine frequently comes up for discussion.

Admiral Raborn points out that a weapon system does not become obsolete so long as it remains an "efficient instrument for the performance of its mission, in comparison with other weapon systems and in the face of existing defenses."

• **Growth potential**—He points out that the useful life of a submarine is 15 to 20 years, that the Navy is building a 1965 submarine and missile today and that everything that is going in is based on a potential and growth capability.

You have only to look down one of the 16 missile launching tubes of the George Washington to confirm this. While Navy will not give out any statistics on *Polaris*, it is generally conceded by the missile trade press that it has a length of about 26.5 feet and about a 5′ diameter. The Navy is still reluctant to talk about the size of George Washington's launching tubes (even though they were designed on practically 50-year-old standards of torpedo tubes). However, it is safe to assume that they could accommodate a future solid-propellant missile approximately 7 ft. in diameter and more than 40 foot long.

This will extend the range of *Polaris* to an ICBM category without any major revision of the FBM submarine, thus giving it a global coverage capability of 100% rather than an 80-90% of potential enemy targets as previously speculated.

• **Old & new**—It is no secret that the missile launching tubes operate on the tried and proven principle of torpedo tubes—air expulsion. Electric Boat Co. design engineers are inclined to gloss over their design achievement for the tubes and EB's FBM Project Engineer, William G. Atkinson even refers to them as "simpler than torpedo tubes." He adds that they are bigger and easier to service and maintain.

But back of this came good shipbuilding engineering. Included was a special air-ejection system for the missile. Another air compressor has been added to the submarine's system to handle missile launchings which probably will be made at 4500 psi.

With 16 missile tubes lined up of the conning tower sail in pairs eight, CG principles and additional sign parameters for water pumping trim compensation were major sideration. The George Washing a sister ship to the Skipjack—wo fastest submarine—differs only in addition of a 130-foot missile sec aft of the conning tower sail. Th are no provisions for reloading missile tubes from the submarine.

After the firing tube hatch c has been opened M/R has learne plastic diaphragm directly above missile reportedly keeps the missile Air pressure within the tube equal outside water pressure. The missil fired through the diaphragm, an special water compensation system to be installed to accommodate great change in weight.

One example of support equipm for the tubes are heat transfer u developed by Tranter Manufactu Inc. of Lansing, Mich. Each *Po* firing tube will have the units—w consist of embossed sheets of m welded together to form channels the passage of hot or cold wate maintain the solid fuel at the spec temperature at the time of firing. T perature will be maintained withi range of plus or minus three degree

• **Seats open**—One source says submarine missile men are taking new tubes in stride. In both the for and aft missile compartments on three decks are card tables of cribbage variety, nestled between tubes. Cribbage has been a fav submarine game for many years, submarine missile men apparently take advantage of the new-found sp

Atlas Parts Test Stand Produced by Rocketdyne

CANOGA PARK, CALIF.—A port Components Test Stand for all ele pneumatic and hydraulic parts of *Atlas* ICBM has been delivered Vandenberg AFB by its designer, ketdyne Division of North Amer Aviation, Inc.

The three-ton unit, first of se to be constructed, will make it pos to check out *Atlas* parts at SAC sq ron level. Incoming spares or co nents removed for service or r can be field-checked prior to inst tion in the missile.

Under design and fabrication the past year to meet requests of vair, Rocketdyne and *Atlas* su engineers, the test equipment will dle all parts that are field repair including Convair-developed co nents.

A Mammoth Gantry for *Saturn*

Structure will cost $9.5 million with test tower, opening new dimension in missile support equipment

HUNTSVILLE—America's biggest e vehicle—the 1.3-million-pound- t *Saturn*—will be assembled in nation's largest gantry, a 305-foot ter which will tower into the sky igh as a 28-story building or a of four *Atlases*.

onstruction of the huge mobile gantry is scheduled to begin ly. It will signal a new era in the of missile support equipment for r space vehicles yet to come.

he Army Corps of Engineers, n designed the structure with the Ordnance Missile Command and ice H. Connell & Associates, ai A&E firm, says bids will be itised soon. Construction may be or at Cape Canaveral.

stimated cost of the gantry and t test tower will be $9.5 million. static test stand towers are 135 high, by comparison, and cost d $1 million apiece.

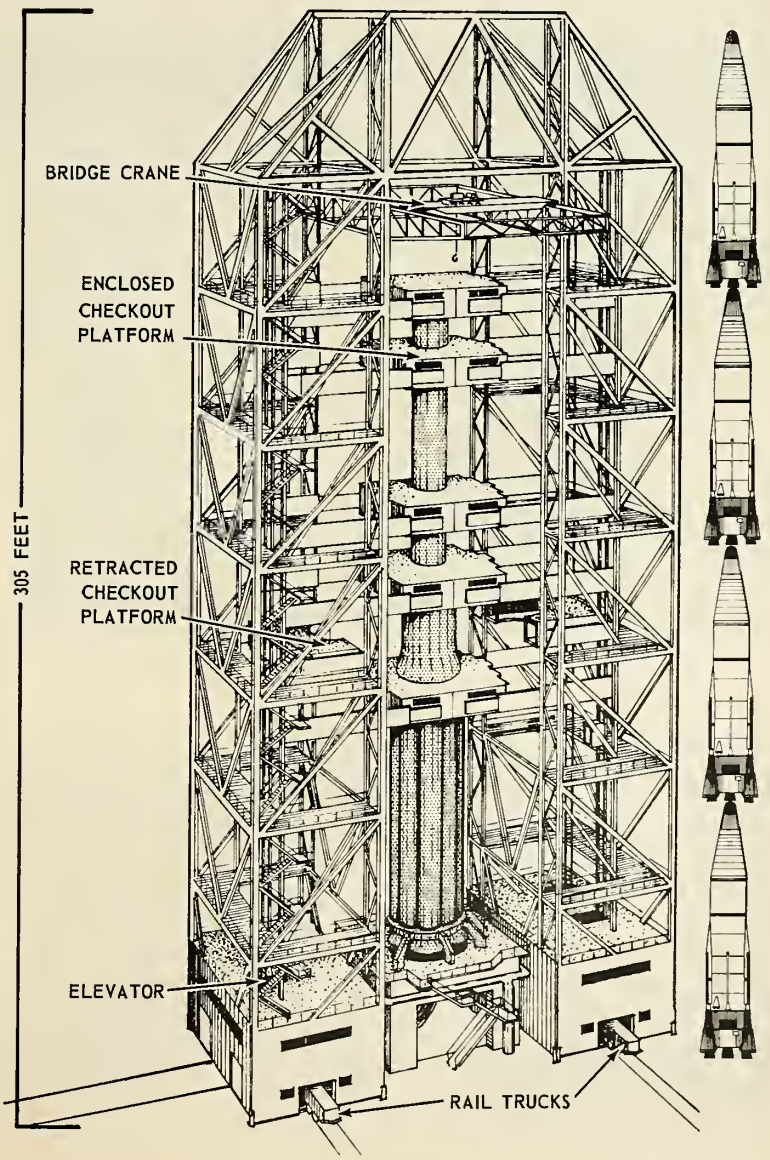
he gantry to accommodate the tage ARPA-ABMA *Saturn*, which ave a cluster of eight H-1 Rocket- *Jupiter* rockets as a booster , May 25, page 36), will be a etely self-sufficient unit. It will n "on-board" diesel electric gen- s sufficient to power all equip- and propel the structure along ts of railroad tracks at 40 feet inute.

ecifications call for one freight wo passenger elevators. Bridge , vertically positionable from 43 25 feet high, will be capable of ing out to a point 20 feet beyond ructure. There will be six en- checkout platforms located at of stage interconnection, control uidance sections, payload and stage fueling and servicing.

nge of platform vertical adjust- will be 175 feet, extending from evation of 50 feet above the ing pad upwards to 225 feet. service platform is halved for re about the rocket vehicle, will be about 200 feet high. The platforms are retractable into er legs, facilitating the handling ckout equipment.

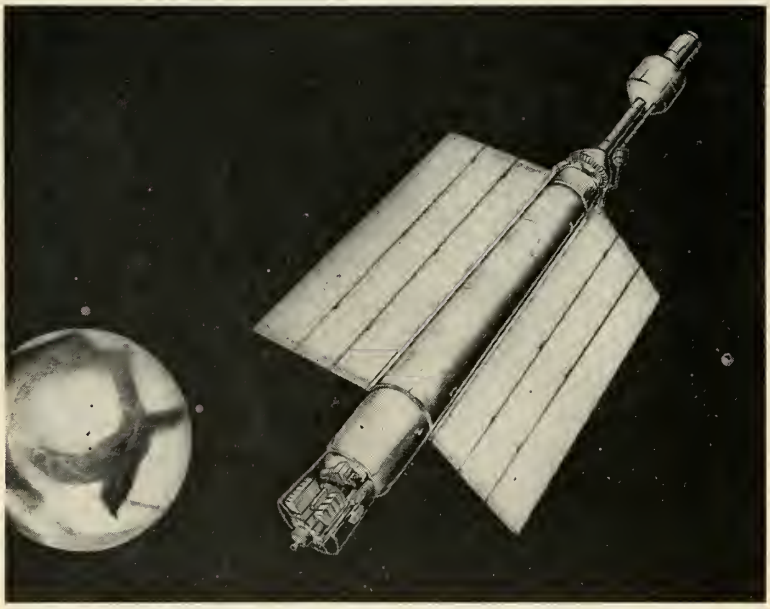
borate facilities have been in- corporated to provide for fire and lightning protection, personnel safety, heating and air conditioning.

Static firing of *Saturn's* booster-cluster is expected here some time this fall. Flight testing may come at the Cape next year. If the big gantry is built here, Corps of Engineers officials say it will be transported to the Cape as nearly intact as possible.

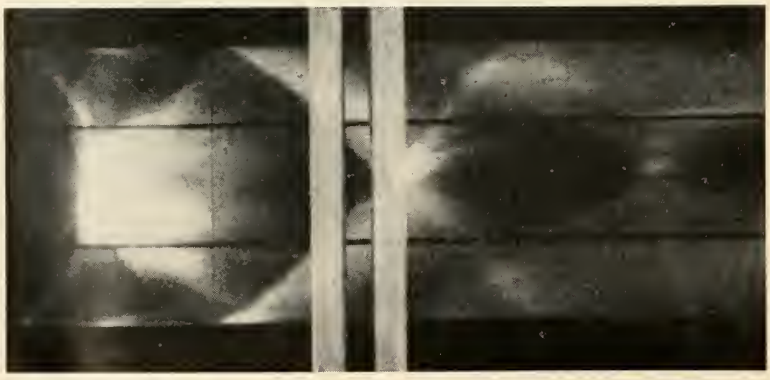


Plasma Engine Delivers Nearly 2-lbs.

Republic's experimental 'magnetic pinch' engine produces over 4000-lbs. at peak with 1700 sec. I_{sp}



PROPOSED MARS vehicle's folding "wings" would be heat radiators. The nuclear reactor would be housed in the nose with plasma engine in tail.



STREAK PHOTOGRAPH of cylindrical pinch was taken through 0.05 slit in upper electrode.

by Hal Gettings

FARMINGDALE, N.Y.—A unique
plication by Republic Aviation C
of ion (or, more properly, "plasn
propulsion promises to provide a p
tical interplanetary space vehicle
gine within a relatively short time.

The device is capable of thrusts
above those obtained by present
perimental ion propulsion systems.
"magnetic pinch" engine produces p
thrusts of more than 4000 pounds
a specific impulse of over 1700
onds. Average thrust runs 1-2 lbs.
systems to date have produced thr
of only fractional pounds.

Most of Republic's work has b
done in company-sponsored resea
The firm will release no figures or
investment to date, but it is estim
that Republic has spent somewher
the neighborhood of a million do
on the program in the last two year

The company recently received
contracts totaling $193,000 to
tinue the work: one, with AF O
of Scientific Research for analysis
pinch effect gas dynamics; the o
with Office of Naval Research for
peated pinch cycling techniques.

• **Will provide 800 kw**—Repub
design for an interplanetary en
calls for a nuclear power source w
provides 800 kw of electrical po
Present plans include a nuclear
actor-turbo generator combinat
With the rapid strides being mad
thermoelectricity however, a di
conversion system may be avail
when needed. Weight of the engine
power plant will total somew
around 12,000 pounds. The additio
propellant, structure, guidance,
metering, etc., will bring total pay
weight to around 27,000 pounds—
within the capability of super
liquid boosters now under develop

The advantage of the Republic

ne is that it is easier to get suffi-
ent mass movement from the mag-
tic pinch than from conventional ion
chniques. A patented "curved nozzle"
ilizes the pinch to form a shock wave
iston" which produces the high-
locity axial thrust. A further ad-
ntage is that the pulsing technique
bjects the engine itself to only micro-
cond-duration high temperatures. The
erall heating effect is small and no
oling is necessary except for long-
ration flights.

The plasma engine uses a heavy gas
ch as liquid oxygen or nitrogen and
rns it into plasma—a fourth state of
atter evolving from gases in which
e molecules are broken into electrons
d positive ions. This provides tre-
endous power for a comparatively
all amount of fuel.

• **Utilizes intermingled particles**—
cret of the plasma engine is a
ethod of compressing and accelerat-
g a fluid in a cylindrical magnetic
ld and shooting plasma out the rear
tremendous velocities. Unlike the
oposed ion engine which accelerates
ns and negative particles in separate
eams, the plasma engine utilizes the
ermingled particles in a single jet
rust. It can also operate on fuels
re readily available than those re-
ired for the ion engine, and attain
eater thrust.

The basic principle of the plasma
ch is illustrated in Figure 1. A 6000-
lt charge from a capacitor is dis-
rged into a gas confined in a cyl-
der, the ends of which are electrodes.
rrent then flows in the outside cir-
mference, or "skin," of the resulting
ized gas (plasma). The magnetic
ld set up by the flowing current ex-
s an inward force on the plasma
ylinder" causing it to constrict to a
n tube at the axis of the electrodes,
ing it the action of a piston. This
gnetic piston causes a shock wave
ich raises the temperature and pres-
e of the gas. If a hole were cut in
center of the right-hand electrode,
resulting energy could be released
ough it to provide a high-velocity
j

This principle is utilized in the
public engine and greatly enhanced
forming the electrodes into a curved
zzle. The piston action is very simi-
to that described for the basic en-
e in Figure 2. The pinch effect
ves the gas towards the center and
hock wave is generated ahead of the
on. The curvature of the electrodes
ces the wave into an axial direction.

The compressed and accelerated
s then leaves the nozzle-electrode at
h velocity. The exhaust nozzle is
igned to convert a substantial
unt of thermal energy existing in
exhaust to kinetic energy. At the

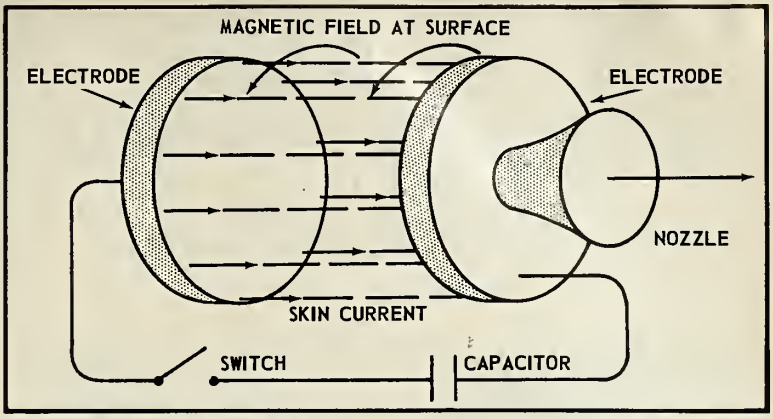
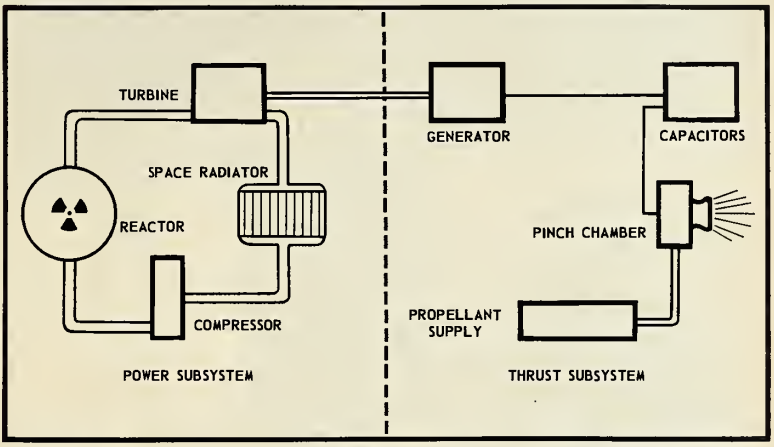


FIG. 1—Schematic drawing of basic engine shows skin currents and magnetic field set up by the high-voltage discharge into the gas between the electrodes.



POWER PACKAGE for Mars vehicle. Units shown would weigh 14,000 pounds. Development of direct thermoelectric source would eliminate turbine and compressor.

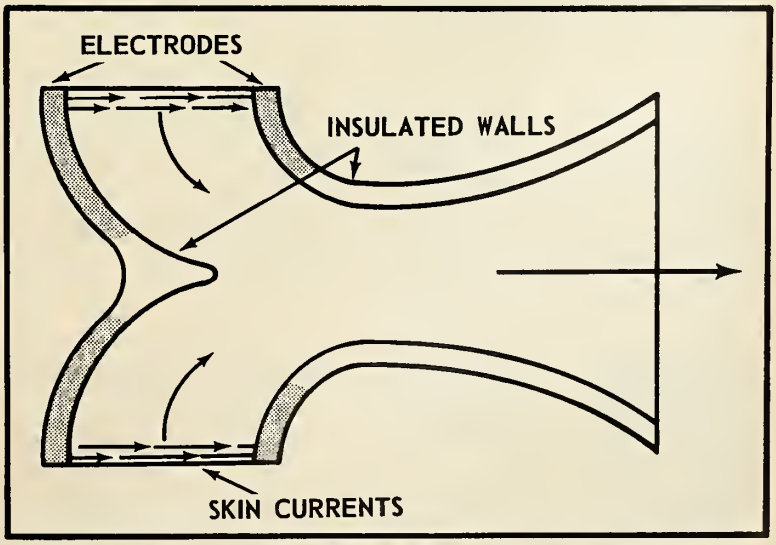


FIG. 2—Republic's patented "curved nozzle." Magnetic pinch produces shock wave in throat which expels high-velocity mass to develop thrust.

R/M PYROTEX® REINFORCED PLASTICS ...DEVELOPED TO ENDURE THE FIERY REALM OF THE ROCKET

Light, strong, heat resistant . . . for low-cost, precision fabricated rocket parts— both structural and aerodynamic



Smooth, strong rocket fin and nose cones made of R/M Pyrotex resist aerodynamic heat; have low, uniform ablation rate. The fin shown was subjected to tests at Mach 7.

Looking for a material that will withstand the elevated temperatures generated by missiles and rockets—internally from burning propellants, externally from aerodynamic heating? Must this material have good insulation and thermal properties, chemical and water resistance, and take a smooth finish? If so, one of R/M's family of Pyrotex reinforced plastics may be the solution to your problem.

The many outstanding thermal and structural features of R/M Pyrotex have led to its use on almost every U.S. missile. It has been fabricated into parts such as nose cones, fins, igniter tubes, rocket throats and sliver traps. Its exceptionally good dimensional stability makes possible mass production to precision standards. And it is low in cost. Write for additional information.

RM

RAYBESTOS-MANHATTAN, INC.

REINFORCED PLASTICS DEPARTMENT, Manheim, Pa.

FACTORIES: Manheim, Pa.; Bridgeport, Conn.; Paramount, Calif.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Asbestos Textiles • Laundry Pads and Covers • Engineered Plastics • Mechanical Packings • Sintered Metal Products • Industrial Rubber • Rubber Covered Equipment • Brake Linings Brake Blocks • Abrasive and Diamond Wheels • Clutch Facings • Industrial Adhesives • Bowling Balls

nozzle throat the energy produced approximately 50% kinetic and 50 thermal. Expansion in the nozzle cc verts a significant percentage of tl thermal to thrust-producing kine energy.

The thrust produced exists for period of a few microseconds. T cycle is then repeated an undisclos number of times per second. Resear work is going forward on optim cycling techniques and periods.

• **Prototype built**—An experimen prototype of the engine has been bu and operated over a period of seve months. First test results showed thrust over twice as great as earl calculations had indicated.

There are many unknowns in tl new field, however, and some of t analysis must be based on assumptio Many areas, too, have moved ahe of existing instrumentation techniq and the velocities, temperatures, et must often be measured with less th perfect precision.

Exhaust velocities from the engi range around 150,000 fps. Temperatu are in the neighborhood of 20,0(25,000°K. As mentioned before, ho ever, since the high temperatures ex for only microseconds at a time, t cumulative heating effect is small.

The plasma engine can find ma applications in various space vehicl One specific use would be for positi and attitude control of satellites. Su an application would require only small version of 1/100 to 1/10 pou thrust. It could use a solar cell pow source for ionization current.

• **For Mars mission?**—Since t plasma propulsion system is a lo thrust low-propellant consuming engi it is primarily suited for low-accele tion long-range missions in relative force-free fields. It would, therefo fit well, for example, in an interplar tary vehicle such as the Mars reco naissance ship illustrated. The "wing of such a craft would be necessary contain the radiators for bleeding the heat generated by the nucle power source.

The Mars vehicle would be d signed to take departure from a 10 km earth orbit and culminate in a 5 km Mars orbit. Travel time wou require approximately eight months

Republic recently announced a $ million space research and develo ment program and construction of $14 million engineering research cent has begun. The company plans to co tinue its own research on plasma pu pulsion along with the work presen under contract. The program will carried on by a staff of 50 scienti and engineers under the direction A. E. Kunen who has directed t plasma research from the start.



ADMIRAL CORP. nuclear engineer remotely handles components in the company's 20 kilocnrie cobalt 60 radiation chamber.

Radiation Effects: What's Being Done?

by Charles D. LaFond

CHICAGO—Nuclear radiation enviments born of our scientific and ineering advances in recent years essarily have altered requirements test methods for electronic coments.

The problem was recognized early, both the military and industry been testing a multitude of deand components with particle and radiation at varying energy levels. goal of course is to acquire enough vledge to evolve new or modified ronic components that will funcreliably under otherwise damaging tion.

uch radiation can occur from a ear explosion or in the field of a ar reactor. The design engineer is bled primarily with the latter. The or is a problem only when insuffishielding is provided. This occurs a weight limitation prevents the of suitable shielding. And space air-supported vehicles in our presoncept inherently demand this limn.

he proposed nuclear-powered ram*luto,* the boost-glide *Dyna-Soar,* other possible orbiting satellites by their nature, require electronic onents capable of surviving in nments of sustained high nuclear tion.

he Nuclear Physics Department of ral Corporation, located here, has a strong arm in the continuous Force program investigating the se effects of unconventional enments. The program has been sup since January, 1955, by a series search contracts from the Elec- Components Laboratory of Wright Air Development Center. Admiral currently is working under a $2-million contract to study contemporary and future requirements for electronic components.

• **How it happens**—The two damaging constituents of nuclear radiation are neutrons and gamma rays. In all tests, the energy spectrum of each must be known since variations can have damaging effects ranging from normal extremes to complete failure.

In addition, two other damaging conditions must be considered: large amounts of ozone are produced in the local atmosphere by highly ionizing gamma radiation; and increased temperatures in components will result from gamma radiation absorption. The ozone problem will be serious only during long sustained flight.

Admiral research has indicated that about 0.01 watt/grain is dissipated in components (subjected to radiation in the CP-5 research reactor at Argonne National Laboratory), and that the resulting heat rise will effect a derating in performance or require supplemental cooling equipment.

One of the most confusing problems Admiral has faced is the current use of different dose units in technical literature describing magnitudes in particular environments. (Example; Roentgen Equivalent Physical (rep) or Mammal (rem).)

The problem is readily evident. A neutron dose rate of 10^4 fast neutrons/cm²/sec equals 1 rep/hr. Also, 7 x 10^5 gammas/cm²/sec of 1 mev energy equals 1 rep/hr. But it has been proved in the laboratory that radiation-induced damage to a resistor by an equivalent rep dose of neutrons far exceeds that of a rep dose of gamma rays. Without the knowledge of the neutron-to-gamma ray ratio, an apparent fallacy exists.

Research to date has provided other highly significant general conclusions:

• Thermal characteristics of proposed nuclear-powered space-aero vehicles will severely limit capabilities of electronic components.

• The provision of sufficient gamma ray shielding in these vehicles is doubtful and the magnitude of gamma heating will vary directly with reactor power and shielding.

• New techniques may have to be developed to transmit or receive from these vehicles. As a result of attenuation and share rotation suffered by an



RADIATION-INDUCED damage to image orthicon tube by 18-hr. exposure to the CP-5 nuclear environment.



RADIATION damage received by oil-filled capacitor. Distortion and swelling is caused by gas evolution in the hydro carbon insulation oil. Again cause was CP-5 environment.

electromagnetic wave propagated through the ionized medium, complete reflection from the ionized boundary layer can occur. This same ionization also tends to limit impedance levels within the various circuit devices. The situation worsens with increased reactor power, but is dependent also on the presence of an atmosphere.

• The neutron-gamma ray dose received by any component is a function of both the neutron and gamma ray dose rates at the component position and of the total time of irradiation.

• Although some conventional electronic components operate reliably in radiation of moderate severity, future high-power weapon systems will necessitate radically new components. More work must be accomplished on electronic components development if they are to be suitable for contemporary nuclear-powered vehicles.

Typical relative environments to which space-aero vehicles in sustained flight will be subjected are shown in the table below. (More precise data are available but these are still classified for security reasons.)

• **Component damage**—A summary of some of the more pronounced effects of nuclear radiation will indicate the seriousness of the problem. In many instances, damage is very severe.

Irradiation of components in the Argonne CP-5 reactor represented dosages comparable to those which would be expected in contemporary nuclear-powered vehicles. The time period was approximately 3000 hours maximum.

Electron tubes demonstrate rather marked effects: most glass envelopes shatter; all glass envelopes darken. Borosilicate-type hard glasses are most susceptible to these shattering effects, attributed to neutron bombardment; discoloration results from gamma rays.

In general, all photo-sensitive components are sensitive to gamma rays, but gas-filled tubes and ionization devices are not. The most notable result observed with electronic tube devices was the rapidity of failure once the radiation damage began—often occurring within a few minutes.

Results of in-pile tests of semiconductor devices are sometimes conflicting. Damage also seems to vary more with manufacturing methods than with the properties of the solid-state components under test.

During bombardment of semi-conductor diodes, it was found that the forward currents decreased and backward currents increased. Oddly, post-exposure tests indicated partial recovery. In the transistors tested, gain was found to decrease under irradiation. But there were exceptions, since some devices showed a gain increase followed by a greater decrease later.

With respect to radiation resistance, silicon generally proved less susceptible, but again there were instances when the reverse was true.

In general, vacuum tubes have shown greater resistance than semiconductor diodes; the diodes have done better than transistors.

Crystal units tested indicated appreciable damage to component parts under gamma-neutron irradiation. Quartz structures darkened and fiber board and glass-to-metals seals in particular proved unsuitable.

Various types of capacitors were tested using mica, glass, ceramic, oil impregnated paper, and plastic. Both capacitance and dissipation factor were observed under irradiation.

Swelling and distortion were very apparent in oil-filled capacitors, resulting from a characteristic gas evolution. In general, capacitance decreased, dissipation factor increased. All of the other types of capacitors showed only slight capacitance change with somewhat more sensitivity in dissipation factor.

			Sustained Flight		Boost-Glide	Satellite
			Contemporary	Future	Future	Future
Temperature			-65 to +200C	-65 to +500C	-65 to +1000C	-65 to +500C
Pressure			0.04 In. Hg.	0.04 In. Hg.	0.04 In. Hg.	0.04 In. Hg.
Moisture (100% R. H.)			10C	10C	10C	10C
Vibration	Cycles/Sec G		10 - 2000 15	10 - 3000 40	10 - 3000 40	10 - 3000 40
Shock	Time (MSEC) G		11 ± 1 50	11 ± 1 50	11 ± 1 50	11 ± 1 50
Air-Induced Vibration	Cycles/Sec Pressure*		150 - 9600 160	150 - 9600 165	150 - 19200 165	150 - 9600 165
Acceleration	Time (MSEC) G		10 50	10 50	10 50	10 50
Nuclear Radiation	Dose Rate	Neutrons Gammas	10^9 10^{11}	10^{16} 10^{18}	10^{18} 10^{20}	10^9 10^{11}
	Total Dose	Neutrons Gammas	3.6×10^{15} 3.6×10^{17}	3.6×10^{22} 3.6×10^{24}	3.6×10^{24} 3.6×10^{26}	3.6×10^{16} 3.6×10^{18}
	Time (Hours)		10^3	10^3	10^3	10^4
Operating Life (Hours)			2×10^3	10^4	10^4	10^5

TYPICAL relative environments to which space vehicles will be subjected.

Different types of resistors w irradiated and, as might be expect wirewound types showed the least s sitivity. In general, resistance chang either because of damage to the c ducting material or the insulation. also is believed that parallel condu tion paths from the radiation-induc ion fields may have lessened res ance. This varied with reactor intens for all types of resistors.

With respect to wire and insulati results of irradiation are fairly consta —insulation material deteriorates lo before any appreciable change in t metal conductor occurs. As the rad tion field is increased there is a c responding decrease in insulation sistance, probably associated with c rier production in the material.

• **Contemporary and future co ponents**—As indicated above, many our present components are not se ously affected by expected radiatio from contemporary nuclear-power vehicles. But, as indicated in Table the environments of the future wea ons systems have factors of from to 10^9 probable dose rates above th of existing facilities. Similarly, therm environments will double in range. do not now possess components capa of functioning reliably in such e tremes.

The combinations of extreme e vironments will cause even grea complications. The big problem is t limited size of existing nuclear reacto which will not permit the simulati of synergetic environmental con tions. A partial answer would be velopment of small environmen chambers which might be placed side an existing irradiation facility.

• **Future design**—What can be do to provide more suitable compone for such damaging environments? A miral, as a result of its research, lieves there are several practical proaches:

(1) Minimize damage by selecti of component materials with high sistance to gamma-neutron bomba ment: high-purity mica, ceramics, ra ation-insensitive glass (under develo ment), and the use of inorganic rath than organic materials.

(2) Higher temperature operati This is based on the concept that crystalline and vitreous structur damage by radiation can be voided an annealing process. The ideal c would exist when the rate of radiati induced damage equals the rate annealing of damage areas.

(3) The best approach proba will be development of wholly n solid-state components which will designed for use in these difficult vironments.

Miniaturization—A Swelling Tide

Chain reaction of new breakthroughs could lead to microscopically small parts before trend runs its course

Heyward E. Canney, Jr.

SHINGTON—A bold new engineer-cipline fostered by the advent of ex weapon systems and high-e rocketry, miniaturization is al-a cornerstone of guided missile ace-flight technology.

e small artifact has been known ntiquity in art, jewelry, and the of documentary pinhead in-ns, but it can hardly have been ective undertaking for more than de or so. There was no need for re the complexity of rapid war-diotelemetry and automatic com-And before modern quality con-d reliability concepts, it was not feasible.

t only has miniaturization made e products available to the pri-tizen, it has so condensed tech-systems that large numbers of nits have created new systems y. New capacity, in turn, has new vistas, generated new goals then demanded still further min-ition.

ividual components shrink y in size with each new break-n in concept, materials, design, brication—and then swarm on ne again in more-dizzying pro-At the present rate, there is a enuine prospect that individual as we come closer to compre-g the basic behavior of matter may become invisible to the eye.

What is it?—Miniaturization is an ring discipline devoted to re-the size of a useful artifact to one or more functions which in scope or efficiency specifi-cause of the miniaturization. It is applied to individual parts to total size of an assembly, com-or system fabricated from such Although the discipline now in-cludes mechanical idioms, its untimate implications involve matter and energy of a fineness which begs the distinction between electricity and mechanics.

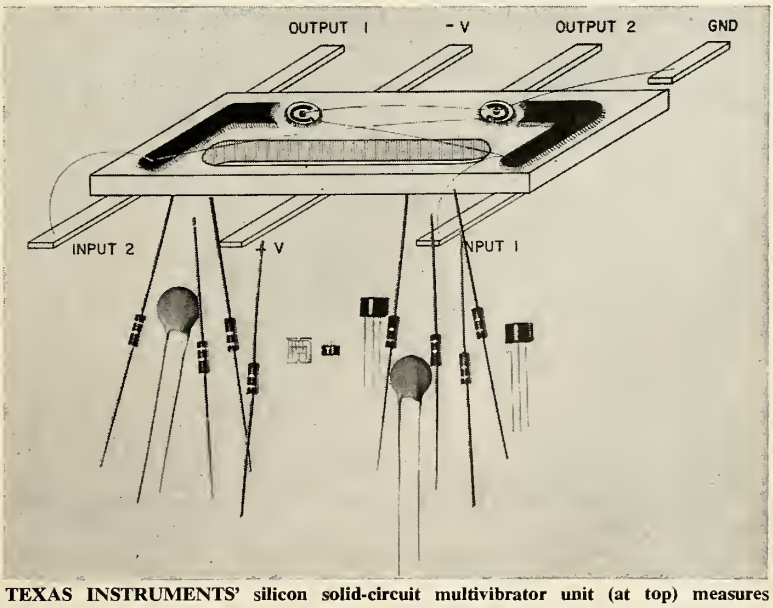
Miniaturization aims to increase performance and/or portability, or to prevent non-portable devices from growing to unmanageable size. The result is properly a tool or technical instrument generally involved with handling information in some form.

It is achieved through scaling down dimensions, using new materials for lightness in basic or aggregate structure, involuting and telescoping structural configuration for reduced space envelope, and adopting new concepts of interplay between matter and energy.

It is aided by new philosophies of fabrication which may not be intrinsically miniature themselves but which enhance the general undertaking—such as (in electronics) the use of printed circuitry, modularization, and intrinsic agencies for drawing all or part of a device's operating energy from the environment.

• **Methods and factors**—The most direct method is scaling down, which can be done when function does not directly depend on size, or compensations must be made. Resistors, for example, must adopt a new active element of greater resistivity beyond a certain point. A voltmeter ¼″ in diameter has dubious utility, though one doubtless could be built.

Redundancy is made possible, but must be used intelligently to avoid



TEXAS INSTRUMENTS' silicon solid-circuit multivibrator unit (at top) measures less than 1/4x1/8x1/32 inches but has equivalent of conventional components shown.

bogging down through mechanical and electrical loss accumulations. And one should be willing to include a non-miniaturized part where its performance is clearly better.

Lightness of material of carefully chosen properties is utilized, though resistance to environment, vibration, acceleration, impact, and internally-generated heat must be considered.

Redesign of intimate and general structure is very important: individual parts may be placed closer together; structural support may be involuted; parts may share interface, be placed inside each other, or be made both functional and structural at the same time.

Mechanical linkages and power trains may be shortened, rotating parts substituted for sliding ones, and so on. Primary power agencies may be arranged to eliminate intermediate step-up or step-down. This makes for compactness or high component density, and hence greater weight, which must also be reckoned with in the end result. Problems of heat dissipation, magnetic isolation, and access for service also arise.

Techniques of fabrication include printed wiring and circuitry, which permit automated dip-soldering and flatness for dense stacking, and sometimes the use of stampings and extrusions. Micromodularization, made possible in part by deposit of filmy circuit elements on wafers which are then stacked and potted, promotes shortness of leads, positive connections, low loss, and structural integrity.

Deposited elements spring from a still more basic practice of producing elements from solid-state materials such as semiconductors, or magnetostrictive or piezoelectric substances from an essentially chemical origin, and stretching into thin ribbons.

Construction may be adapted to accommodate twistors, cryotrons, MASERS and ferrites, which may demand exotic provisions of environment such as extremely low temperature.

Finally, systems may be reduced by relying on extract of power from gravity, buoyancy, friction, fluid intake for chemical action, radiations, static- and piezo-electricity, and magnetism. In a few cases all power may be so derived (though this is often risky) and in others, minute amounts of energy for reference or control will suffice. In handling data, one may convert the form of coding and telemeter for reduction elsewhere.

• **Why miniaturize?**—The impulse springs partly from the way Man looks at his relationship to the total environment, and in part from certain basic realities of interplay between matter and energy.

In looking at the environment, one compares goals with resources. The Russians surveyed an essentially mediocre average of craftsmanship in a vast labor force, built things to relatively relaxed tolerances, and got crude and heavy results. These doubtless included nuclear warheads, which needed large rockets for delivery, and which were crude and heavy for the same reason. The word "crude", here, hardly means oxcart crudity. A MIG is a lot of airplane, and a very crude 10-megaton ICBM warhead detonating on target will be distinctly noticeable.

The comparison is with "sophistication"—the lavish resources of American money and craftmanship combined with a yen for convenience resulting from disinterest in world conquest. Convenience, among other things, meant reducing both non-portable and portable systems to economical and manageable size. Before we realized it, we were involved in a chain reaction of alternate conveniences of miniaturization and acceptance of greater and greater challenge opened up by complexity. We considered our resources and decided on many peaceful conquests rather than one warlike conquest.

In the process, we happily discovered that the richness of our approach revealed the above-mentioned physical relationships of interplay between matter and energy. We discovered, for example, that with increasing RF frequency, electron-tube geometry —based on the concepts of the time— required reduction in tube size in obedience to such requirements as interelectrode capacity. Power levels eventually dwindled to useless amounts, except in the laboratory, and electrical forcing in practical equipment only burned out the tube. Physical laws are implacable, and the only thing left was to start with a new approach. We eventually came up with transistors, and it wasn't long before everything was being miniaturized.

Conceptual daring paid off handsomely. Proliferation of parts created complex systems, which permitted the audacious approach of "doing big jobs conveniently." It turned out we also did them better, faster, and more cheaply.

• **Advantages**—Aside from the general desirability of convenience, there were direct benefits in technical performance. Parallel duplication improved reliability . . . and you can afford duplication if what you are replicating is small and light. Also, things can be done with the same ability when parts are small, since tems can get more complex.

Portability is advantageous in planes and missiles because it incr capacity and performance per weight and volume. As for non-p bility, if you are erecting an ambi digital computer, it is a real bene contain it in a room rather th whole building.

Space and weight reductions a obvious boon to satellite and launching systems, because it's ch to use a smaller rocket to loft the load. In mass production, small are generally cheaper per unit, an payload itself also costs less. In lites and probes this is no trifle.

Removal or reduction in nun of moving parts increases reliab Micromodules, which permit stan ization and potting, have impr structural strength and environm protection. Shortening leads and ages reduces power loss and pe smaller power sources, again red size and weight. Printed or depo wiring and circuitry permit auton production, which saves money.

Component density permits l duplication in parallel to increase all capacity, or deal as a team specific functions to promote reliab In many cases, sensing elements reduced area have improved sign noise ratios.

• **Trends and prospects**—Emp cally higher component density is way. Until the recent breakthr about 60,000 parts per cubic foot the limit. About 300,000 looms fo reasonably near future, and som perts forecast densities between 5, 000 and 34,000,000 if whole sys can be fabricated solely of mo like the Texas Instrument multiv tor, the Westinghouse module, others. The Air Force is already ously studying a new realm of "m tronics" . . . involving volumetric aturizations of 1000:1.

Wider operational tem ture ranges are in prospect, thank only to extensive encapsulation but to the closer packing resulting standardization of modules. Auton production, increasing use of m modules, and automatic testing of systems and systems seem likely, v the assembly jig is constantly conn to testing instruments, so that te can proceed as the systems are a bled. Testing itself will be more ous, and greater confidence may i diately be placed in the received e ment.

Data itself will be subject to so

d new themes of coding, and com-
ive devices will have ingenious
iques of storage, access, process
eadout. There may also be some
cant developments in transmission
ta through novel types of phasing,
plexing, and compound pulsing.
odules will tend to have highly
ic functions, but also be capable
ried applications. Incredibly high-
automatic GO/NO-GO sequence-
olled checkout equipment will ap-
Design will provide for rapid
ement of critical components for
diate initiation or resumption of
e, with repair done elsewhere by
l facilities.
xtremely small size will permit not
new degrees, but also new dimen-
of redundancy. Supercritical cir-
may be triplicated into strategic
subcircuits (von Neumann "ma-
organs") to optimally reinstate
ons whose failure would be catas-
c.
n the far horizon lies the vista of
iniaturization, which will pro-
materials and devices capitalizing
ernal fields, molecular spin reso-
and electrostatic charges. Power
ation or extraction agencies will
inutely integrated and dispersed.
this degree of smallness, the no-
of following classical schematic
is and notation boggles the mind.
eaches an operational threshold
substances, with trivial changes
m and loading, can act as almost
reviously-known circuit part. That
y may amplify, detect, rectify,
, resist, have capacity, or respond
tely to a magnetic, mechanical,
or radiative stimulus.
agination flags when one ponders
ssible nature of completely in-
circuitry, or the equipment to
e it—and can only entertain
vague inkling of three-dimen-
scanning for impression of
e-down images . . . creating mo-
circuit components by locally-
lled stresses in specially-prepared
tate "raw" material.
Et we can go only so far. Even-
the Principle of Indeterminacy
in, as the sensing agencies for
eedback loop become as small
at they are measuring. This is
dsly a vast distance into the fu-
Whenever it comes, miniaturiza-
vill then presumably have to
in the towel. But maybe it won't
Arrival at that state of fineness
mean that artifact has finally
l parity with biological detail . . .
an may have then available some
providing him with a direct
e link between his mind and the
l Universe.

Beryllium Structure Made

BALTIMORE—The Martin Company has successfully fabricated structurally sound beryllium sheet material which has been used to construct the world's first beryllium structure.

Use of beryllium in frame structures will make it possible to solve many of the aerodynamic and structural heating problems associated with space flight and re-entry of the earth's atmosphere at speeds up to 18,000 miles per hour.

Martin engineers believe the achievement brings interplanetary travel within the realm of practical engineering design because frame material research has not, to date, kept pace with the rapidly advancing state of the art of propulsion research.

The project was accomplished under an Air Force contract placed with Martin in the summer of 1957. Development and fabrication was performed in conjunction with Nuclear Metals, Inc., Concord, Mass.

• **Other approaches**—The Martin approach to beryllium is just one of many avenues now being explored. Manufacturing Methods Division of Air Materiel Command is developing test criteria to evaluate the Martin program as well as work being done by Brush Beryllium Corp. under AMC contract.

The sheet program is only one of many now under way. Others include: a contract with Beryllium Corp., Reading, Pa., to determine the feasibility of making beryllium castings and to develop methods for producing shaped castings; Northrop Corp. is attempting to develop a process for producing extrusions of adequate aircraft quality; Ladish Company, Cudahy, Wis., is working to develop forging techniques to permit the production of beryllium parts and to develop necessary engineering data; Kettering Laboratory, University of Cincinnati, is trying to develop sufficient industrial, medical, toxicological and industrial hygiene engineering information to safeguard industrial personnel working with beryllium.

Still other contracts include: Brush Beryllium to improve the ductility of beryllium sheet by addition of alloys; Avco to develop techniques for joining beryllium; Nuclear Metals Division to fusion weld beryllium; Lockheed Aircraft to study the effects of notches and cracks on the structural quality of beryllium; and Armour Research to make casting studies.

• **Merits**—The Avco research possibly deals with nose cone technology. It is interesting that in recent testimony before the House Appropriations Subcommittee, Lt. Gen. Roscoe Wilson, AF deputy chief of staff for development, commented that a beryllium nose cone would weigh about 13 pounds while a comparable copper cone weighs approximately 100 pounds.

Beryllium is lighter than magnesium, has a melting point twice that of aluminum and a stiffness factor exceeding that of stainless steel. All desirable attributes for missiles and space vehicles.

The combined properties of beryllium are superior to all other structural materials from the standpoint of strength, stiffness, heat absorption, and lightness in weight, Martin engineers said. Its use in frame manufacturing will enable designers of space vehicles to effect vital savings in weight, fuel loads, and vehicle size.

In addition, beryllium structures may not require complicated cooling systems to compensate for structural heating caused by friction at the time of high speed re-entry. Instead, they said that ordinary insulation may be sufficient for structures made of beryllium.

Ballistic missiles can utilize beryllium in nose cone construction to take advantage of the material's great heat storage capacity. Beryllium can absorb two-and-a-quarter times more heat than any other structural material under conditions of a given rise in temperature.

• **Barriers cleared**—Until now all characteristic forms of beryllium—castings, forgings, rolled sheet, etc.—have exhibited non-uniform properties and brittleness akin to glass. This stumbling block has been largely removed with the development of sheet material possessing homogeneous properties suitable for structural fabrication.

Brittleness in beryllium forms has been due primarily to planes of weakness in the metal's metallic crystal. Martin and Nuclear Metals, Inc., took an unusual approach in solving this problem by attempting to control both the crystal size and orientation during basic sheet fabrication. Test results on both the material and the completed structure indicate that excellent properties have been achieved, the engineers said.

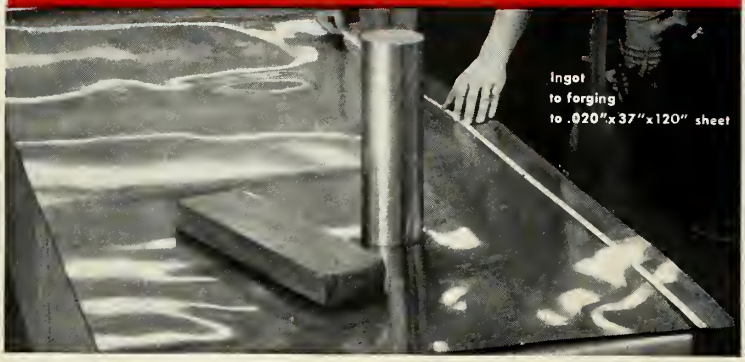
Other limitations for beryllium usage, however, still remain. In the first place, forming or bending the sheet can be performed only within a finely defined band of hot forming temperatures. It can presently be joined only with fasteners, and cannot be fusion welded.

As for extrusions, forgings, and rolled sheet forms, Martin tests indicate that all continue to yield crystal orientations resulting in the familiar brittleness.

2 MORE FANSTEEL SPACE-AGE ALLOYS

with

High Strength-To-Weight at HIGH TEMPERATURES



FANSTEEL 80 METAL

Alloy—Columbium-zirconium

Melting Point—4350°F.

Density—
8.6 grams per cc (0.311 lb. per cu. in.)

Tensile Strength—
Annealed 70°F.; 47,000 psi.

Stress-To-Rupture—
100 hr. 2000°F.
(argan) 18,800 psi.
500 hr. 2000°F.
(argon) 11,000 psi.

Other Praperties—Ductile to brittle transition temperatures in annealed state are well below raom temperature.

Advantages and Uses—Extremely high strength-ta-weight ratia far high temperature applicatians. Excellent weldability, ductile welds with little or no tendency to fracture in heat affected zones. Easy fabricatian at room temperature, as worked ar annealed. For missiles, rockets, spacecraft, ather high heat applications.

FANSTEEL 82 METAL

Allay—Columbium-tantalum-zirconium

Melting Point—4550°F.

Density—
10.26 grams per cc (0.371 lb. per cu. in.)

Tensile Strength—
Annealed 70°F.; 55,000 psi.
2000°F. in air; 29,600 psi.
2400°F. in air; 11,700 psi.

Stress-Ta-Rupture—
100 hr. 2000°F. (argon) 17,500 psi.
500 hr. 2000°F. (argon) 13,500 psi.

Other Properties—High oxidation resistonce compared to pure refractory metals. Oxide film is tenacious, non-volatile, tends to form protective coating. 16-haur, 2000°F. tests in flowing air show remarkably low scaling af 0.01 cm.

Advantages and Uses—Exceptionally suitable for air-frames and certain missile applications. Provides desirable strength-to-weight advantages at higher temperatures plus the same workability, weldability and ductility of Fansteel 80 Alloy.

AVAILABLE in ingots, fargings, bar, rod, plate, sheet and fabricated parts.
Write for latest technical bulletins.

FANSTEEL

HIGH TEMPERATURE METALS

K594A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

reviews

SPACE DICTIONARY OF GUIDED MI AND FLIGHT, **Grayson Merrill (Ed Van Nostrand Company Inc., Prin N.J., 688 pp., $17.50.**

The rapid advance in missile rocket technology has produced a dered, somewhat unwieldy new nology. Fusing terms from the varie diverse scientific field represente rocketry has brought about a compl jargon completely understood by Heat, as a term, for example, mean thing to the physicist, another t chemist, and something else again veterinarian.

This dictionary is a good attem bring some order out of the chaos explain most of the commonly used in the guided missile and space fields today.

Terms defined include current an torical guided missiles and space their systems for guidance and co propulsion, armament and launchin components that make up these sy and all related terms from aerodyn astrodynamics, electronics, astronom physics. Included are terms for typ antennas, circuits, radar systems anc pellants, as well as laws, relation equations, space environments and cepts which govern utilization in de

Illustrations help define difficult and a comprehensive cross-referenc tem is provided. Aiding Mr. Mer the preparation of this lexicon were expert missilemen and missile linc C. W. Besserer of STL; Kraf Ehricke of Convair, and Ballard B. of the Aberdeen Proving Grounds.

CONCISE DICTIONARY OF SCI **Frank Gaynor (Ed), The Philoso Library, Inc., 546 pp., $10.00.**

The terminology confusion ramp the missile and rocket industry is tive of the fusion of old sciences, ar vent of many new sciences. This under one cover, attempts to provid cise definitions of terms and concept taining to all fields of science.

Included is a coverage of many newer sciences such as virology, e ology, cytogenetics, radio-chemistry, energy and solid-state physics, etc. by a science writer of merit, the dict is a valuable addition to any librar

ROCKET ENCYCLOPEDIA ILLUSTR **John W. Herrick (Ed), Aero Publ Inc., Los Angeles, Calif., 607 pp.**

An attempt to marshal most presently known rocket facts and th into one compact volume. Profuse pictures, charts, and drawings, the makes an ideal text for the specia the field who wants to keep abre the other phases of rocketry.

This is one of the first attem publish an encyclopedic presentatio Theodore von Karmann writes the duction.

moscow briefs

by Dr. Albert Parry

pressure of 5 million atmospheres chieved by a group of Soviet ex- enters acting on the initiative and ctions of Academician Y. B. vich. In reporting this accomplish- *Komsomolskaya Pravda* admits 'this monstrous pressure" lasted moment, yet the fact that it was d at all, even for such a short on, is truly a great triumph of science. The pressure was the of the clash of two plates, one of was accelerated "to the speed of k."

riting in *Literaturnaya Gazeta* of successes with *Sputniki* and . T. Trifonova makes an admis- are for Russian propagandists: who does not know that on the o these triumphs there had been difficulties, bitter failures . . . es of despair . . ." This is a direct diction of the frequent assertions onid Sedov and other Russian experts that their *Sputniki* were ed on the very first tries, with tely no failures ever marring 's rocketry progress.

"Steam Moves a Rocket" is the title of a brief article in *Sovetskaya Aviatsia,* which comments on the latest researches and experiments of using "ordinary water vapor instead of products of burning fuel for rockets." The article is accompanied by a diagram evidently adapted from a West German source, as the Russian author remarks that "West German military experts, feverishly working on their job of equipping the re-emerging Wehrmacht, predict a bright future for this inexpensive motive power" in rocketry.

The diagram and text in the Moscow publication describe the steam rocket engine as a vessel made of steel, by its appearance resembling a large balloon with compressed air. It has a widening nozzle with a faucet that can be turned on and off. The steel container is filled with water to three-quarters of its capacity.

The water is heated to a high temperature with the aid of oil burners or electricity. In this water-heating process the pressure in the chamber rises to 40 or 50 atmospheres. At this point the faucet is turned open, and the hot water rushes into the nozzle. As the water flows out it evaporates with tremendous force. The speed of the vapor stream is considerable. Thus comes the jet power to move the rocket.

It is true, the Soviet commentator adds, that this rocket energy lasts less than one minute, since the vapor pressure in the steel container falls rapidly. But with a steel container holding 500 kilograms of heated water, the very first 10 seconds will give the rocket a respectable momentum. The entire weight of such a steam-powered rocket engine, together with its water, does not exceed 800 kilograms.

A new type of star accumulations or galactics was announced in Moscow as a recent discovery by the staff of the Burakan Astrophysical Laboratory in Soviet Armenia headed by the famous astronomer Victor Ambartsumian. He named them "Non-Stationary" or "Azure Blue." A considerable part of them is gas, out of which apparently new stars are now being formed. Because of this initial stage of star formation, physical processes occur in these "Azure Blue Galactics" far more intensively than in all of the already known constellations.

Professor Ambartsumian says that a thorough study of the Azure Blue Galactics should show new physical phenomena and qualities of matter.

Look...

TREVARNO **Flame-Resistant Polyester System, using Trevarno's Glass Fabrics, is specified for the new Douglas DC-8 Jetliner's Palomar Unit-Ized Seat Desk-Tray.**

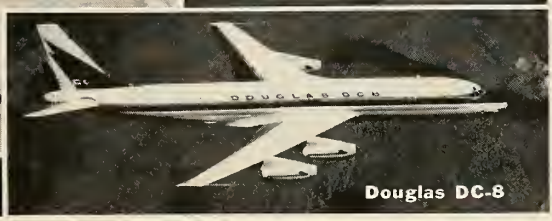
This entirely new approach to airline writing desk-ray combinations is made of light weight Douglas "Aircomb" sandwich with skins of Trevarno Flame-Resistant Polyester-Impregnated Glass Fabric . . . or easy and uniform fabrication . . . PLUS flame esistance!

For information about how Trevarno Resin Pre-Impregnated Glass Fabric can help ou solve your problems, write or all the District Office nearest you:

os Angeles:
35 S. Kenmore Street—DU 8-5260
allas, Texas:
924 Greenville Ave. — EM 8-7871
n the Midwest:
15 N. Main St., South Bend, Ind.
E 3-1821 . . . or write directly to
oast Manufacturing & Supply Co.
. O. Box 71, Livermore, California







Douglas DC-8

Trevarno GLASS FABRICS

AF Contractors' Backlog Now Totals $7.191 Billion

Backlogs of principal Air Force contractors as of March 1, 1959, totalled $7.191 billion. Twenty-four companies are involved representing approximately 75 percent of Air Force procurement funds. Breakdown in millions, including both missiles and aircraft and covering engines and electronics equipment: A-C Spark Plug, $43.8; Aerojet General, $33.1; Allison Division, General Motors, $96.1; American Bosch ARMA, $53.7; Avco, $24.2; Bendix Aviation, $32.8; Boeing Aircraft, Seattle, $839.5, Wichita, $592.8; Burroughs, Detroit, $80, Paoli, Pa., $11; Convair, Fort Worth, $554.3; Astronautics Division, San Diego, $108.6, San Diego, $371.3.

Douglas Aircraft, Long Beach, $286.6, Tulsa, $27.7; Ford Motor, Aircraft Engine Division, Chicago, $26.9; General Electric, Evendale, Ohio, $179, Philadelphia, $53.3, Syracuse, $158.2, Gas Turbine Division, Utica, $73.9; Hughes Aircraft, Culver City, $232.7, Tucson, $137.6; International Business Machines: Kingston, N.Y., $216.5, Owego, N.Y., $64.2.

Lockheed Aircraft, Burbank, $191.7, Marietta, Ga., $224.5, Sunnyvale, Calif., $13.8; Martin Co.: Baltimore, $110.4, Denver, $58.2; McDonnell Aircraft, St. Louis, $448.1; North American Aviation, $458.1; Northrop Aircraft, Inc., Hawthorne, Calif., $209.9; Pratt & Whitney, Hartford, $566.1; Radio Corp. of America, Camden, N.J., $214.2; Republic Aviation, Farmingdale, N.Y., $239.0; Sperry Gyroscope Co., Division of Sperry Rand, Long Island, $88.7; Western Electric, $79.5.

The Senate Space Committee has okayed a $485.3 million authorization bill for NASA. This is $4.7 million more than approved by the House for space R&D and hardware.

Zeus' Breakthrough

Breakthrough is claimed in the solid propellant motor for *Nike-Zeus* antimissile missile with the development of extremely thin casing walls, a new high-energy propellant and plastic nozzle. Joint effort of Douglas Aircraft and Grand Central Rocket Co. produced a full-scale tactical motor designed for *Nike-Zeus* sustainer which performed perfectly with the series of new improvements.

Sensor to control missile fueling is being placed in production by Pioneer-Central Division of Bendix Aviation. The company says the instrument to detect any change from liquid to gas or vice-versa will be used in *Titan* support and an evaluation order has been received from Convair for use on *Atlas* fueling system.

Air Force Office of Scientific Research is planning to build late this year a hypersonic wind tunnel at the University of California. Tunnel will be used to pursue investigation of re-entry problems, ion propulsion R&D and high-temperature research.

Follow-on $15 million contract for additional production of the 20-foot truck-launched *Lacrosse* surface-to-surface missile has been awarded Martin-Orlando by the Army. This makes $25 million contracted for the artillery-type weapon since January. Two battalions are to be equipped with *Lacrosse* at Ft. Sill, Okla., before the end of this month.

Sound Assaulted

New assault on the effects of sound energy—believed to be the cause of many missile and rocket failures—will be attempted with a new acoustic high-energy generator which theoretically could shred a human brain in 30 seconds. The $100,000 generator produced by Transducers Inc. will be used for testing components by the Autonetics Division of North American Aviation. Reportedly the device can actually simulate the sounds encountered under normal service operating conditions. Horn section is exponential acoustic impedance matching device with more than 100 50-watt high and low frequency drivers. Transducers for high and low frequency drivers are powered by 3500 watt amplifiers, each capable of peaking at 10,000 watts.

HM11XA is first die-castable alloy (1% thorium, 1% manganese and the balance magnesium) to be developed for service above 500°F, according to Dow Chemical. The company reports the new alloy, which has density of 0.064 pounds per cubic inch, also retains good mechanical properties through 800°F.

BMEWS Facility

Domed facility 15 stories high to checkout BMEWS radar and computers is being built near Moorestown, N. within sight of the New Jersey T pike by RCA, prime contractor fo missile warning system. Tower porting antenna and radome wil constructed on pylons descending dependently through the base buil and anchored in an octagonal slab feet wide and 8-feet thick. This meet extreme accuracy requireme tracking equipment which must re unaffected by wind, snow, ice or shi of the building.

Flight testing is under way of tronic Specialty Co.'s low-cost *P* proximity fuse. All weather evalu is being conducted under $93,000 tract with AF Special Weapons Ce Kirtland AFB, N.M. The company mates armed services will spend million in next five years on electr proximity fusing.

Ivar C. Petersen, formerly dir of technical services for Aeros Industries Association, has gone Boeing. After leaving AIA he wa volved in unsuccessful attempt to a ground support association.

EIA estimates authorizations thr FY 1970 for the space market total over $14 billion with electr getting 33% or $4.8 billion. N funding, EIA says, may hit $2 bi a year by 1970.

Astrodyne Development

Astrodyne Inc. reports develop for Navy of low-cost, lightweigh sulator for solid-fueled rocket mo Composed of rubber and asbestos, material has resulted in successful firings with significant thrust level durations of over 3½ minutes. Ext casing temperature was held to 2 for that period while motor wa hausting 5500°F flame.

Canada's Department of De Production has awarded a ceramic neering study contract to Titania tric Corp. of Canada, a subsidia Gulton Industries Inc., Metuchen, Study will be directed at electroni nuclear applications.

Schlumberger Ltd., which ha quired an 80% stock interest in puter Systems Inc., New York plans to invest $3 million in expa CS. . . . Hycon Eastern Inc., bridge, Mass., has switched its na Hermes Electronics Co.

propulsion engineering

New liquid hydrogen plant . . .

at Palm Beach, Fla., is huge—one of the largest industrial gas plants ever built. The facility, which Lt. Gen. Bernard A. Schriever says turns out the "purest hydrogen ever made" has a compressor building six stories high and a quarter of a mile long. Data for the rest of the plant, operated by Air Products, is classified. Schriever told the Institute of Aeronautical Science and the Air Force Academy Cadet Engineering Society meeting at Colorado Springs that the plant is turning out liquid hydrogen in "large tonnage" quantities, thanks to a scientific breakthrough.

This "breakthrough" is not really new . . .

and has been reported twice in this column—March 30, April 6. It is the National Bureau of Standards process for converting unstable orthohydrogen to stable para-hydrogen. Liquid hydrogen ortho molecules naturally want to convert to the para form. The conversion releases considerable heat which constantly vaporizes the liquid hydrogen. This is why liquid hydrogen is so difficult to store and generally calls for recycling refrigerating equipment. The NBS found a way—based on hydrous ferric oxide as a catalyst—to speed up the natural conversion. The technique results in 95% conversion. Since the para-hydrogen is stable, no further heat is evolved and it's possible to store liquid hydrogen in much the same way LOX is stored.

ARDC and Air Materiel Command took over the Bureau of Standards technique and awarded contracts for development of practical, large-scale equipment to Air Products and Stearns-Roger Mfg. Co., Bakersfield, Calif. Each company built small development facilities, and Air Products designed and built the Florida plant.

Development time was remarkably short. The NBS Cryogenic Engineering Laboratory, Boulder, Colo., announced its conversion process only last year, and the Air Products plant was turning out liquid hydrogen last month.

Liquid hydrogen—LOX . . .

propellant system offers 40% more thrust than best present propellants. H_2O_2 will be used in Convair *Centaur* second stage, which has a Pratt & Whitney engine.

Ozone-hydrogen is next . . .

on the list of propellants. Work is progressing in this field, much of it under the direction of Dr. A. V. Grosse, Temple University Research Institute, Philadelphia. Grosse and A. G. Streng recently determined the density of solid ozone, the first time this has been done. Their value, at 77.4°K, is 1.728 grams/cubic centimeter. The liquid density at the same temperature (77.4°K is the melting point-freezing point of O_3) is 1.614 g/cm³. Thus, expansion on melting is 7.1%.

Density of solid ozone had not been measured before because of its ability to detonate at the slightest provocation," Streng and Grosse report in the *Journal of the American Chemical Society*. Their biggest problem was in devising adequate safety measures. Once the pure ozone was frozen into cylinders, it was fairly easy, they say, to measure the length and compute the density.

High-intensity arcs and plasma jets . . .

est Carborundum Company's high-temperature ceramics. C. E. Shulze of Carborundum's Research and Development Division, Niagara Falls, N.Y., says the free-burning high intensity arc and the plasma jet (Propulsion Engineering, March 30) have been extremely helpful in development of ceramic composition for high-temperature use.

Specimen surface temperatures above 5000°F are reached in only about 30 seconds of testing, Shulze told the Philadelphia meeting of the Electrochemical Society. Test samples are cylinders one-half inch in diameter. They are subjected not only to high temperatures, but also to subsonic and supersonic jet velocities.

THE
PENNSYLVANIA PLAN:
100% financing
for your
new plant

Complete financing for Lease-Purchase of a new plant is available in labor-surplus areas of Pennsylvania through combined efforts of lending institutions, non-profit community organizations and the Pennsylvania Industrial Development Authority. Interest as low as 2%, with deferred amortization, can be applied on up to one-half of total plant cost.

100% financing is also available in other areas of the State, provided by community organizations, banks, insurance companies and other sources. You select the community you want. You specify plant construction details or choose one of several plant "shells" now being readied for completion.

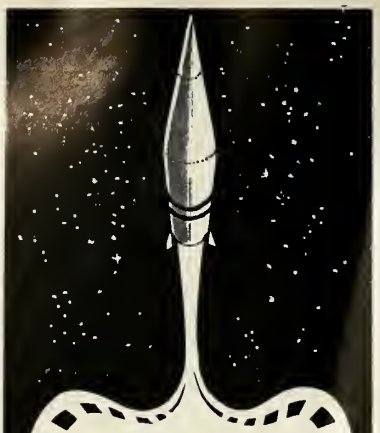
100% Financing at a Glance . . . Industrial Plant Construction Costs—

Subscribed by local non-profit community sponsored builder-owner corporations.	*20%*
2nd Mortgage Loan, Pennsylvania Industrial Development Authority.	*30%*
1st Mortgage Loan obtained from banks, insurance companies and similar lending institutions.	*50%*
Total financing, secured through local subscriptions and mortgage loans, without cash investment by the manufacturer.	*100%*



For free copy of "Plant Location Services" pamphlet, or for details on 100% financing, write or call:

Pennsylvania Department of Commerce
South Office Building
473 State Street, Harrisburg, Pa.
Phone: CEdar 4-2912



priceless

When your priceless test data are recorded on film, you will find no more reliable source of film processing than CFI. At CFI all of your film requirements... for sales, training, and visual aids, 16 or 35mm, will receive the most careful attention.

CFI UNDERSTANDS your film problems. CFI has processed the invaluable film records of many vital projects. CFI recognizes the need for uncompromising quality and fast action.

CFI FACILITIES are complete... and modern. CFI has developed many new processes and is the leader in its field. CFI has complete security clearance, assuring safe handling of highly classified material.

CFI EXPERIENCE includes 40 years as the nation's largest and most progressive organization, with complete lab facilities in both Hollywood and New York.

FOR COMPLETE INFORMATION on capabilities and service available, write or call for a sales representative.

cfi

CONSOLIDATED FILM INDUSTRIES
959 Seward St., Hollywood 38, Calif. • HO 9-1441
521 West 57th St., New York 19, N.Y. • CI 6-0210

missile business...

By WILLIAM E. HOWARD

Along Wall Street and its backwaters, financial men appear to be getting more and more wary of the "glamor" stocks—fast-moving shares of missile/aircraft, space and electronics companies. Ask almost any stock broker what he thinks of the missile industry issues, and more than likely the answer will come back: "overpriced, I guess, maybe . . . maybe not."

How can any stock selling at 70 to 80 times earnings . . . be worth it? Just a few years ago many brokers were loath to recommend stocks selling at 30 times earnings. Is the stock market now moving into an entirely new era? Or will there be a sharp downturn and a reversion to the old standards? You can get as many different answers to these questions as you can find experts.

Monopsomy is a word bandied about . . . of late in the money marts. One broker defines it as describing an economic condition where there are many sellers—and one buyer. The missile industry and the Government. On one hand monopsomy may hold a degree of security in that weapon contracts are large and payment is certain. But, on the other hand, contracts are subject to cancellation and the Renegotiation Act and the profits can be small. Competition is keen.

Accordingly, the watchword of many investment dealers on missile stocks is caution. They say a "shake out" of the industry is bound to come—a "shake out" in which some big companies now in the field may wind up small as far as missiles are concerned. While some experts concede upward revision may be in order for the earnings-price ratio, they point out that stock prices have been helped to new highs by a relative scarcity of stock compared to public demand.

Predicting the "market could break anytime" . . . the vice president of a mutual fund management firm said recently his investment trusts are cashing in their profits and investing in blue chips. "In our opinion (missile stock) prices have reached levels completely unrealistic to their true worth because of wild speculation by the public," said William S. Palmer of Templeton Debbrow & Vance.

Could the public be right . . . are worries unjustified? Taking a long look into the future, Walter K. Gutman of Shields & Co. investment house, says it is possible that modern technology can bring about a "complete economic solution" for all the people of the world by 2000 or shortly after. The 1929 crash was a disaster in his opinion which has become a "neurotic fixation with us." At that time, Gutman says, the market was saying something big and may be saying something equally big today—because the huge industrial output and profits 1929 speculators dreamed about have come to pass "and even more than they dreamed."

In a few years today's prices . . . may seem "very conservative," says the optimistic stock broker. "The stock market is far from ahead of our true industrial potential." And Gutman believes this will be borne out after 1960.

And he sounds another cheery note . . . "Perhaps there will be several sorts of disaster between now and the year 2000—but if these disasters do not occur . . . if year by year we find the vision becoming more real . . . then we will have to recognize that the stock market of 1957-59 was seeing truly—not giddily.

"It was not drunk, just enthusiastic."

William A. M. Burden, New York financier and aviation consultant, has been elected chairman of the board of trustees of the Institute for Defense Analyses.


BURDEN

The Institute is a non-profit corporation formed in 1956 at the request of the White House nalyze and evaluate the nation's de- systems and provide other technical ices to the Executive Office of the ident, the Secretary of Defense and t Chiefs of Staff.

Burden recently won unanimous ap- al from the Senate Space Committee it on the National Aeronautics & e Council. He is also a director of Council on Foreign Relations, a di- or of the Hanover Bank, Cerro de o Corp. and other companies.

Varo Mfg. Co. Inc.'s new division, owave Power Laboratory, will be ed by **Jack G. Smith,** vice president- neering. This division will exploit epts and applications of very high owave power outside the radar and munications fields.

William A. Mussen, former chairman of Southwest Research Institute's Electrical Engineering Department, was named chief development engineer for the Singer-Bridgeport facility of the Singer Military Products Division, and will be in charge of military n and development projects. At hwest Research, Mussen maintained hical and administrative control over rical engineering activities from 1955 gh 1959.


MUSSEN

red W. Trebes has been appointed general manager of Hydromatics, Inc's. Pacific Division. Trebes was engineering group leader on control valves for the Rocketdyne Division of North American Aviation, Inc. He was formerly in power plant engineering for North- Aircraft, and later for Douglas Air-

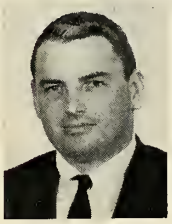

TREBES

r. Winfield W. Salisbury, who has appointed technical director of the on, is known for his pioneering efforts in high power RF sources starting with cyclotron development at University of California in 1937. **Dr. Fred L. Whipple,** Director, Astrophysical Observatory, Smithsonian Institution, will act as consultant.

The staff will be expanded to 150, of which 50 will be physicists and engineers. Several new facilities will be required.

Two men have been appointed to management positions for the Missile Development Laboratory of Minneapolis-Honeywell Regulator Co., as part of a staff expansion program. **Kenneth H. DeRoche,** 34, of the sales engineering and administration departments, has been named contract manager.

Samuel H. Cantwell, 30, named manager of administration, has been employed by the company's Aeronautical Division for five years in the personnel and contract management departments. He is a graduate of Harvard University.


CANTWELL

Harold S. Geneen has resigned as executive vice president of the Raytheon Manufacturing Company to become president of the International Telephone and Telegraph Corp. Geneen joined Raytheon in 1956 from the Jones and Laughlin Steel Corp., where he had been vice president and controller. Prior to that he served for four years with the Bell and Howell Co.

Thomas H. Evans has become controller of Servomechanisms, Inc. He had been serving the accounting firm of Ernst & Ernst as consultant analyzing Servomechanisms, operational requirements. He will now be responsible for the company's dealing with governmental agencies on financial affairs.


EVANS

William L. Reynolds recently submitted his resignation to Electronic Industries Association to accept the position of general attorney of Litton Industries, Inc. Before joining EIA in 1953 as staff attorney, Reynolds was an associate in the Washington law firm of Covington & Burling. He was named assistant general counsel of EIA in 1956 and elected by the Board of Directors in 1957 to succeed **Glen McDaniel** as general counsel of the Association.

Edmund G. Shower was appointed to the new position of production engineering manager for the Sperry Semiconductor Division, Sperry Rand Corp. He will direct the development, design and construction of new facilities and equipment for volume production of silicon transistors, diodes, and rectifiers.


SHOWER

The Senate has confirmed the nominations of **William A. M. Burden** of New York (see above) and **Dr. John T. Rettaliata** of Illinois to be members of the National Aeronautics and Space Council. Both were endorsed unanimously by the Senate Space Committee.

William F. Hafstrom was appointed assistant to Bendix Aviation Corp. vice president and group executive **E. K. Foster.** In his new capacity, Hafstrom will work directly with the management officials of Bendix Radio Div., York Div. and Cincinnati Div., the three divisions for which the vice president is responsible.

It has been announced that a long-time employe of Avco's Crosley Division, **A. J. Verax,** has become manager of its Cincinnati plant. Verax was Crosley's director of purchasing. **R. B. Megrue,** who has divided his efforts as plant manager between Crosley's Evendale and Cincinnati facilities, now will devote his full attention to the Evendale plant. Verax joined the Crosley Division in 1946 and since that time has been associated with the Division's Purchasing Department. He first was employed as a follow-up man, then successively became a buyer, project leader, manager of defense procurement, senior buyer, purchasing agent for commercial products, and, in July of last year, director of purchasing.


VERAX

Robert E. Gross, chairman of the board of Lockheed Aircraft Corp., and **Donald H. Douglas,** chairman of the board of Douglas Aircraft Co., were co-winners of the California Industrialist of the Year Award, presented by the California Museum of Science and Industry.

Gross was recognized for leading Lockheed's development of the new jet prop Electra and achieving success in a space program including system management of *Polaris* and the *Discoverer* series.

Douglas was honored for directing development of the DC8 jet passenger transport and the *Thor* IRBM.

CHRYSLER CORPORATION
Advanced Projects Organization

Opportunities For Top Scientific and Engineering Personnel

CHIEF-OPERATIONS RESEARCH
CHIEF-AEROBALLISTICS

To head staffs responsible for advanced planning and systems synthesis, Missile and Space programs.

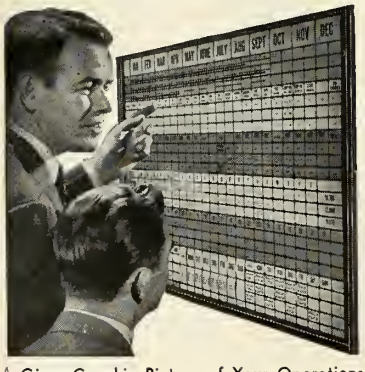
PROJECT MANAGER
ELECTRONICS

Familiar with current developments and theories in detection, radiation, and counter-measures, and/or communications.

Please submit resume, in confidence, to:

Management Recruiting and Placement
CHRYSLER CORPORATION
P. O. BOX 2688
DETROIT 31, MICHIGAN

You Get Things Done With Boardmaster Visual Control



☆ Gives Graphic Picture of Your Operations —Spotlighted by Color
☆ Facts at a glance—Saves Time, Saves Money, Prevents Errors
☆ Simple to operate—Type or Write on Cards, Snap in Grooves
☆ Ideal for Production, Traffic, Inventory, Scheduling, Sales, Etc.
☆ Made of Metal. Compact and Attractive. Over 350,000 in Use

Complete price **$49.50** including cards

FREE 24-PAGE BOOKLET NO. JC-10 Without Obligation

Write for Your Copy Today
GRAPHIC SYSTEMS
55 West 42nd Street • New York 36, N. Y.

—letters—

LITES Suggested

To the Editor:

In a recent article by Major William C. Mannix, USAF, and an editorial—both in the April 27th issue of M/R, an appeal was made to the "scientific community" for some method of standardizing velocity terms and units.

Major Mannix suggests the use of the word "Optik" until something better could be applied. He also requested the reader to let him know if a better word could be applied for the unit.

My suggestion, strictly from a layman's point of view and without taxing a scientific mind is the word LITES—which is derived from Light In Thousandths of Energy Seconds—or 1 LITE equals 186 mps.

Major Mannix is to be highly complimented on his article—a text well within the reach of the average mind. Too many "brains" today try to talk as far above the average citizen as the intersteller space that they are speaking of.

A special bit of praise should also go to the Missiles and Rockets editorial staff for a magazine unexcelled in its field.

F. A. Fleckenstein,
Engineering Analyst,
Cleveland Ordnance Plant,
Cadillac Motor Car Division

Moon Trolley

To the Editor:

Undoubtedly the task of keeping up with all the latest developments in missile and space projects keeps you extremely busy, but you may find that the following epochal communication will be of interest to scientists and engineers engaged in research and development on the ways and means of space travel. Our group, which is occupied with less esoteric problems, reads your magazine avidly and, indeed, considers it a "must" to be well-informed in the field. However, we feel that coverage of events will be incomplete without the addition of the plan outlined below.

After deciding during one of our recent coffee breaks to solve some pressing problems confronting the world today, we have come up with a practical, relatively inexpensive means of shuttling men and materials to the moon and back. Once instituted, our plan will enable diversion of the astronomical sums of money now being spent for rocket ships into other channels.

Since the moon always presents the same face to the earth a cable, securely anchored to the moon's surface, could be stretched to within 20 miles of the earth's surface. The earth end of the cable will simply be left hanging, free to circle the earth as it is pulled around by the moon. The moon's orbit is not quite circular, therefore the distance from the surface of the earth to the free end of the cable will vary somewhat and should be sufficiently great to prevent the cable from scraping on mountains.

Most of the cable's mass will lie wit in the earth's gravitational influence a will therefore try to fall to earth; ho ever, since its earthward movement constrained by being anchored to t moon, the net result will be to keep t cable taut. The farther away from t earth and moon the cable is, the less w be the gravitational attraction on t cable. Therefore, the cable possesses ma but relatively little weight along mo of its length. This property will help prevent the cable from failing in tensio

Next, we attach a cable car to t cable, and use the car to climb the cab until it reaches the gravitational influen of the other body, either moon or ear depending upon direction of travel, which point the car will start to desce the cable. The car will be kept at a re sonable speed by braking during desce to the surface of the attracting body.

Shuttle rocket planes will be used ferry men and materials to the cable c at the earth's end to which a passeng terminal and observation platform wou be attached for convenience of waiti passengers.

We have not worked out minor d tails such as size of cable necessary, a lowable car speeds, etc., but perhaps sor of our mathematically-inclined frien may be interested in working out the problems.

Obviously this solution will not wo for travel between planets because of t variations in orbits, but we expect to wo on that problem in future coffee breal

Francis A. Handville
Raymond F. Pohl
Picatinny Arsenal
Dover, New Jersey

P.S. The coffee contains nothing mo than cream and/or sugar.

Hardeman Participating

To the Editor:

Paul Hardeman, Inc., is proud of participation in the design and constru tion of missile test and launching facilitie To date we have participated in over major projects of this nature. We a particularly enthusiastic about our late participation in the *Titan* program throu the start of construction of the first ni operational complexes at Lowry Air For Base, Colorado.

We were distressed, therefore, to fi our name missing from the list of o joint venture partners on page 45 of t May 11 issue of MISSILES AND ROCKET The correct information is as follows:

Morrison-Knudsen Company; Pa Hardeman, Inc.; F. E. Young Constructio Co.; Johnson, Drake & Piper, Inc.; Olso Construction Co. have been awarded contract for the construction of W 107A-2 technical facilities, Lowry A Force Base, Denver.

Morrison-Knudsen Company is th sponsor of the joint venture and Pa Hardeman, Inc., and personnel will be a substantial share of the responsibility.

Patrick R. Black,
Vice President, Engineerin

We regret the omission . . . Ed.

WASHINGTON—The Department of fense has announced that it awarded otal of $213,400,000 in contracts **Lockheed Aircraft Corp.,** for work military satellites. The amounts had been disclosed previously. $96,-),000 applies to Project *Sentry,* an erimental satellite designed to size enemy installations with camera ipment. $106,000,000 was awarded to April 30 for experimental *Dis-erer* satellites, closely tied in with *Sentry*. $10,800,000 is allocated to ject *Midas,* the experimental satel- being designed to warn against my missile attacks.

NASA

4,805—**Avion Div. of ACF Indus-tries, Inc.,** Parmus, N.J., for pro-duction of transistorized electronic devices for the Project *Mercury* capsule (subcontract by Collins Radio Co.).

NAVY

557,000—**Aratz Contracting Co.,** San Francisco, for guided missile support facilities at the Naval Am-munition Depot, Concord, Calif.

$0,000—**Perkin-Elmer Corporation,** Norwalk, Conn., for design and construction of a 36" aperture tele-scope to be used in high-altitude photography of planets and celes-tial bodies (subcontract by Prince-ton University).

€,631—**Thompson Ramo Wooldridge Inc.,** Cleveland, for labor, facilities and material to manufacture *Side-winder* 1-0 motor tubes.

AIR FORCE

$2,500,000—**The Crosley Div. of Avco Corp.,** for radar equipment. Many items to be sub-contracted o other companies.

$1,000,000—**Western Electric Co., Defense Projects Div.,** for design and installation of a communica-ions network in support of AF facilities in the Aleutians. **Bell Tele-phone Laboratories** will participate with 50% of the work being sub-contracted.

$2,00,000—**Vitro Engineering Co.,** for operation and maintenance of power facilities on SAGE-*Bomarc* bases.

$2,00,000—**Astrodyne, Inc.,** Mc-Gregor, Tex., for research, de-velopment and testing of large-scale rocket motors and new high-energy solid propellants. Included is 188,000 for the manufacture of *Aegaboom* solid propellant rocket motors for Holloman AFB.

$400,000—**The Siegler Corp., Halla-more Electronics Div.,** Denver, for development and installation of photo optical, film camera and closed circuit TV systems used with the *Titan* missile. **The Martin Co.** is the prime contractor.

$251,300—**Philco Corp.,** Philadelphia, for technical services (two con-tracts).

$100,000—**The Johns Hopkins Uni-versity,** Baltimore, for research on design, development and operation of instrumentation to make auroral spectral measurements from rockets, balloons or satellites.

$93,000—**Electronic Specialty Co.,** Los Angeles, for testing of its new low-cost Panda proximity fuse.

$53,500—**The University of Michigan,** Ann Arbor, for research and study of rocket measurements of aero-dynamic quantities.

$52,000—**Stanford University**—Stan-ford, Calif., for research and in-vestigation of the current flow of plasmas.

$50,000—**Stanford Research Institute,** Menlo Park, Calif., for research on phenomena related to high-speed impact of particles with gases.

$31,187—**Oklahoma State University of Agriculture & Applied Science, Research Foundation,** Stillwater, for design, development and construc-tion of meteoritic microphone de-tectors of various sensitivities for use in satellites.

$25,450—**Massachusetts Institute of Technology,** for research and de-velopment for determination of heats of formation, heats of fusion and heat capacities of compounds of magnesium with Group IVb elements.

The Budd Company, Philadelphia, has announced that they have been awarded a contract by the **Utah Div. of Thiokol Chemical Corp.,** for construction of solid-propellant rocket engine cases for the *Minute-man* ICBM (amount not disclosed).

ARMY

$15,181,000—**The Martin Co.,** Balti-more, for additional production of *Lacrosse* artillery missiles. (Total amount contracted for this weapon $25,181,000.)

$3,024,735—**Ray M. Lee Company,** Atlanta, for building construction at Redstone Arsenal.

$2,757,897—**Blount Brothers Construc-tion Co.,** Montgomery, Ala., for construction of *Bomarc* facilities in-cluding all related work at Raco Auxiliary Field, Raco, Mich.

$2,669,250—**Blow Knox Company,** Pittsburgh, Pa., for 20 sets of pro-pellant loading skid assemblies.

$2,320,567—**California Institute of Technology,** Pasadena, for research and development on the *Sergeant* missile program. Work to be done at the Jet Propulsion Laboratory in Pasadena.

$2,000,000—**Raytheon Mfg. Co.,** Wal-tham, Mass., for engineering serv-ices on the *Hawk* missile. This prime contractor invites sub-con-tractors in NE for drafting services, specs writing and technical manual preparation.

$807,642—**Ashburn & Gray, Inc.,** Huntsville, Ala., for site prepara-tion for missile systems test facility for solid propellants at Redstone Arsenal.

$238,962—**C. H. Leavell & Co.,** El Paso, Tex., for modifications and additions to existing launching areas at White Sands Missile Range.

$99,638—**M. Steinthal & Co., Inc., Aeronautical Equipment Research Corp., Div.,** N. Y., for design, de-velopment, fabrication and test parachute recovery system for the *Redstone* booster.

$43,712—**Yale University,** New Haven, Conn., for research study of theo-retical nuclear physics.

$39,557—**Harvey Aluminum, Inc.,** Tor-rance, Calif., for production engi-neering.

$37,250—**Beckman/Berkley Div.,** Rich-mond, Calif., for computer analog.

$34,000—**C. H. Wheeler Mfg. Co.,** Philadelphia, for two items of single stage, double suction volume, horizontal split case pumps.

$32,952—**Potter Aeronautical Corp.,** Union, N.J., for six items of tur-bine type flow-meters.

$32,920—**Redel Engineering Corp.,** Pasadena, for generators and amp-lifiers.

$32,175—**Olin Mathieson Chemical Corp.,** East Alton, Ill., for research and development of missile com-ponents by use of explosive media.

$27,965—**Consolidated Electrody-namics Corp.,** Pasadena, Calif., for two 36-channel oscillographs.

Lycoming Div., Avco Corp., has been awarded a contract for develop-ment and delivery of AC-DC power systems incorporating a mechanical constant speed drive for the AN/-USD-4 *Swallow* surveillance drone. **Republic Aviation Corp.,** Farming-dale, L.I., is the prime contractor. (Amount not disclosed.)

when and where

JUNE

American Rocket Society, Semiannual Meeting, El Cortez Hotel, San Diego, June 8-11.

American Society of Mechanical Engineers, Semiannual Meeting, Chase-Park Hotel, St. Louis, June 14-18.

United Nations Educational, Scientific and Cultural Organization, UNESCO House, Paris, June 15-20.

Michigan Aeronautics and Space Association, Industry Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, June 16-17.

Cornell University Industry Engineering Seminars, Cornell University, Ithaca, N.Y., June 16-19.

Institute of the Aeronautical Sciences, National Summer Meeting, Ambassador Hotel, Los Angeles, June 16-19.

Institute for Practical Research on Operations, The University of Connecticut, Storrs, June 21-July 3.

American Institute of Electric Engineers, Air Transportation Conference, Olympic Hotel, Seattle, June 24-26.

Nuclear Industry Division, Instrument Society of America, Second National Symposium, Idaho Falls, Idaho, June 24-26.

Institute of Radio Engineers' Professional Group on Military Electronics, Third National Convention on Military Electronics, Sheraton-Park Hotel, Washington, D.C., June 29-July. 1.

Pennsylvania State University, Summer Seminar on Plastics—Its Mechanical Properties, Design and Applications, University Park, Pa., June 29-July 3.

JULY

Tenth Annual Basic Statistical Quality Institute, University of Connecticut, Storrs, July 12-24.

Radio Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Third Biennial Joint Meeting, Ambassador Hotel, Los Angeles, July 16-17.

Second Annual Institute on Missile Technology, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 26-Aug. 7.

The Denver Research Institute of the University of Denver, 6th Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 30-31.

AUGUST

Institution of Investigation of Biological Sciences, sponsored by Air Force Office of Scientific Research-Aeronautical Div., World Health Organization and United Nations Educational, Scientific and Cultural Organization, Montevideo, Uruguay, Aug. 2-7.

William Frederick Durand Centennial Conference, Problems of Hypersonic and Space Flight, Stanford University, Stanford, Calif., Aug. 5-7.

Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

Institute of Radio Engineers, Western Electronics Show & Convention, Cow Palace, San Francisco, Aug. 18-21.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

Air Force Association and Panorama; send reservations to AFA Housing Bureau, P.O. Box 1511, Miami Beach, Sept. 3-6.

Standards Engineering Society, Boston Section, Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, Conference and Exhibit, Chicago, Sept. 21-25.

Industrial Nuclear Technology Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology, Nucleonics Magazine and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

American Rocket Society, Solid Propellants Conference, Princeton University, Princeton, N.J., Sept. 24-25.

Institute of Radio Engineers, 1959 National Symposium on Telemetering, Civic Auditorium, San Francisco, Sept. 28-30.

OCTOBER

Electronics Industries Association Conference, University of Pennsylvania, University Park, Oct. 6-7.

Now Available

NUCLEAR EXPLOSIONS IN SPACE

by Prof. S. Fred Singer

the story behind

Project ARGUS

Reprints of this exclusive M/R report are now available due to repeated requests.

A series of four illustrated articles combined, this important M/R special contains scientific explanations of:

* **project ARGUS**
* **creation of an artificial particle belt**
* **effect on manned space vehicles and nuclear warheads**
* **effects on radar and long-range communications**
* **scientific techniques for detecting such explosions**

50 cents per copy
(bulk rates on request from publisher)

missiles and rockets
1001 Vermont Ave., N.W.
Washington, D.C.

Advertisers' Index

Aerojet-General Corp., Sub.-General Tire & Rubber Co. 10
Agency—D'Arcy Adv. Co.

Birdair Structures, Inc. 3
Agency—The Rumrill Co., Inc.

Caterpillar Tractor Co. 8
Agency—N. W. Ayer & Son, Inc.

Chrysler Corp. 48
Agency—N. W. Ayer & Son, Inc.

Coast Mfg. & Supply Co. 43
Agency—Long Adv., Inc.

Commonwealth of Pennsylvania, Dept. of Commerce 45
Agency—Bachman, Kelly & Trautman, Inc.

Consolidated Film Industries 46
Agency—Gaynor & Ducas, Inc.

DuKane Corp. 2
Agency—The John Marshall Ziv. Co.

Fansteel Metallurgical Corp. 42
Agency—Symonds, MacKenzie & Co.

Graphic Systems, Inc. 48
Agency—Diener & Dorskind, Inc. Adv.

Nems-Clarke Co. 4
Agency—John E. Waterfield

New Departure Div., General Motors Corp. 51
Agency—D. P. Brother & Co.

Northrop Corp. 26, 27
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Raybestos-Manhattan, Inc. 36
Agency—Gray & Rogers

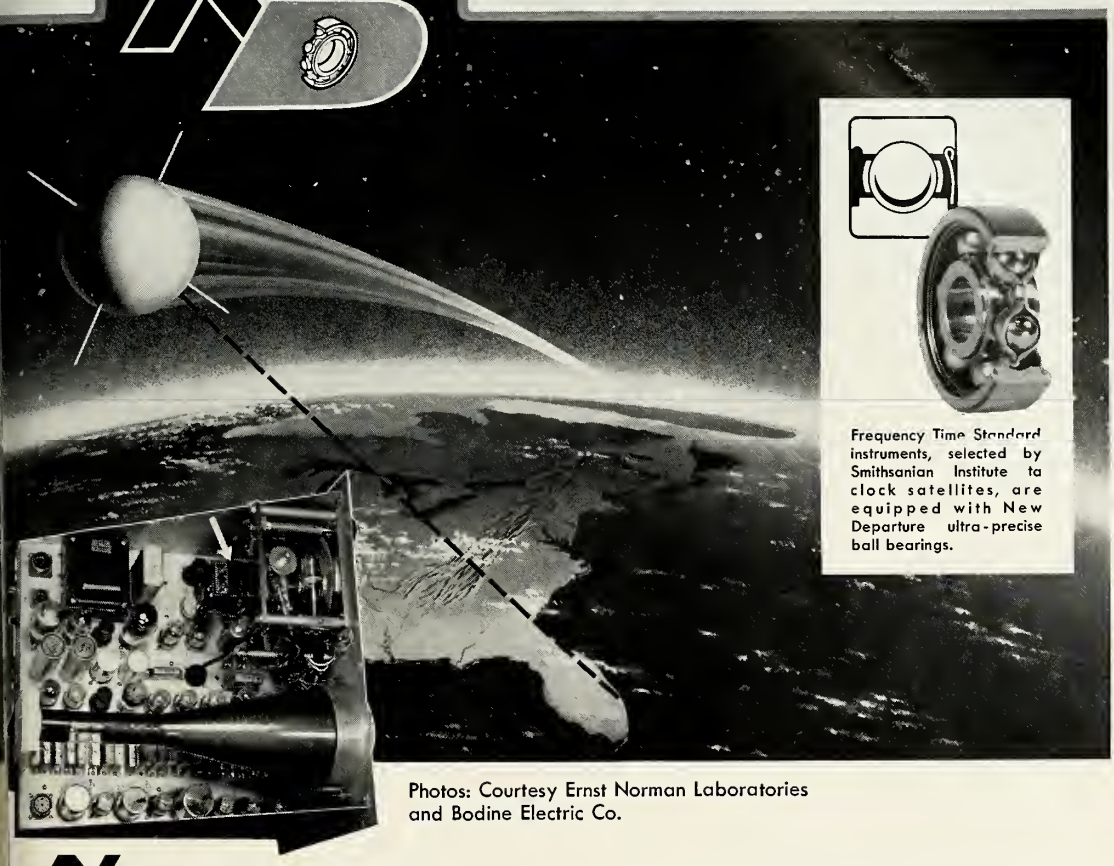
Thiokol Chemical Corp., Rocket Div. 52
Agency—Brown & Butcher, Inc.

Wyman-Gordon Co. 6
Agency—The Davis Press, Inc.

CLASSIFIED

HI-FIDELITY components, tape recorder and tapes at wholesale prices. Send fo FREE catalogue. **CARSTON 215-RM,** Ea 88, N.Y.C. 28.

CASE HISTORIES



Frequency Time Standard instruments, selected by Smithsanian Institute ta clock satellites, are equipped with New Departure ultra-precise ball bearings.

Photos: Courtesy Ernst Norman Laboratories and Bodine Electric Co.

Ultra Precise Ball Bearings Help "Clock" A Satellite!

CUSTOMER PROBLEM:

Require ultra-precise bearing design for Bodine electric motor used in satellite-tracking micro-clock. Bearings must provide uniformly low starting torque, precise location of rotor shaft and minimum maintenance, to help mechanism achieve time determinations to 0.001 second.

SOLUTION:

N/D Sales Engineers studied special bearing requirements, and recommended New Departure ultra-precise ball bearings. These ball bearings measured up to every requirement for micro-clock motors . . . thanks to New Departure's advanced equipment for research, development and production. N/D equipped micro-clocks, selected by the Smithsonian Institute, are operating in a dozen locations around the world right now, keeping track of vital satellite movements . . . to accuracies of one millisecond and better!

If you're manufacturing or designing electric motors for any high precision applications, including instruments, why not call on New Departure? N/D engineering and research facilities are turning out the latest in high precision instrument ball bearings and advanced ball bearing designs. For more information write Department K-6.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

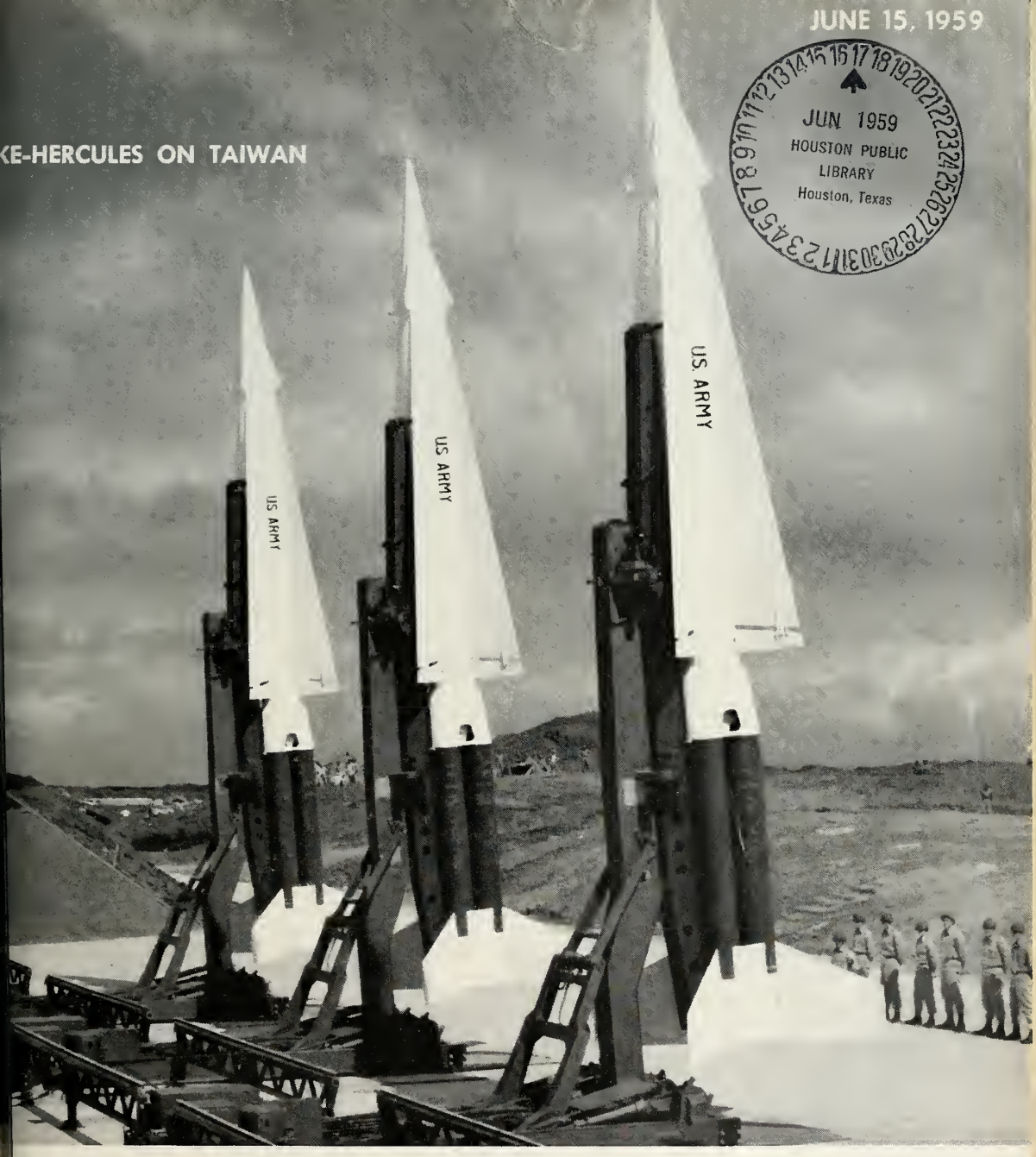
NOTHING ROLLS LIKE A BALL


REACTION MOTORS Division of Thiokol
X-15
at
DENVILLE
New Jersey
Reaction Motors—America's first rocket company and an outstanding pioneer in the field of liquid propellant rocket engines—now, a part of Thiokol Chemical Corporation, is contributing important advances in rocket engineering. Developing power plants for the Air Force's X-15 manned rocket plant is one of the current projects. With the addition of Reaction Motors Division's experienced personnel and modern facilities, Thiokol has expanded its leadership in the design, development and production of rocket propulsion systems to both solid and liquid rocket engines.
Engineers, scientists—perhaps there's a place for you in Thiokol's expanding organization. Our new projects present challenging problems and the chance for greater responsibility.
Thiokol® CHEMICAL CORPORATION
TRENTON, N. J. • ELKTON, MD. • HUNTSVILLE, ALA. • BRISTOL, PA.
DENVILLE, N. J. • MARSHALL, TEXAS • MOSS POINT, MISS. • BRIGHAM CITY, UTAH
®Registered trademark of the Thiokol Chemical Corporation for its liquid polymers, rocket propellants, plasticizers and other Chemical products.

JUNE 15, 1959

JUN 1959
HOUSTON PUBLIC
LIBRARY
Houston, Texas

KE-HERCULES ON TAIWAN



missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Catalogues Support Items . . . 21
bbee Sounding Rockets 25
e Food Development 28

AN AMERICAN AVIATION PUBLICATION

INSTANT
INDICATION OF VOLTAGE TOLERANCE



with the NLS 50 Go/No-Go Voltage Comparator

Here's a new method for determining whether or not an input voltage is within prescribed limits . . . and to do so quickly, easily and accurately! Just set the front panel dials of the NLS 50 Voltage Comparator to read any two voltages within the range of ± 0.001 to ± 999.9 volts. Apply the voltage under test and in 90 milliseconds the NLS 50 gives a clear go/no-go indication of voltage tolerance. Watch the limit lamps on the front panel. If the green "Between Limits" lamp lights, the applied voltage lies within the pre-set limits. If either of the red lamps light — "Upper Limit" or "Lower Limit"—the voltage under test is too high or too low.

With a sensitivity of 0.005% and its limit settings precise to ± 0.01%, the NLS 50 Voltage Comparator outperforms any other type of voltage limit detector. It's transistorized, too . . . for reliability and ruggedness. And it's so compact . . . the only limit detector complete in one package. Comparison amplifier, limit setters, reference supplies and range multiplier are all included in the one instrument, a 3½-in. high unit that fits conveniently into a standard 19-in. rack.

In addition to giving visual warning to the operator, the NLS 50 gives go/no-go commands to such electrical devices as cut-off relays, sorting chutes, data printers, tape or card punches, and audible warning equipment. Extremely versa tile, the instrument may be used as a high-accuracy voltmete without modification and may be adapted easily to detec resistance limits.

The broad applications of the NLS 50 Voltage Comparato include the following:

- Automatic checkout of missiles and electronic systems.
- High-speed, high-accuracy warning systems involving an parameter that can be converted to voltage (speed, tem perature, liquid level, distance, angle, acceleration, mag netism, weight, pressure, flow, light or other radiatio flux).
- Automatic component test equipment for testing resistor relays, diodes, transistors, vacuum tubes, batteries, tachom eters, motors, speed regulators and slip rings.
- Automatic process control, receiving inspection, produc tion quality control.

Write today for more detailed information concerning th capabilities, applications and operation of the new NLS 5 Go/No-Go Voltage Comparator.

PRICE $1775.00 COMPLETE • F.O.B. DEL MAR

Originators of the Digital Voltmeter

non-linear systems, inc.

DEL MAR (San Diego), CALIFORNIA

NLS — Digital Instruments That Work . . . And Work . . . And Work!

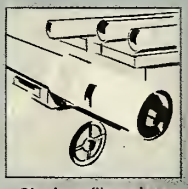
Circle No. 9 on Subscriber Service Card.



Huge rocket case furnaces



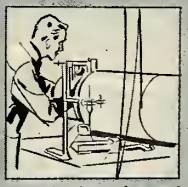
Complete design facilities for development or production



Steel—or fiber-glass —rocket cases for weight-savings



Quality control—by X Ray, hydrostatic and complete metallurgical test equipment



Thrust axis engineered to watchmaker's precision



10-year experience harnesses the high specific impulse of newest solid propellants

Foresight with a **wallop!**



Foresight which saw the coming of the Space-and-Missile Age enabled Goodyear Aircraft Corporation to begin construction—*more than ten years ago*—of what is today one of the most advanced and largest integrated rocket engine case facilities in the nation.

Furnaces—among the largest ever built for the task—spawn these exacting space-conquering units. Experienced technicians, backed by batteries of test equipment, control the quality of the materials—insure the soundness of each weld—maintain tolerances to thousandths of an inch.

This foresight, these skills, this equipment have made Goodyear Aircraft the birthplace of more large-size rocket engine cases than any other producer.

For more information on this completely integrated facility, write Goodyear Aircraft Corporation, Dept. 916PF, Akron 15, Ohio.

ROCKET ENGINE CASES—One of the Prime Capabilities of

GOODYEAR AIRCRAFT

Plants in Akron, Ohio, and Litchfield Park, Arizona

Built-in sea legs...for

UNLIMITED DIGITAL DATA RECORDING WITH DATATAPE SYSTEMS

From isolated monitoring outpost to cramped shipboard quarters at sea, DataTape's two new 5-680 Series Digital Recorder/Reproducers are more than a match for severe environments and critical operating conditions. Sturdy construction, completely transistorized electronics and fungus resistant component materials provide reliable instrumentation of long life.



TYPE 5-681— TAPE SPEEDS RANGE FROM 2 TO 30 IPS. ACCESSORY HINGED DUST COVER COMPLETELY SEALS TRANSPORT WITH A CONTINUOUS GASKET.

TYPE 5-682— TAPE SPEEDS UP TO 150 IPS. VACUUM BUFFER CONTROL OF TAPE LOOP ASSURES SHORT STOP AND START TIMES FROM HIGH SPEED WITHOUT UNDUE STRESSES ON TAPE.

DataTape's 5-681 and 5-682 are available with automatic tape skew correction...parity test circuitry...pulse activated remote control...visual signal monitoring...and remote footage indicator. Other features specified by users can also be incorporated.

The transports fit standard 19″ racks and require only 24½″ of vertical space. They accommodate NARTB reels to 10½″, and special reels are available. Type 5-681 provides 5-millisecond stop and start times and 5-682 operates at 3 milliseconds. Tape positioning accuracy of both units is ±0.05″ in forward or reverse. Start, stop and reverse cycling rates to 100 per second are easily achieved. Speed changes are made by electrical switching of multispeed capstan motors. Operating power requirements are 110 volts, a-c, ±10%, 60 cycles ±1 cps, at 10 amperes.



For complete information, call your nearest CEC sales and service office or write for Bulletin CEC 1618 X-4.

EASY ACCESS—ENTIRE TRANSPORT ASSEMBLY SWINGS OPEN ON STUROY HINGES FOR FULL ACCESS TO ALL COMPONENTS. SPECIALLY DESIGNED REEL MOTORS WITHSTAND INTERNAL TEMPERATURES TO 250°C.

DataTape Division, CEC

CONSOLIDATED ELECTRODYNAMICS 300 n. sierra madre villa, pasadena, california

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

Executive Editor .....CLARKE NEW
Managing Editor ....DONALD E. PE

EDITORIAL STAFF
News Editor .....REED B
Military & Defense .....BETTY OS
JAMES
Electronics/Support Equipment ..HAL GET
Electronics Engineering ....CHARLES D. LA
Missile Manufacturing .....WILLIAM E. HO
Missile Business .....ERICA M.
NASA .....PAUL M
Los Angeles .....FRED HU
RICHARD VAN C
FRANK MCC

London .....G. V. E. THOM
Paris .....JEAN-MARIE F
Geneva .....ANTHONY VA
Art Director .....WILLIAM M
Ass't Art Director .....BACIL G

CONTRIBUTORS
Propulsion Engineering .....MICHAEL LOR
Industry .....JAMES J. HAGGERTY
Soviet Affairs .....DR. ALBERT P
Space Medicine .....DR. HUBERTUS STRUG
Astrophysics .....DR. I. M. L
Research .....HEYWARD CANNE

ADVISORY BOARD
DR. WERNHER VON BRAUN ROBERT P. HAV
DR. PETER CASTRUCCIO DR. ARTHUR KANTR
KRAFFT EHRICKE DR. EUGEN SA
R. F. GOMPERTZ ALEXANDER S

BUSINESS STAFF
Assistant Publisher .....E. D. MUH
Advertising Sales Manager .....W. E. B
Circulation Director .....L. L. BRE
Promotion Manager .....J. E. MC
Advtg. Service Manager ..MRS. GLADYS BU
Production Manager .....J. F. W
Ass't Production Mgr. .....ELSIE
New York .....17 East 48 S
Eastern Advtg. Mgr. .....P. B. K
P. N. AND
A. B. SCH
Detroit .....201 Stephenson
K. J. V
Chicago .....139 N. Cla
G. E. Y
Los Angeles .....8929 Wilshire
J. W.
C. R. MAR
Miami .....208 Almeria Av
R. D.
Toronto .....12 Richmond
ALLIN ASSO
London .....28 Bruto
NORALL &
Paris .....11 Rue Cond
Geneva .....10 Rue G

Missiles and Rockets Volume 5 Number

Published each Monday by American Avi
Publications, Inc., 1001 Vermont Ave.,
Washington 5, D.C.

WAYNE W. PARRISH .....*President & Pub*
LEONARD A. EISERER ...*Executive Vice Pres*
& General Ma
A. H. STACKPOLE .....*Vice Pres*
FRED HUNTER .....*Vice Pres*
ERIC BRAMLEY .....*Vice Pres*
ROBERT R. PARRISH .....*Vice Pres*

Printed at the Telegraph Press, Harrisburg
Second class postage paid at Washington,
and at additional mailing offices. Copy
1959, American Aviation Publications, In

Subscription rates: U.S., Canada and Po
Union Nations—1 year, $8.00; 2 years, $12
3 years, $14.00. Foreign—1 year, $10.00
years, $18.00; 3 years, $26.00. Single c
rate—$.75. Subscriptions are solicited
from persons with identifiable commer
or professional interests in missiles
rockets. Subscription orders and change
address should be referred to Circulat
Fulfillment Mgr., M/R, 1001 Vermont A
Washington 5, D.C. Please allow 4 we
for change to become effective and enc
recent address label if possible.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

JUNE 15 HEADLINES

Air Force Begins Historic Missile Support Catalogue
"Technical Information File" coming off presses soon is expected to save money through standardization and is seen as a possible stride toward genuine service unification 21

How to Make Weapon System Integration Work?
AF has established Project Offices with broad authority for overall management of the much-criticized systems 24

A New Line of Sounding Rockets
Aerojet claims *Astrobee 200* and *500* series give better performance at lower cost than the *Aerobees* 25

ASTRONAUTICS ENGINEERING

AF Seeks Answers to Detonation Phenomenon
Research could lead to greater reliability, more efficient combustion and clear a roadblock to "scaling up" rockets 23

MISSILE SUPPORT

Special Foods Being Developed for Astronauts
Industry is footing most of the bill for research on a variety of items which could sell themselves at the supermarket 28

MISSILE ELECTRONICS

Ampex Turns Out Smaller Lighter Magnetic Tape Recorder
Fully transistorized AR-200 is seen as possible forerunner of future missile-borne tape devices 35

Positive Identification of Inner Van Allen Belt 39

Highlights of AFCEA's Washington Convention 40

THE MISSILE WEEK

Washington Countdown 15

Industry Countdown 19

More About the Missile Week 32

NEW MISSILE PRODUCTS

Electrostrictive Discs Used in Voltage Meter
Mullenbach prototype models are less than ¾" wide 51

DEPARTMENTS

Editorial 9
People 42
West Coast Industry 44
When and Where 58
Propulsion Engineering ... 46
Reviews 49
Contracts 56



COVER: Nationalist Chinese will take over a *Nike-Hercules* battalion on Taiwan (See p. 22)

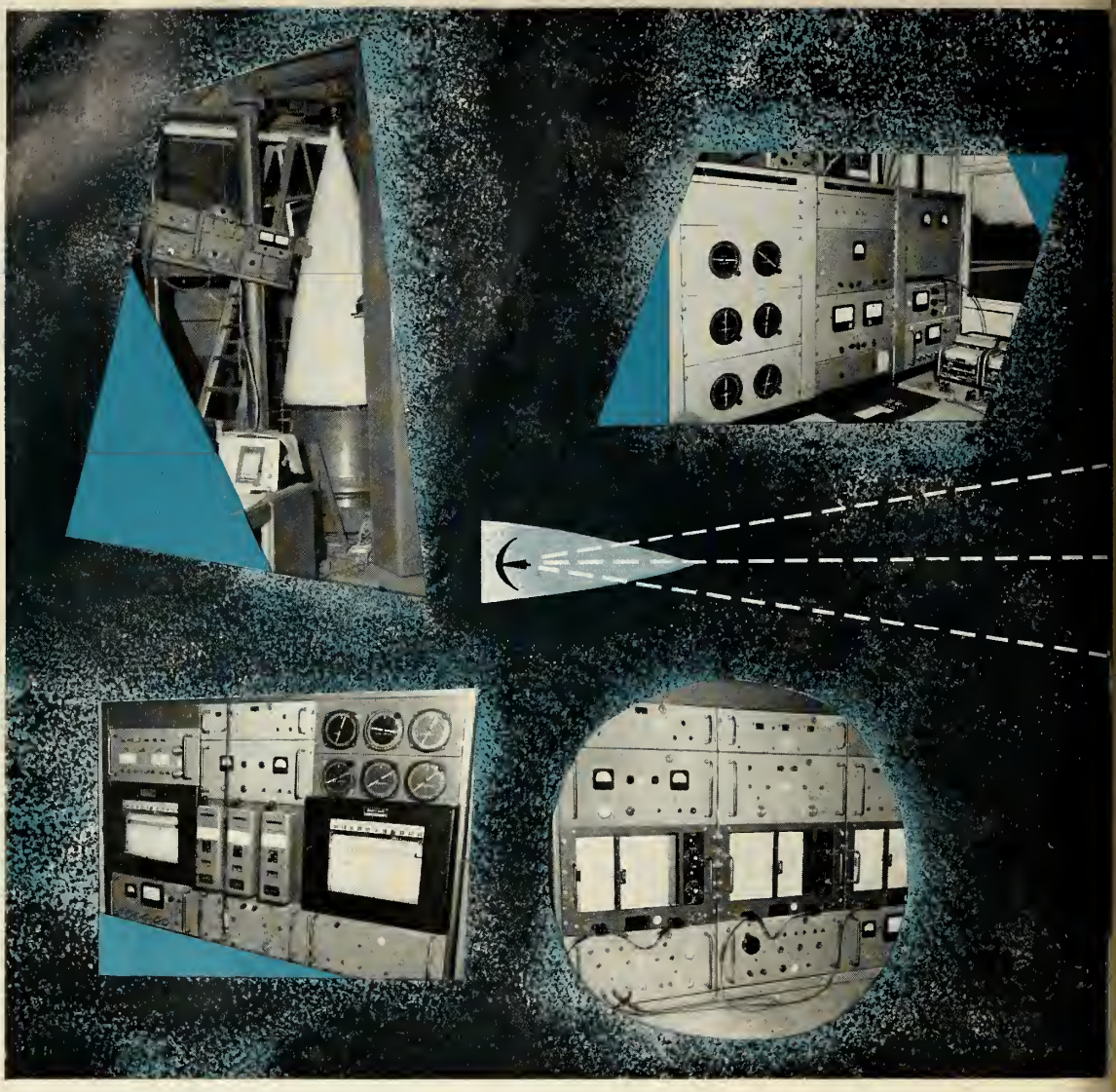
ATLAS GETS A LIFT







ATLAS ERECTOR-LAUNCHER slated for use at operational bases is shown in recent successful test by Convair at San Diego. This type of mechanism will be installed at *Atlas* complexes at Warren AFB, Wyo. Missile with erector-launcher will be enclosed in a concrete building. Stored in horizontal position, missile is quickly raised by a 75-hp motor. After it is erect, the nose cone clamp opens and the boom swings out of the way. Westinghouse produced controls.



BORESIGHT ACCURACY TO 1/15 MILLIRADIAN? SEE BRUNSWICK

Brunswick-built radomes are setting new highs not only for strength-to-weight ratios, but accuracy as well. The reasons for the accuracy are simple: Brunswick has the test facilities and know-how that are without peer in the industry. Three radome ranges which automatically detect boresight error to an accuracy of 1/12 to 1/15 milliradian are now in full operation at Brunswick.

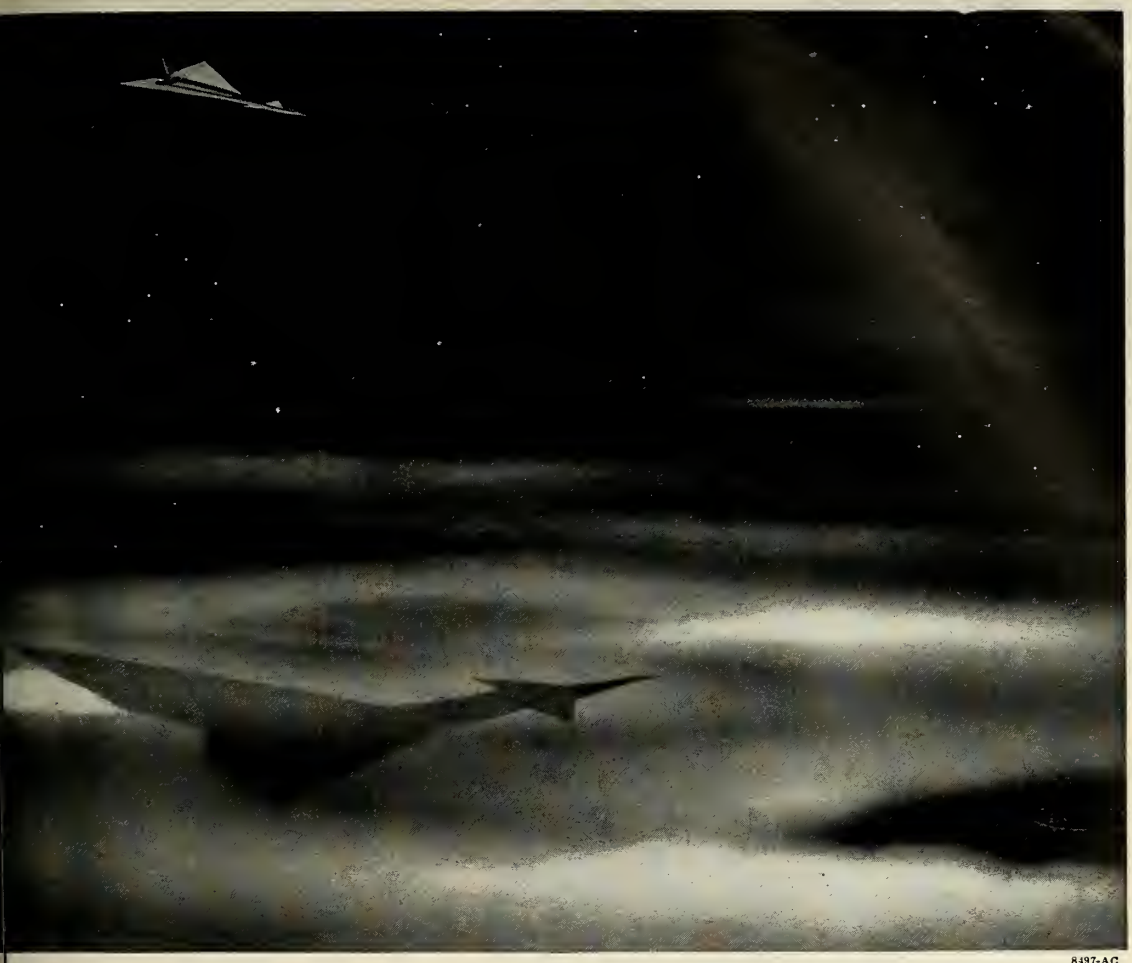
Soon to be in operation: two 1,000-foot ranges, manually operated, that will assure even more refined accuracy, detecting errors as small as 5 seconds of arc. Also, as an aid to design, quality control and maintenance of electrical tolerances, Brunswick is currently utilizing a one-horn interferometer for accurate IPD measurements and corrections before final range testing.

Behind these extensive test facilities operates an engineering team skilled in both detecting and *correcting* boresight error. To learn how this combination of facilities and engineers can give you uniquely accurate, tough and lightweight radomes, write to: Brunswick-Balke Collender Company, Defense Products Division Sales Manager, 1707 Messler St., Muskegon, Michigan

BRUNSWICK

MAKES YOUR IDEAS *WORK*

Circle No. 11 on Subscriber Service Card.



8497-AC

SPECIFICATION: AERONCA BRAZED HONEYCOMB STRUCTURES

DESTINATION: *MACH 3!*

To meet the critical demands of Mach 3 performance, new concepts in air vehicle structures have been evolved. Stainless steel honeycomb sandwiches, for example, are specified as major structural components in current weapons systems designed to operate in high mach environments.

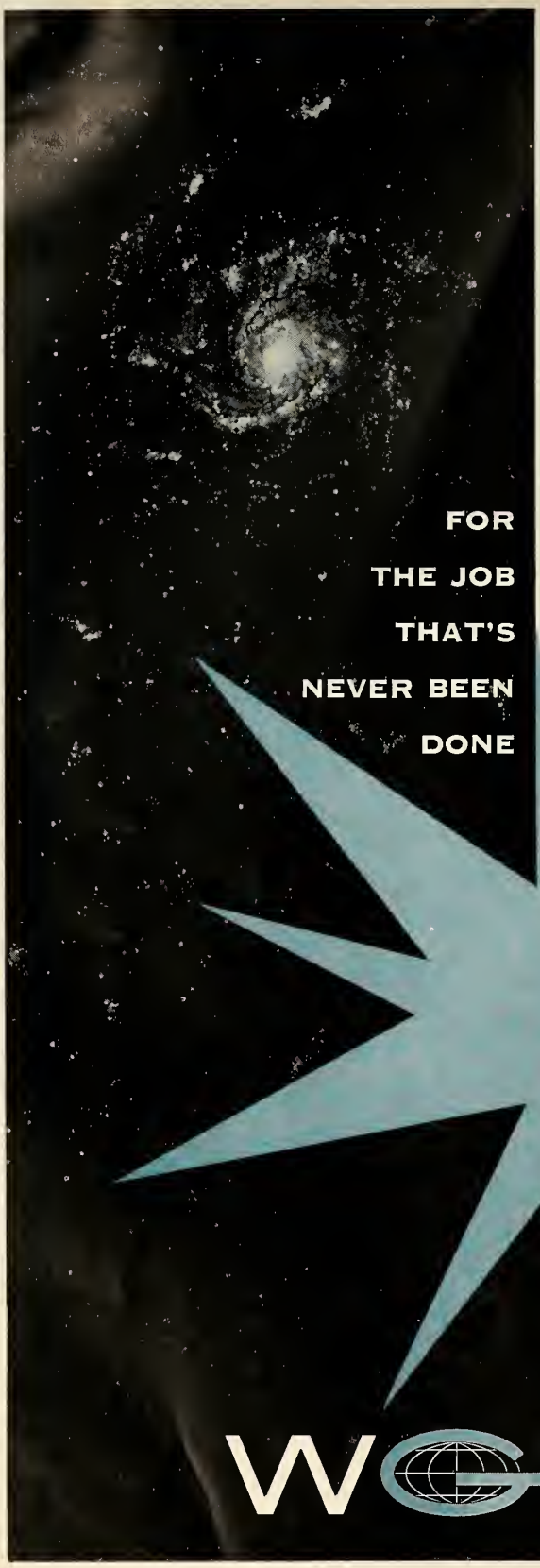
Aeronca, a pioneer in the application of stainless honeycomb to air weapons, has developed advanced production methods and facilities under a proprietary research and development program. As a result, Aeronca is one of the few companies actually producing these high-temperature structures in quantity.

Aeronca is proud that its capabilities have been selected to support the North American B-70 and F-108 Weapons Systems.

AERONCA manufacturing corporation
1716 GERMANTOWN ROAD • MIDDLETOWN, OHIO

Expansion of our operations has created openings for additional senior engineers. Write to L. C. Wolfe, Chief Engineer.

Circle No. 12 on Subscriber Service Card.



in missile propulsion systems and components, ask **WESTERN GEAR**

Western Gear Corporation's research program is carrying its Precision Products Division higher and higher into the field of missile propulsion. Western Gear laboratories are constantly probing into unexplored fields, evaluating and testing materials. Production contributions under prime and sub-contracts in the missile propulsion field include turbo pump drives, thrust chambers, nozzles, jetavators and APU drives.

But research is only the beginning. After the impossible job is resolved in theory, Western Gear throws these factors into the project: 71 years of precision manufacturing; broad experience in electro-electronic and mechanical power transmission equipment; large engineering teams in many fields; outstanding test facilities; Systems Management control and direction; and TOTAL RELIABILITY in product performance.

Are you faced with unusual reliability requirements in a missile propulsion system? Write for full information to:

WESTERN GEAR CORPORATION
Precision Products Division
P. O. Box 192 • Lynwood, Calif.

6904

Circle No. 13 on Subscriber Service Card.

The New Deputy Secretary of Defense

Early in May, when Thomas S. Gates had resigned his place as Secretary of the Navy and expected to leave public service behind him probably for all time, he sat down and wrote a farewell address. These apparently were not words put together by a speechwriter, but Gates' own thoughts and reflections after some ten years of Government service both in and out of uniform.

He wrote:

"Tonight I am going to let the chips fall. I do so in hope that I can be helpful. I do so as I reach the beachhead of so personal a D-Day."

The talk was delivered to the Navy League and as such was inevitably pointed toward the Navy viewpoint, but the convictions and philosophy of Thomas Gates as an American carry a certain reassurance in their calm tolerance and soundness. He said:

"It is not to banish hope but to achieve realism that we seek to penetrate the clouds that hang low over our country. Peace we hope for and believe in, but it will be an uneasy peace. The basic concepts of communism will not change quickly—if at all. The United States has no thought of varying from the ideals of freedom on which this nation was founded. No true partnership can be built between these directly conflicting philosophies. Temporary arrangements might be made, from time to time, in mutual self-interest, but a partnership requires more substance.

"The struggle between two great power blocs and two great religions of the spirit will stay about as it is for years. The intense effort of trying to convince and win the respect of the uncommitted rising people of many lands will go on and on in extra innings. This we must accept and learn to live with.

"The USSR will continue to probe and test our determination and our will.

"As an essential part of this forecast, we will see an indefinite requirement for strong military services, large defense spending, alert and combat-ready forces in being with which to back up our foreign policy.

"The need will continue and grow for more enlightened American leadership, foreign help to those less fortunate—a need to travel, to see, to talk the languages, to invest, experiment, to gamble and to sell."

Mr. Gates is a Navy man and believes in the Navy, but he had a word of warning which fits the three services equally:

". . . If in our preparation for the future we are influenced by self-interests; if we tend to divide internally into traditional blocs of interest; if we continue to jealously watch the other services and to resist change, it is not going to be a very good destiny.

"For example, we should not focus on differences with the other services, but rather learn from them, help them and work with them. We might even buy some of their strong convictions."

Although agreeing that the horror and destruction of a major nuclear war made such a prospect virtually unthinkable, his words conveyed the thought that we have no alternative but to accept the concept of deterrence. It was, he said, "common sense."

His thoughts on the subject of limited wars revealed his attitude toward the other side of the coin. He said:

"The cold and limited war problem is not simple, but it is vital to understand it. In a limited war situation, the Navy must maintain a capability to use either nuclear or conventional weapons to the controlled degree necessary to achieve the objective. More funds are required for this purpose. More accent on its importance is needed. This support will have to come from the elimination of certain of the very expensive mass-destruction, single-purpose weapon systems which have a priority of claims against our national resources."

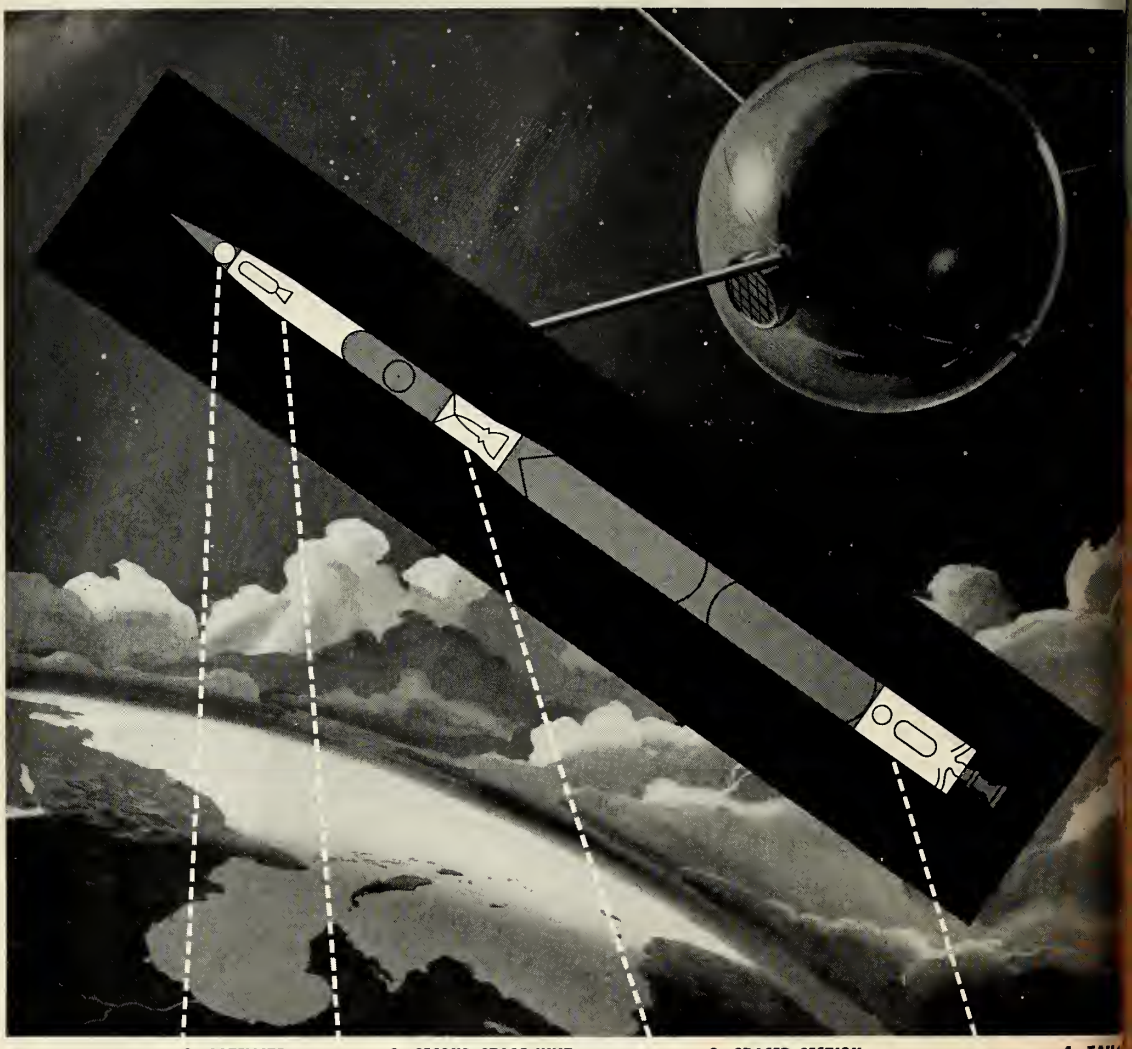
In general observation, Mr. Gates said:

"The Joint Chiefs of Staff continue to struggle with divided opinions as to the emphasis to be placed on various systems; and the Secretary of Defense continues to struggle handicapped by traditionally divided service opinions. The kind of constructive, objective teamwork that enabled us to win wars would help him. Again, good sense argues for understanding and agreement. Intelligent answers can be found within the informed minds of the best of our military and civilian officials."

There are few things there that any of the services can quarrel with, and much to give hope of wise judgment in an assignment where the lack of it can be a costly thing. If he can inspire—or create by organization—the kind of teamwork he pleads for, if he can do this alone he will have been successful.

Clarke Newlon

DOW | MAGNESIUM PRODUCTS



1. SATELLITE

The rigid external skin of the weather satellite is made of magnesium alloy, AZ31B. It is plated with gold and other materials to reflect heat.

2. SECOND-STAGE UNIT

The skin is made of HK31A, magnesium-thorium alloy sheet. This elevated temperature alloy must withstand temperatures of 700° F. and above.

3. SPACER SECTION

The skin is formed of AZ31B magnesium alloy sheet. Magnesium was selected for its light weight and high strength-to-weight ratio.

4. TAIL

Again AZ31B magnesium alloy chosen because it is the world's ligh structural metal.

LIGHTWEIGHT MAGNESIUM SPEEDS WEATHER ROCKET FOUR WAYS

The shell of the satellite and several parts of the Vanguard Rocket are made of standard magnesium-aluminum-zinc and magnesium-thorium alloys. Why was magnesium chosen for this project? Because it is the lightest commercially available metal that could be easily fabricated—one with a high strength-to-weight ratio and able to withstand elevated temperatures encountered during flight. Magnesium alloys met these demanding requirements, as pro by tests conducted by the Naval Research Laboratory Washington, D. C.

Write today for new illustrated brochure on aircraft, m siles and rockets. Contact the nearest Dow Sales Office write to THE DOW CHEMICAL COMPANY, Magnesium Produ Sales Dept., Midland, Mich., Dept. MA1302CL6-15.

THE DOW CHEMICAL COMPANY · MIDLAND, MICHIGA

Circle No. 14 on Subscriber Service Card.

A TALENT FOR WEAPONS TEST EQUIPMENT



AVAILABLE NOW FOR ANY WEAPONS SYSTEM: SCATE—Stromberg-Carlson Automatic Test Equipment

- Completely solid state; modular.
- Punched Mylar tape with photoelectric reader programs tests at rates up to 7,000 bits per second.
- Tests any weapons system, component or sub-assembly.
- Follows weapons system from prototype to operational status.
- Self-checking; self-calibrating.
- Detailed fault location down to the smallest resistor.
- Provides rapid HI-GO-LO and numerical evaluation as well as permanent printed record.
- Reduces cost and time of designing test equipment for each individual requirement . . . because most modules are standard.
- In a typical case, SCATE has reduced a 12-hour manual testing program to less than 5 minutes—a reduction of over 99%.

Today's SCATE system—currently in production for an advanced weapons system—is equally applicable to those of tomorrow.

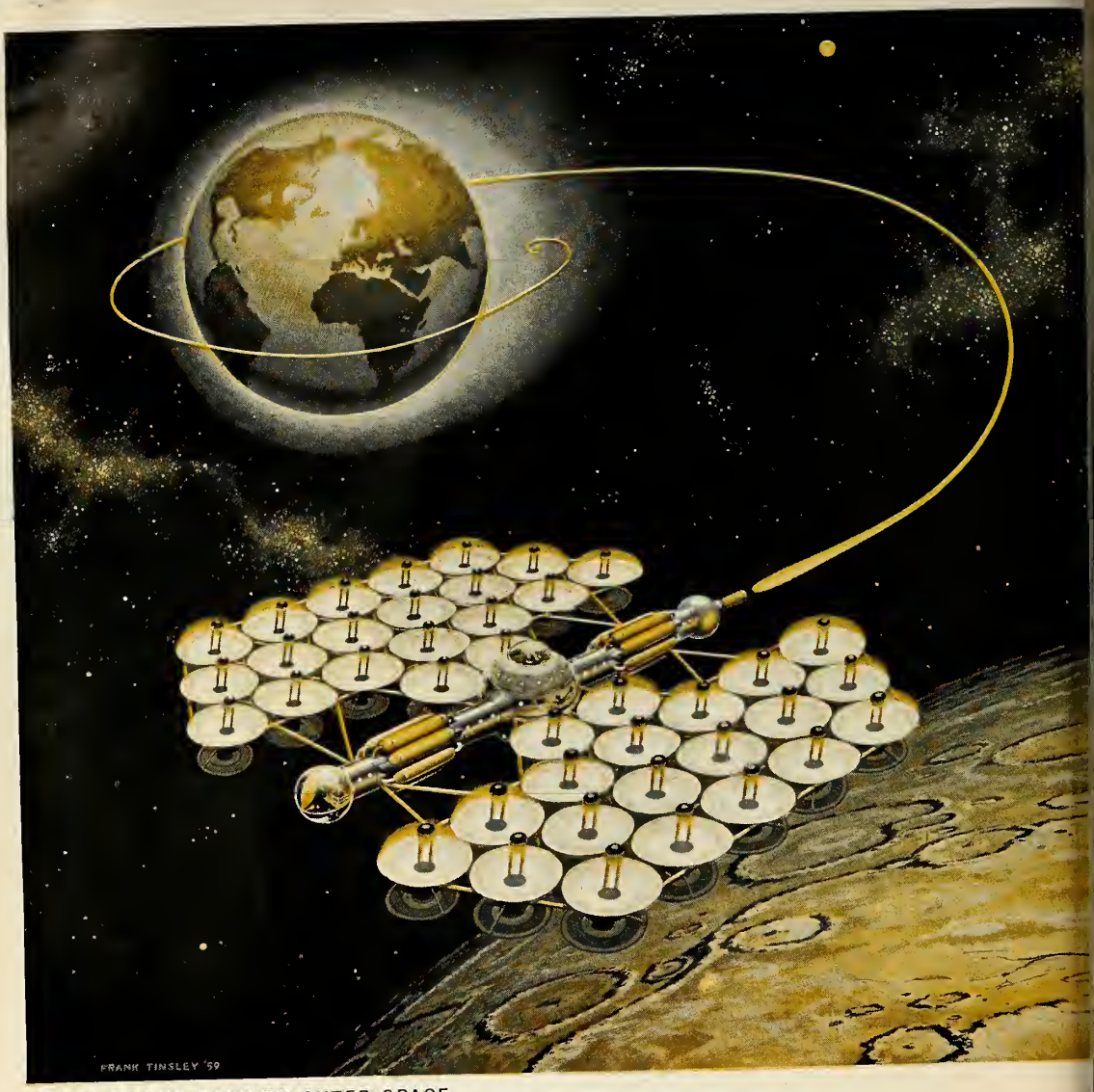
H. C. Sager, Manager of Sales, is available to discuss your specific application. Literature on request.

Engineers with experience in the above area may contact the Manager of Technical Personnel at the address below.

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION
1400 NORTH GOODMAN STREET • ROCHESTER 3, N. Y.
ELECTRONICS AND COMMUNICATION FOR HOME, INDUSTRY AND DEFENSE

Circle No. 1 on Subscriber Service Card.



STEPS IN THE RACE TO OUTER SPACE

Cosmic Butterfly

Spreading its wings to absorb the eternal flow of solar energy is the Cosmic Butterfly, a space vehicle of a type first conceived by Dr. Ernst Stuhlinger of Redstone Arsenal.

Each of the fifty-foot parabolic mirrors in the wings concentrates the Sun's rays on a boiler at its focal point. Steam is developed, which drives a 200-kw turbo-generator in the base. Cooled by frigid outer space in heat diffusers, the steam reverts to water and is pumped back to the boiler to be used over and over again.

The current thus generated drives the main propulsion unit, an ion rocket in which powerful electric fields accelerate charged particles, shooting them from the rear of the rocket exactly as the electron gun in your TV set bombards the screen. Sunlight, then, is the power source, whereas cesium is the propellant.

While the recoil thrust is relatively small, the weightless vehicle is operating in a vacuum and the push is enough to enable the Butterfly to reach interplanetary speeds. Unlike conventional rockets, the Butterfly is under power the entire trip. Half way to its destination it turns around, and the ion thrust is used to slow the craft down to arrival speeds.

Since its thrust is entirely inadequate to cope with the gravity of major planets, the Cosmic Butterfly never lands. It is assembled in space and shuttles betw artificial satellites.

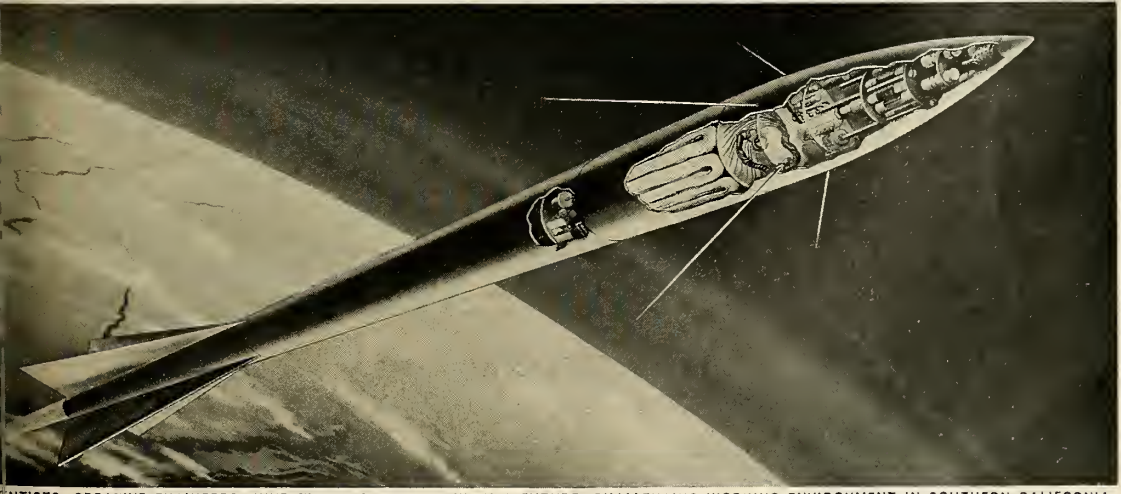
The Cosmic Butterfly could carry passengers and 50 tons of cargo an Earth satellite to a comparable orbiting around Mars in about one of continuous travel.

Inertial navigation systems will pla increasing role in the exploration of space. ***ARMA***, now providing such tems for the Air Force ATLAS ICBM be in the vanguard of the race to space. ***ARMA*** . . . Garden City, A Division of American Bosch Arma

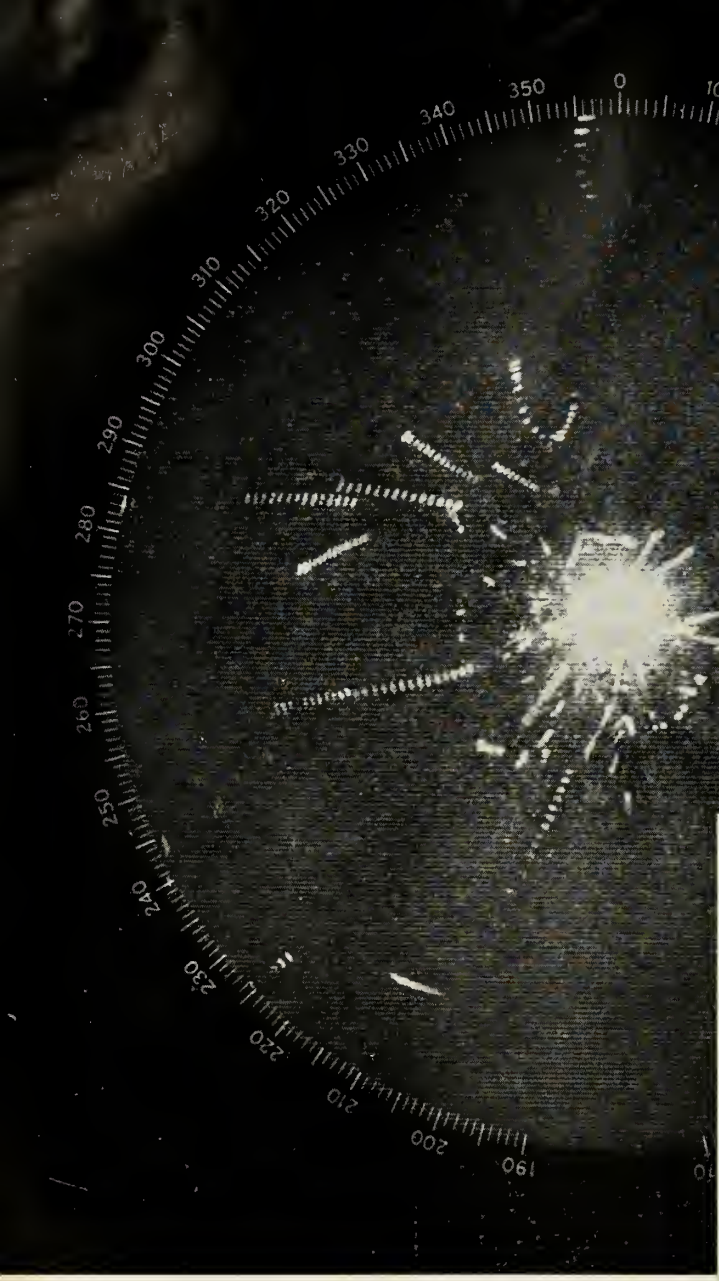
AMERICAN BOSCH ARMA CORPORATI

missiles and rockets, June 15,

The simple, low-cost way to gather weather data above 100,000 feet...proved rocketry service by CDC. CDC proved rocketry extends your meteorological study range beyond balloon altitudes, yet simplifies every task from wind sounding to density measurement. Well within the scope of even a small budget, CDC rocket service does the whole job for you—from rocket instrumentation and launching to tabulation of data. Our specialists have an unviable record of success for the Armed Forces and leading scientific institutions in wind sounding, weather investigation systems, and air measurement techniques. May we help you? Cooper Development Corporation
2626 South Peck Road, Monrovia, California
BSIDIARY OF MARQUARDT CORPORATION
GET THE FULL STORY IN OUR BROCHURE—YOURS ON REQUEST



NTISTS, CREATIVE ENGINEERS—INVESTIGATE THIS FIELD WITH A FUTURE. CHALLENGING WORKING ENVIRONMENT IN SOUTHERN CALIFORNIA.



BRIGHT DISPLAY

...WITH A MEMORY

Raytheon's two-gun memory tube makes possible MEMRAD,* a new approach to radar data display. In addition to its other capabilities, MEMRAD adds a new dimension in improving the detectability of targets by making possible the correlation of scan-to-scan data.

The PPI display is a continuous bright picture presentation, eliminating the conventional bursts of information. The system permits viewing with normal room illumination at any number of locations on standard TV-type monitors. Manual plotting is eliminated entirely. Furthermore, recognition and comprehension of target trails are made possible by presenting the recent history of target position. MEMRAD allows an immediate assessment of target velocity and maneuver, permitting discrimination between jet and conventional aircraft.

Raytheon Trademark

PROFESSIONAL ASSOCIATION WITH A FUTURE

Raytheon has excellent openings for qualified engineers and physical scientists with BS or advanced degrees interested in systems, development, design or manufacturing engineering of complex electronic equipments. Please write Donald H. Sweet, Government Equipment Division, Raytheon Company, 624 Worcester Road, Framingham, Massachusetts.

RAYTHEON

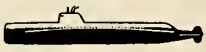
Excellence in Electronics

Engineering Laboratories: *Wayland, Maynard, Sudbury, Mass.; Santa Barbara, Calif.*
Manufacturing Facilities: *North Dighton, Waltham, Mass.*

GOVERNMENT EQUIPMENT DIVISION



LAND



SEA



AEROSPACE

washington countdown

IN THE PENTAGON

The Administration still withheld announcement of its so-called "master plan" for missile air defense as M/R went to press. However, all signs pointed to a new compromise between the Air Force and the Army with both the **Boeing** *Bomarc* and **Western Electric** *Nike-Hercules* programs cut back somewhat, *Nike* probably getting the worst of it. Inter-service fighting over the basic issue of anti-air defense is expected to continue regardless.

A new interservice hassle . . .
may be in the offing over ARPA's Project *Transit*—development of a navigation satellite. The Navy has been handling much of the work, under overall ARPA management. But now that development is reaching advanced stages the question is which service is going to be given the system.

• • •

The Army is expected . . .
to pump the bulk of the extra $200 million voted it by the House into a production program for **Western Electric's** *Nike-Zeus*. That is, if the Senate goes along with the increase. The Army expects to be able to fire the 450,000-pound-thrust solid missile in 1960.

• • •

Move to establish . . .
a Strategic Command encompassing both Navy and USAF forces will probably live or die on the point of organization. Proposed now is a vertical Navy command, a vertical Air Force command for the strategic forces of each, with a unified commander over both. To say Navy is reluctant is putting it mildly, but it might agree if guaranteed certain command lines.

• • •

Maj. Gen. Charles M. (Sandy) McCorkle . . .
will leave the Pentagon early in July to assume command of the Air Force Special Weapons Center at Kirtland AFB, Albuquerque. His successor as assistant chief of staff for guided missiles will be Brig. Gen. Robert E. Greer, present deputy.

Both the Convair *Atlas* . . .
and the **Martin** *Titan* are all but certain to be used as second stages for *Saturn*—the clustered 1.5-million-pound-thrust engine being developed by the Army and **Rocketdyne.** *Atlas* will be used at first, *Titan* later.

• • •

***Discoverer IV* scheduled . . .**
for late this month or early July will not carry mice as did the ill-fated *Discoverer III*. However, if all goes well there will be another attempt to recover the satellite's biomedical capsule. The main purpose of the launching will be to check out all of the *Discoverer*'s equipment before making another attempt to recover an animal from orbit.

ON CAPITOL HILL

The Pentagon . . .
may be about to give a green light after all to speeding up development of the nuclear-powered plane—strategic companion of the ALBM. The Pentagon is scheduled to give the Administration's decision to the Joint Congressional Atomic Research Subcommittee this month. And congressional sources say chances are good for a go-ahead.

• • •

Candidate for star-studded . . .
congressional investigation of the year: The House Armed Services Investigating Subcommittee's forthcoming inquiry into the hiring of retired military and government officials by defense contractors. It's expected to begin about July 1. And it could result in a headline-hunt for alleged "collusion"—enlivening many a front page while Congress is in recess.

AROUND TOWN

Some of the reports . . .
that are being passed as the "latest" in the nation's capital:

. . . The Air Force is thinking of developing a rocket-ground effect train for transporting missile cars swiftly.

. . . If the cold war gets hotter, both Republicans and Democrats will vie with each other to become the "Big Defense" party during the 1960 election year.

. . . The Senate Space Subcommittee headed by Sen. Stuart Symington (D-Mo.) will recommend major shakeups in the organization of the nation's space agencies.



Bloodhounds ready for launching during acceptance trials at Woomera

EFFECTIVE

More advanced Bloodhound for defence of UK confirms particular suitability for European defence needs

Already in operational service with the RAF and adopted by non-NATO Sweden, Bloodhound Guided Weapon System is now to be further developed for the RAF.

This developed Bloodhound possesses substantially increased operating range and altitude, with advanced technique ensuring still greater lethality at these increased ranges and heights. Low altitude performance is further improved to counteract the threat of low-flying targets.

Development, rather than replacement, of Bloodhound offers the obvious economic and operational a inherent in making use of an existing system.

Proved in many hundreds of test firings; Europe's largest missile-manufacturing com particularly suited to European defence need Ferranti Bloodhound forms *the world's most e fence system now and for many years to come.*

Security forbids publication of full details following facts about Bloodhound can now be g

WEAPON DESIGN AND CONSTRUCTION BY BRISTOL · GUIDANCE AND CONTROL BY



CROWN COPYRIGHT RESERVED

DEFENCE

The Bloodhound is powered by two Bristol amjets—jet engines with no moving parts. nsure power and range flexibility, burn kero- mple and safe to handle.

System. Semi-active: i.e., ground crew directs a on to target, which is reflected to a receiver in d, ensures highest accuracy—regardless of siles may be fired, singly or in salvoes, using dar.

. Employs unique and advanced monoplane ng configuration—two advantages: quicker recise response, as well as greater accuracy of interception; superior at high altitudes. This configuration was selected at initial design stage to embody maximum development potential.

BRISTOL/FERRANTI
Bloodhound
GUIDED WEAPON SYSTEM

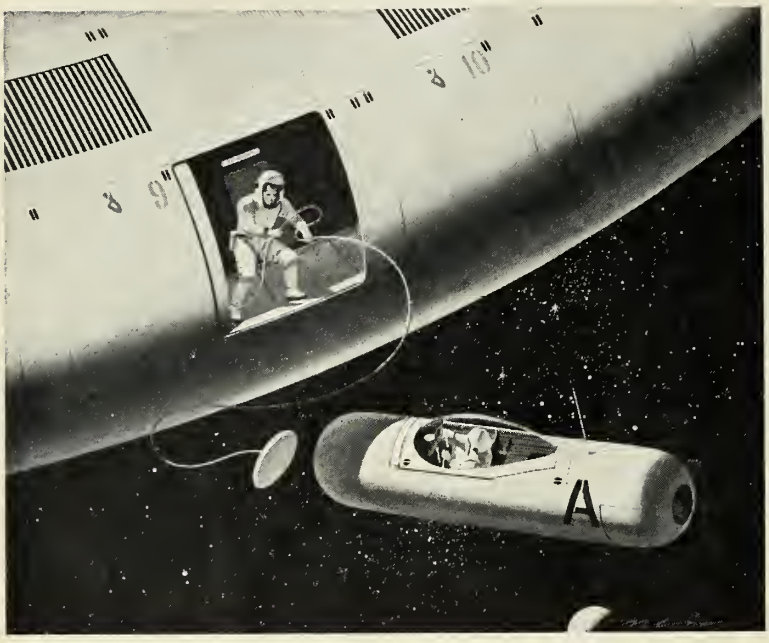
BRISTOL AEROPLANE CO (USA) INC
400 PARK AVENUE, NEW YORK 22, NY

UMINATING RADAR BY BTH · SYSTEM SALES ORGANISATION BY BRISTOL AIRCRAFT LIMITED

Circle No. 15 on Subscriber Service Card.

COUNT DOWN!

for the conquest of space



WHAT KIND OF ENGINE FOR A SPACE-JEEP?

It takes a unique engine to jockey a space-jeep in for a landing on an orbiting space station—one that will give a space pilot instant control and precise maneuverability.

Such an engine is the fully controllable rocket engine—ideal for space travel yet as easy to operate as an automobile engine.

The rocket engines are ready now

Although the space-jeep is still a gleam in an engineer's eye, the controllable rocket engine is available now...and has immediate application for existing aircraft. The pilot of a plane with auxiliary rocket power can switch it on for sudden, swift acceleration at high altitudes . . . the aircraft's air-breathing turbojets supplying power for ordinary flight operations. This is the mixed-power theory. Since World War II several mixed-power concepts have been developed in foreign countries, including Russia, France and England.

Extra power for today's aircraft

Rocketdyne already has designed, tested, and manufactured rocket engines for mixed power applications. The AR-1 rocket engine is a liquid-propellant system, as are the large power plants for the Atlas, Thor, Jupiter, and Redstone ballistic missiles. The AR-1 passed stringent flight tests as a supplementary power plant on modern jet aircraft. Substantial improvements over normal near-sonic speed and 50,000-foot altitude capabilities were demonstrated in more than 100 test flights.

The AR-2, second in a series of four rocket-engine models developed by Rocketdyne, is a fully-throttleable engine that provides varied thrust. Using fuel from the airplane's t[a]nk—which automatically ignites [w]ith hydrogen peroxide—these eng[ines] have full stop and restart capabi[lity].

More value for taxpayers' mone[y]

The auxiliary rocket engine [gives] present aircraft superperform[ance] capabilities at a relatively low co[st] provides the increased speed and [ma]neuverability that could spell the [dif]ference between the success or fa[ilure] of an intercept mission. Almost [any] existing jet aircraft, as well as [those] now on the drawing board, ca[n be] adapted readily for AR engines.

Looking forward to tomorrow

Beyond a doubt, rocket power [will] leading role in the Free W[orld]'s future. Rocket-propelled airpl[anes] such as the X-15, will pave the [way] for man's entry into Outer S[pace]. The multi-million-pound-thrus[t sys]tems that are now under develop[ment] at Rocketdyne will be man's r[ocket] to explore interplanetary Space. [In the] meanwhile, these rapid advanc[es in] rocketry can add great streng[th to] America's present deterrent ar[senal].



THE MEASURE OF ROCKET PO[WER]

The liquid-propellant AR[-1] engines are "static test" Rocketdyne's field labora[tories] measure thrust and perfo[rmance]

FIRST WITH POWER FOR OUTER SPACE

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

Circle No. 16 on Subscriber Service Card.

industry countdown

STRUCTURES

Preoccupation with the *Bomarc-Nike-Hercules* scrap has held up a decision on the *Dyna-Soar*. But most insiders think that since both **Boeing** and **Martin** had many good points in their separate proposals for the boost-glide bomber, the contract is unlikely to go to either company exclusively. They will most likely get the contract as a team, with one being named prime agent.

Announcement is due shortly . . .
that lucrative arming and fusing contract for *Polaris* will go to **Crosley Division,** Avco Mfg. Crosley, which does *Titan* fuzing, will get the contract from the Naval Ordnance Laboratory.

• • •

Vehicle test programs . . .
of **Lockheed-Convair, Martin** and **McDonnell** ALBM concepts are continuing under AF contracts—with results going to **Douglas** which has development contract. Over Cape Canaveral last week, Martin successfully fired its two-stage solid-fueled *Bold Orion* concept. It traveled more than 1000 miles.

PROPULSION

There are indications . . .
that NASA may undertake another parallel development program in multi-meg liquid boosters with contract ball possibly being passed to **General Electric.** GE has plugged nozzle concept which is creating a good deal of interest and speculation; has put about $1 million of its own money into the concept—designed to eliminate heavy and complex metallurgy such as thrust vectors, jetavators, gas bleeds, verniers, etc. Material for cone-shaped plug and fabrication techniques are closely guarded proprietary information, and there are patent rights to be settled. GE isn't talking except to opinionize that conventional design for large-meg boosters will be too costly and will run into too many combustion and stabilizing problems.

• • •

The cheaper fuels . . .
probably will have to be used in million-pound thrust boosters. Just multiply costs per pound of propellant at flow rate of 6000 pounds per second at 1.5 meg and you come up with astronomical fuel charges.

ELECTRONICS

Some market analysts . . .
are predicting silicon transistor sales to upswing sharply from estimated 47.1 million units in 1958 to 69.6 million in 1962. Switching performance reportedly is the best feature of silicon in missile and computer applications, with low reverse current an important factor.

• • •

With many problems . . .
still unsolved in visual search and recovery of space vehicles, look for stepped-up action in the next few months in connection with Project *Mercury*. While water landings are still planned, new techniques for sighting capsules are under investigation for mountainous terrain, wooded and snowy areas.

• • •

High altitude recovery . . .
of 15,000-pound *Atlas* used as *Mercury* booster is programmed before end of this year. Method is being developed by **Space Recovery Systems Inc., CBS Laboratories** subsidiary, utilizing "marriage" of electronics and aeronautics to trigger parachute and return equipment to pre-determined area.

• • •

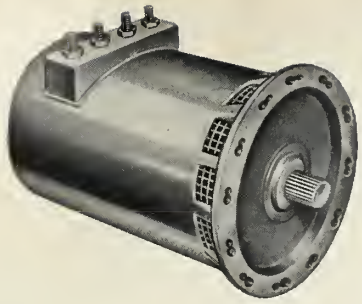
Booster recovery . . .
would save millions of dollars worth of hardware which could be used over again. But some industry skeptics believe development of reliable recovery system will cost more than boosters—particularly if they can be made cheaper in mass production.

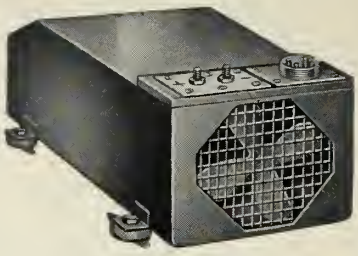
ASTROPHYSICS

"Moon-chips" . . .
is name given to stone meteorites by Dr. Harold C. Urey, University of California, who theorizes they may come from collisions between meteors and face of the moon. Chemical composition of "chips" is unlike anything found on earth. Measurement of their cosmic radiation exposure content indicates age of 2 million to 90 million years, which Urey believes would put origin near earth's orbit. Iron meteorites on other hand have exposure time of 100 million to 1.5 billion years, suggesting they may have originated between the orbits of Mars and Jupiter.

SPACE MEDICINE

Required reading . . .
for astronauts: *Human Tolerance to Prolonged Forward and Backward Acceleration.* Report on g effects found in tests on WADC human centrifuge is available through OTS, U.S. Department of Commerce.





WEIGH THEM...PRICE THEM...MEASURE THEM.. THEN COMPARE THEM WITH LELAND AIRBORNE'S NEW DUAL-WOUND AC-DC GENERATOR...



A single unit delivering Controlled AC and DC!

Normally, a 20 KVA AC generator at 8000 RPM weighs 42 to 44 lbs. including regulator...a 200-ampere unregulated transformer rectifier weighs 20 to 28 pounds, with a maximum total weight of 72 lbs. Leland's integral, dual-wound AC-DC generator, for the same application, weighs only *53 lbs. and eliminates the extra space, weight and cooling requirements required for the transformer rectifier.*

Directly connect your DC load to LELAND AIRBORNE'S new AC-DC generator ...less weight, less space, less cost.

AMF LELAND AIRBORNE PRODUCTS

LELAND AIRBORNE PRODUCTS

Division of AMERICAN MACHINE & FOUNDRY COMPANY

MAIN OFFICE & PLANT—VANDALIA, OHIO
West Coast Office—7046 Hollywood Blvd., Los Angeles 28, Calif.

Circle No. 17 on Subscriber Service Card.

NE 15, 1959—VOL. 5, NO. 25

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AF Cataloguing Support Items

Massive volume due July 1 should save millions in wasteful development of redundant equipment and should standardize handling and checkout gear

by William E. Howard

Sixth of a Series on Missile Support

WASHINGTON—Within a few weeks Air Force—with industry's help—start closing the missile support formation Gap."

Coming off the presses about July 1 the first 500 pages of what eventu- will be an encyclopedic catalogue ng missile/aircraft support equip- it purchased or under development the Air Force. It will be called the port equipment "Technical Informa- File."

As the first inventory of the vast port field, TIF appears destined hape the industry's future for years ome. Pentagon procurement policy ers already are counting on it to me the key instrument in:

- Saving millions of dollars by inating wasteful development of ndant equipment and continued urement of obsolete equipment.
- Standardizing ground handling checkout devices at a further sav- in more efficient procurement and ing of maintenance personnel.
- Bringing about development of lti-purpose" support items—capable erving more than one missile, or aps both a missile and its carrier ane.

Moreover, the Air Force TIF is the runner of a Defense Department e to standardize missile/aircraft ort equipment development and urement throughout the armed es, M/R has been told. A study ect (MISC0001) headed by the Air e is trying to establish a system an Army-Navy-Air Force TIF.

he study group already has reached rvice agreement on a format for sheets to describe equipment. It nilar to the Air Force TIF format. the knottier problems of organiz- ing a catalogue so that it can be used as a common purchasing and design reference by all three branches of the military remain to be resolved.

• Unification step?—Success of this project might in itself be a giant step toward bringing about practical realization of the old, much-talked-about, long-pigeonholed dream of unifying the services.

The Air Force TIF is a half-step, at least, in this direction. The DOD is making its use mandatory by Army and Navy procurement officers and contractors.

Differences in weapon systems and sheer magnitude of their ever-multiplying back-up requirements make even the compilation of a one-service technical information file an enormous task. Following up the first 500 AF TIF data sheets will be 23,000 more in a month or two. Listings eventually will reach the hundreds of thousands.

The TIF is being put together by the Air Force Directorate of Supply in the Air Materiel Command at Wright-Patterson AFB. Heading up the job is Martin Connelly, chief of standardization in the Office of Cataloguing and Standardization.

The spawning of whole new families of support equipment during the past few years to service new missiles, says a high Pentagon official, "has created a horrendous problem in training maintenance personnel. Even the checkout equipment has to be checked out.

"It's like fleas having fleas."

TIF will be mostly unclassified. The catalogue will be loose-leafed, so that pages may be removed and new ones inserted as equipment becomes outmoded or there are other changes.

Distribution presently is planned to all prime weapon system and support contractors and military procurement officers. Additional copies will be available at local Air Force procurement districts. An initial press run of around 2600 copies is planned.

But Lt. Col. Oscar B. O'Neill, who headed the industry-Air Force task group which created TIF, concedes that demand very likely will dry up the supply in a twinkling. "This is going to become the Sears & Roebuck catalogue of the missile business," he says with a smile.

O'Neill is chief of the support equipment division, Logistic Support Office, Aeronautical Systems Center, at Wright-Patterson. As chairman of the industry-Air Force group, he supervised the overall development of TIF.

Contributing from industry were representatives of Aerospace Industries Association, Electronic Industries Association, the Society of Automotive Engineers and the National Security Industries Association.

To obtain complete Air Force representation, members were seated on the group from USAF Headquarters, from every AF directorate, the AMC, every air materiel area and depot, all commands such as SAC and TAC and from overseas units.

Field technical requirements came from 16 Air Force Equipment Advisory Groups, comparable to Weapon System Phasing Groups, which are charged with maintaining a continuity of experience in support equipment.

Support equipment catalogue . . .

EAG's were formed also to help promote more "commonality" among ground systems.

Today, an effort is being made to put together in the Air Staff an equivalent group—perhaps informal—to keep going where O'Neill's TIF group leaves off. This would be a support equipment "management panel" to act as a watchdog, keeping a cross-system check with TIF as the guidebook.

"For the first time," says an Air Force official, "we are going to be able to comprehend the size of the support effort." Missile support alone is estimated at more than $3 billion a year. But until TIF no effort had been made officially to compile a complete support equipment inventory between two covers.

• **Designers' quandry**—For some time Air Force regulations have enjoined weapon system contractors to recommend and design into a missile equipment that is currently in use—either "as is" or with modifications. If this is not available, they are to utilize off-the-shelf commercial equipment currently in the Air Force supply system, or other off-the-shelf commercial equipment. Only as a last resort are they supposed to design a piece of equipment from scratch.

The big problem for designers, however, has been in learning what is available, or is likely to be available when they need it, and if it will meet the specs of their system. In some cases, industry officials say, acquiring this information would have entailed major research. So it was faster to design what was needed rather than waste time hunting for a piece of equipment which might not exist.

"Everybody realizes that this produced an awful lot of redundant equipment that was wasteful," comments a member of AIA. "But what were you to do when a weapon was wanted in a hurry?"

TIF will eliminate this information gap. Henceforth, designers will only have to flick through its pages to know what can be turned to their use. This includes equipment which is still in the development stage, but which has progressed far enough to be described on a data sheet.

On the other side of the coin, military procurement officials will have in TIF a handy reference to police contracts. They can tell whether a contractor is following the requirement to utilize equipment that is procurable, or is proceeding willy-nilly to develop it over again.

• **Data sheet format**—Listings will be only of equipment that has procureable status. This means that a manufacturer will have his piece of equipment entered in TIF only if it is in use or on order by the Air Force. The item won't be included otherwise—even if it is identical down to the angstrom with a competitor's item that has status.

Since data sheets will give the name of the manufacturer, some DOD authorities believe the advent of TIF will provoke some "real wild" competition. The low bidder gets in the catalogue, and thus will have an advertising "track" for his item to be designed into future weapons.

Specifications for data sheet preparation by companies, as detailed in MIL-D-19731A, call for sufficient precise data to familiarize maintenance and engineering personnel and government contractors with the "characteristics and physical make-up of the equipment used in support of aircraft and missile systems."

For contractors, they are "intended to provide sufficient information for determination that an item of equipment is suitable or unsuitable for a contemplated application, usually without recourse to supplemental detailed data." However, the data sheets require the reporting of where detailed information is available. This can be requisitioned if the information needed for possible modification of item.

In addition to an illustration of t item, the data sheet also will provi a brief functional description, applic tion and what it is used with. Its re tion to similar equipment also is giv along with a technical description.

This latter description, in tabu form, gives the frequency range, pow output and/or input—including amp age, KVA, number of wires, pha type of receptacle or plug—other p tinent electrical and mechanical ch acteristics, dimensions etc.

Once the TIF compendium is co plete, Air Force officials believe th will be able to proceed to "optimiz standardization of such items as liq fuel generators, fuel transport, stor and service equipment, and other h dling items required by missiles. Th hope to come up with automatic che out equipment for air-to-air and to-surface missiles that is compati with and capable of checking out s tems of launching plane or other m siles.

And, important to suppliers, che out equipment also would be standa ized in Air Force bases and depots that if the mission of a base is chan equipment may be transferred to other base and not junked.

An Air Force official was aske TIF and the mounting push tow missile support standardization m tend to "freeze" some weapon syst and hamper future development others.

"That might be so," was the re "But, on the other hand, where do stop on gold plate? By knowing wh we stand, with the Technical Infor tion File, we will have a better cha of striking a balance of optimum formance with optimum economy."

About the Cover

The *Nike-Hercules*—the Army's entry in its rivalry with the Air Force to maintain the nation's anti-aircraft defenses—is being turned over to Nationalist Chinese troops to guard Formosa (Taiwan).

The Western Electric *Nike-Hercules* first appeared on Formosan soil last year during the Quemoy-Matsu crisis.

U.S. troops set up and manned a 48-launcher battalion of the 75 to 100-mile range missile capable of knocking down enemy aircraft with both conventional and nuclear warheads.

About half of the U.S. troops who manned the *Nike-Hercules* on Formosa already have been withdrawn. Their posts have been taken over by Nationalist Chinese. The switch is scheduled to be completed by mid-August.

Nikes in the hands of the Nationalist Chinese will not be equipped with nuclear warheads.

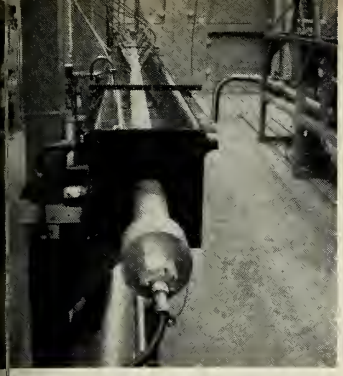
However, U.S. Air Force units on Formosa will continue to man nuclear warhead-tipped Martin *Matadors*.

Heat and Meteorite Impact Effects Studied

DOWNEY, CALIF.—A study of interaction of surface materials and high-temperature boundary of air rounding a high-speed moving has been undertaken by the Aero-S Laboratories at North American tion's Missile Division.

The advanced research proje sponsored by the Army.

A second area of investigation, for the Army, is a laboratory in which minute particles simul meteorites will be bombarded a various materials to determine in effects. Speeds near those of par in space will be achieved with high-velocity equipment being veloped by the laboratories.



CK WAVES resulting in pressures up 0,000 pounds psi are measured in the less steel detonation tube. Walls are half inch thick.

AF Pushes Research On Detonation Problem

by James Baar

WRIGHT-PATTERSON AFB—A multi-ion-dollar missile is on its test d. Its propellant ignites. Seconds t a blast rips through the missile leaves it a pile of blazing ruins.

Why?

And what can be done about it?

One of the keys to answering these tions is a better understanding of phenomenon known as "combus- instability." Some call it "oscil- y combustion."

It results in considerably higher normal pressures, temperatures rates of heat transfer.

A team of scientists at the Aero- ical Research Laboratory at Wright Development Center has been in- gating the phenomenon in a newly- laboratory for the past year.

Their research could lead to:

- Much greater reliability of missiles spacecraft boosters.
- More efficient combustion systems lighter and smaller engines.
- Removal of a principal roadblock to "scaling up" the huge rocket systems needed for space exploration.

The Air Force scientific team headed by Bernard T. Wolfson has constructed for their investigations a special high-pressure detonation research facility. Their equipment enables them to measure fundamental detonation parameters under the conditions present in rocket engine combustion chambers.

The pressure of exploding gases at the time of detonation and the velocity of the resulting shock wave are measured in a stainless steel 15-foot detonation tube. Its diameter is 1½ inches. Its walls are one-half-inch thick.

Pre-mixed gases from remotely located high-pressure storage tanks are fed into the tube and ignited. An electronic timing system capable of clocking passage of the shock wave to within one-tenth of a microsecond takes five readings as the wave moves down the tube. Pressures are measured by a recently developed system capable of accurately measuring large pressure changes ranging to 100,000 pounds psi in a reaction time of less than one-half of a microsecond.

The scientific team also is using:

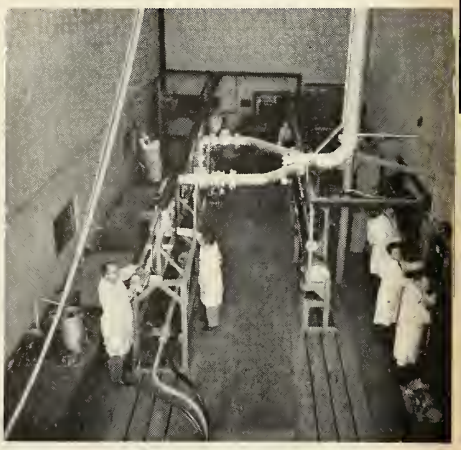
- An 18-foot shock wave-flame interaction tube to investigate the interaction of a shock wave with a stabilized flame front and ignition of a gaseous mixture by shock.
- A 25-foot flow detonation tube for observing the influence of gas flow on detonation wave characteristics.

Both the deflagration and the flow tubes are equipped with windows for visual observation by means of high-speed photography. The 3-inch-wide tubes are made of chromium molybdenum steel.

The investigators are using a Beckman and Whitley ultra-speed framing camera to take pictures of the detonation waves which reach speeds of Mach 10. The camera takes 25 pictures of the wave as it passes an observation window in 1/15 of a millisecond.



LW TUBES for investigating shock- ar: interaction and influence of flow n detonation wave characteristics.



OVERALL VIEW of Air Force high-pressure detonation research facility. Lab has blow-out panels in case of accident.

How Do We Make Weapon System Integration Work?

AF has established Project Offices with broad authority for overall management of all phases

by Betty Oswald

WASHINGTON—Traditional methods of doing business with the Defense Department will have to go by the boards in the years ahead. This means, according to Gen. Edwin B. Rawlings (USAF, ret.), long-time boss of the Air Materiel Command, that the development of new and complex missiles, rockets, space ships and other weapons is forcing the disappearance of the traditional distinctions between research and development, procurement and production, and maintenance and supply.

Quantity production is a dead issue with the high-yield weapons of the future. Today, the talk is of building 40 B-58's in a year—little more than three a month—and of 70 B-52's with fiscal 1960 money. And very limited numbers of very high-cost missiles are obviously in the cards.

These facts, together with the complexity of new weapons and the difficulty of making a complete weapon system operational in the earliest possible time period, lead inevitably to weapon system management and integration and to less rather than more advertised bidding, according to military spokesmen. This is hard for Capitol Hill to swallow because with the shift to limited production, costs are soaring, plants are closing and will close, and small business is perennially in trouble.

This means that the Congress, looking at the highly undesirable end results, is blaming this new and admittedly creaky process known as the weapon system management concept, rather than the change in weapons, according to both military officers and men who deal in weapon system management from industry.

As they see it, the job is to make weapon system integration work. Key to the effort is the Air Force Weapon System Project Offices now set up both by the Air Materiel Command and the Air Research and Development Command.

• **No delegation**—In talking of Project Offices, which are the focal point of the effort to push out a complete weapon at the earliest possible time, AF officers make it plain that they are not delegating their authority or responsibility to the prime weapon system contractor, despite charges sometimes made.

The Weapon System Project Office is basically responsible for the overall management of development, procurement, production, supply, maintenance and integration of each assigned weapon into the Air Force inventory. Hence it is the contact point for both the Air Force itself and industry.

It was created in its present important place in the AF structure in full recognition of the fact that y can't manage development—or for th matter procurement and productio supply or maintenance or even traini and operation, in a vacuum. Integ tion, according to the modern day e perts in logistics, represents the key.

It's important to know right fr the beginning, when the launching pa will be needed, the type of person which will operate and maintain t equipment, the training effort wh will be required to obtain necessa skills, and the facilities which will needed both to produce and to ma tain the new weapons.

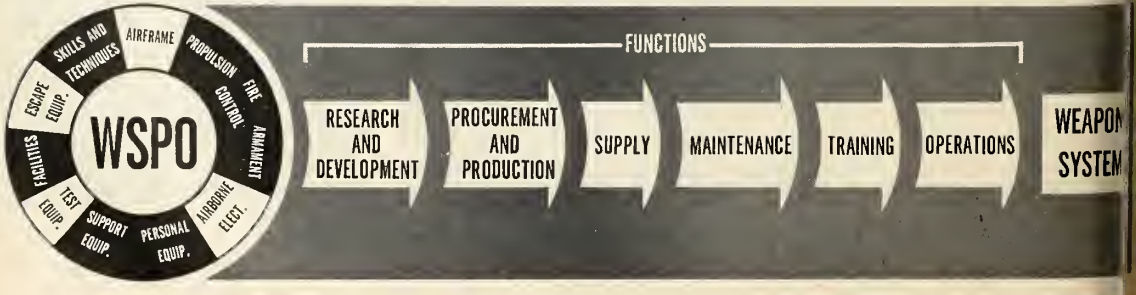
This means that the WSPO's staffed by experts in all of the ma elements of the system, including frame, propulsion, fire control, borne electronics, support and t equipment, facilities, aircraft esca equipment, as well as by people w know what skills and techniques w be required for an operational syste

• **Responsibility**—Management the office depends on whether weapon is only in development, whether the decision has been made produce it for inventory. If the p gram is still in the technical devel ment stage, ARDC has what is kno as "executive management respo bility." If a decision to produce been made, "EMR" shifts to AM This by itself could cause unnecess delays in the program.

In an effort to cut across the wh structure of the AF and eliminate problem, ARDC and AMC weap system project officers are kept wo ing together—either in the sa room or across the hall and on Weapon System Phasing Groups w representatives not only from AR and AMC but also from the Train and Using Commands and from Force headquarters.

These groups meet at least onc month under the chairmanship either ARDC or AMC, depending which command has executive m agement responsibility.

How each group handles its pr lems will be the subject of l articles.



Aerojet's New Sounding Rockets

Company is already taking orders for Astrobee series reportedly costing less than Aerobee but offering improved ease of handling, thrust alignment and attitude accuracy

by Frank G. McGuire

AZUSA, CALIF.—A new series of sounding rockets to take over where *Aerobee* leaves off has been proposed by Aerojet-General Corp.'s Systems Division. Named *Astrobee*, the rocket would consist of two basic vehicles, the *Astrobee-200* and the *Astrobee-500*, with an attitude-control system available if desired.

The *Astrobee* design grew out of an Air Force request through its Cambridge Research Center for a staged solid-propellant rocket with 200-mile-altitude capabilities carrying moderate payloads. The resulting design, *Astrobee-200*, will carry 120 pounds of useful payload to that height.

The larger version, *Astrobee-500*, will carry a gross payload weight of 250 pounds to 725 miles. These performance figures assume a 5° launch angle at sea level.

The first flight test in the series is due in late fall from Fort Churchill, Canada.

Costs on the *Astrobee* run somewhat below the *Aerobee;* the *200* costing about $10,000 to $15,000 and the *500* from about $15,000 to $20,000. Standard materials, such as aluminum fins, are used for construction. The nose cone is composed of an ablative material for re-entry.

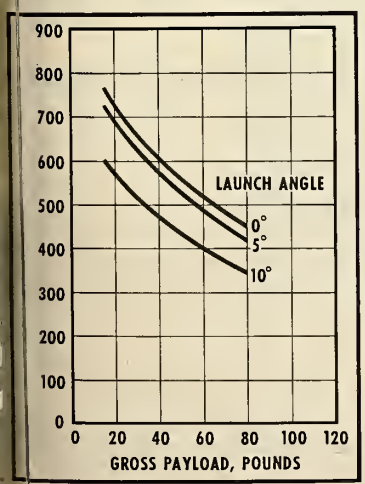
Aerojet has received orders for two *Astrobee-500* rockets and has quoted prices on four more.

Advantages of the new series, as cited by AGC, are ease of handling and servicing, improved thrust alignment, and close manufacturing of longitudinal and lateral centers of gravity. Both versions were designed for launching from rails, and feature fin stabilization and high initial acceleration.

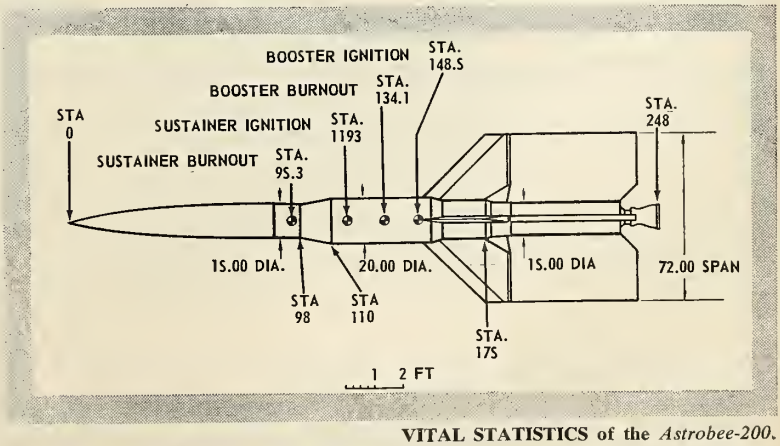
• **Breakdown**—Gross launching weight of the two-stage *Astrobee-200* is 1689 pounds (with zero useful payload). Breakdown of the rocket booster, 593.5 pounds; sustainer, 1071.5 pounds; payload compartment, 24.0 pounds. Payload compartment weight includes that of the heat shield. The booster is a modified MB-1 solid-propellant motor such as used in the *Genie* AAM.

Astrobee-200 is approximately 20.6 feet long overall and its total span is 72 inches. (Booster and payload compartment diameter is 15 inches and sustainer diameter is 20 inches.) The length breakdown: booster, 73 inches; sustainer, 77 inches, and payload compartment, 98 inches.

Aerodynamic heating on the *Astrobee*'s surfaces has been calculated by AGC engineers, and appears as a sharp climb after 25 seconds of flight. At this point, temperature at three inches from the nose is about 175°F,



PERFORMANCE of *Astrobee-500* in sea level launchings with 12-sec. coast time.



VITAL STATISTICS of the *Astrobee-200*.

ASTROBEE-200 TRAJECTORY SUMMARY

Data for: Sea-Level Launch 5° Launch Angle

USEFUL PAYLOAD, LB	100	175	250
BOOSTER BURNOUT VELOCITY, FT/SEC	1340	1290	1240
BOOSTER BURNOUT ALTITUDE, FT	1380	1320	1270
SUSTAINER BURNOUT VELOCITY, FT/SEC	8200	7150	6370
SUSTAINER BURNOUT ALTITUDE, FT	111,000	101,000	93,600
MAXIMUM ACCELERATION, G	20.8	19.9	19.2
PEAK ALTITUDE, STATUTE MILES	215	160	131
SLANT HEIGHT, STATUTE MILES	232	173	141
RANGE, STATUTE MILES	174	130	104
TIME ABOVE BURNOUT ALTITUDE, MINUTES	8.8	7.7	6.9

ATTITUDE CONTROL SYSTEM AZIMUTH AND ELEVATION ERRORS

CAUSE	ERROR CONTRIBUTION (3S VALUE) ASTROBEE-200	ASTROBEE-5
Mass unbalance drift @ 1.2 deg/hr/g	Negligible	Negligi
*Anisoelastic drift @ .02 deg/hr/g²	0.018°	0.020°
Random drift 0.20 deg/hr	0.0167°	0.049°
Alignment of input axis of gyro to gyro case	1 MIL.R	1 MIL.R.
Alignment of gyro case to reference axis	1 MIL.R	1 MIL.R
RMS Total	0.085°	0.097°.

*For purposes of this study, an environment of 100 g² was assumed.

climbing to 1300°F by 45 seconds. At 18 inches from the nose the temperature shows a rise from 125°F at 25 seconds, to over 600°F at 45 seconds. Leading edges of fins show similar temperature rises, but none of the heat increases reaches a critical stage.

The three-stage *Astrobee-500* achieves a maximum altitude of 765 miles with a 15-pound gross payload. This performance changes as payload weight changes, and a 600-mile peak altitude is reached with a 40-pound payload.

Launching weight of *Astrobee-500* is 1862.3 pounds, without payload section, with breakdown as follows: first stage, 602.5 pounds; second stage, 1050.5 pounds; third stage, 209.3 pounds.

Overall length is about 25.5 feet and the span is 72 inches. The first two stages are the same as in the *Astrobee-200*. With the MB-1 booster and the 30KS-8000 second-stage motor (eventually to be used with *Thor-Delta*), is the third-stage *ASP* rocket.

• **Optional equipment**—An attitude-control system has been developed as an optional addition to the *Astrobee* series. Designed to carry a special camera, the payload section can be recovered intact, as well as properly oriented during photography. Dispersion of the film magazine on its return to earth is kept at a minimum. The attitude control is in operation during the entire ascent of the vehicle and the initial phases of descent.

The attitude control equipment for the *Astrobee* series is comprised of an inertial reference system, a reaction-jet servo system, electrical power supply, and a reaction-jet fuel supply. High-pressure nitrogen or air is used as the working gas for the reaction jets. The servo valves control reaction-jet thrust in proportion to a dc electrical signal received from the guidance mechanism by discharge of the compressed gas. A closed-loop pressure-regulation system is used to obtain good linearity and essentially constant thrust sensitivity.

Although the control system for the *Astrobee-200* is also applicable to the *500*, there is an independent system used for the booster of the *500*. Due to the large difference in thrust and total impulse of the two upper stages and the booster, the attitude-control system for the booster is large enough to correct maximum thrust misalignment during operation. The system is contained within the booster and separates with it.

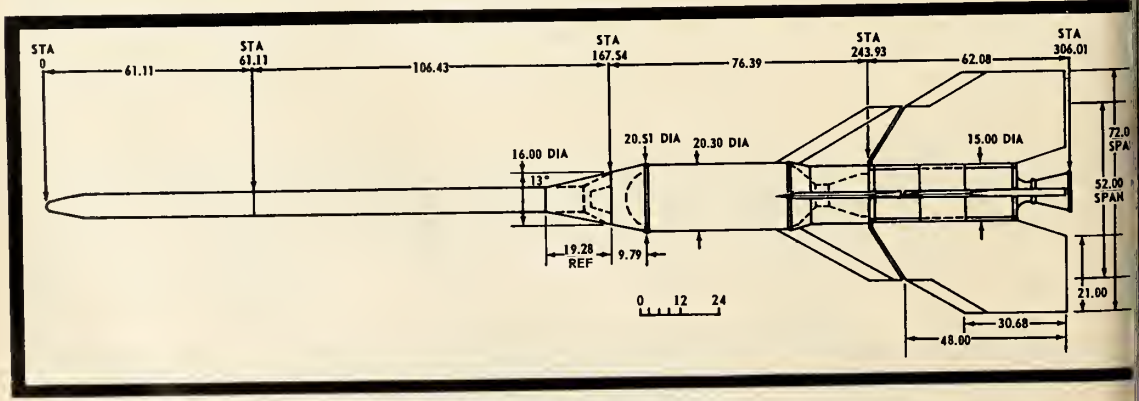
• **Guidance**—The guidance system uses a body-mounted inertial reference of floated rate and rate-integrating gyros. It provides varying rate dc voltages to the appropriate actuation members for the purpose of attenuating disturbing influences on the vehicle. The three miniature rate-integrating gyros accept command voltages to the control system, sense angular velocity about the three major axes, and pr duce corresponding integrated r error output voltages.

The rate damping package has thr orthogonally-mounted rate gyr aligned to the major axes of the v hicle. They measure angular velocit about these axes and supply inform tion to the system for correction.

The electronic compartment, whi provides for the acceptance of d placement and rate information, w forward the data to the appropri polarity-sensitive actuation assembli Other functions of the compartm include gyro temperature control, g monitor circuitry, power amplifiers the gyro spin motors, gyro pickoff citation, preamplifiers, demodulat filters and summing preamplifiers.

Power supply for the guida package and servo-valve assembl consists of 26-volt, 400 cps out from a 21-cell silver-zinc battery w static inverter. The supply occup 150 cubic inches and weighs pounds. Effective rated capacity is watt-hours/pound. Provision will made for possible programming wind shears, coriolis accelerations other effects, as the situation requi

Accuracy of the attitude system been analyzed by AGC, and it has b estimated that maximum angular r about a resultant axis at apogee be less than one-half degree second.



DETAILS of the *Astrobee-500*.



COMMAND DESTRUCT

The flight testing of second generation missiles—more versatile and powerful than their predecessors—requires a device for sure termination of any missile flight that might endanger the test range or surrounding area.

Ramo-Wooldridge engineers, under a United States Army Signal Corps contract, have successfully developed and delivered the first sub-miniature, completely transistorized radio "command destruct" receivers.

Specifically designed for missile flight safety operations, the receiver (AN/DRW-11) can actuate safety mechanisms or destruct devices. It has three command channels, each of which actuates a control relay.

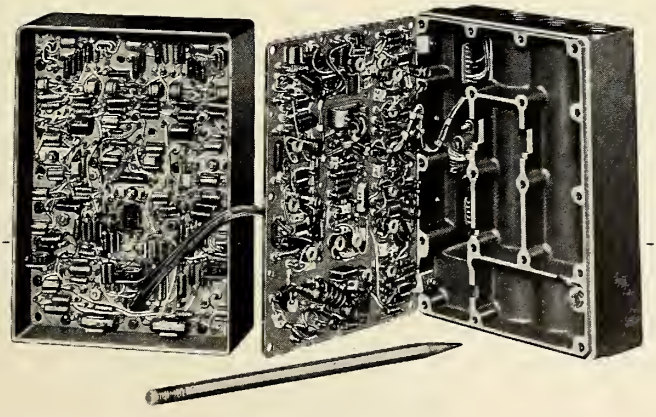
The "command destruct" receiver accepts frequency modulated signals in the UHF radio command control band. It is designed to operate with closer radio frequency and command frequency channel spacing than has been used to date, thus making possible more efficient use of the available radio spectrum.

Compact and rugged, the radio receiver's modular construction permits rapid and complete accessibility to all components. One module houses the basic receiver. The second module contains the three command channels and relays. This integrated package occupies 115 cubic inches, and weighs 4 pounds. The receiver requires no pressurization and operates reliably under the adverse environmental conditions encountered in missile flight testing.

Engineers and scientists interested in being associated with some of the nation's most advanced research and development programs are invited to acquaint themselves with current opportunities at Ramo-Wooldridge. The areas of activity listed below are those in which R-W is now engaged and in which openings exist.

Missile electronics systems
Advanced radio and wireline communications
Information processing systems
Electronic language translation
Anti-submarine warfare
Air navigation and traffic control
Analog and digital computers
Infrared systems
Electronic reconnaissance and countermeasures
Basic and applied physical research

For a copy of our brochure, *An Introduction to Ramo-Wooldridge,* or other additional information write to Mr. Donald L. Pyke.



RAMO-WOOLDRIDGE

P. O. BOX 90534, AIRPORT STATION • LOS ANGELES 45, CALIFORNIA

a division of ***Thompson Ramo Wooldridge Inc.***

Circle No. 18 on Subscriber Service Card.



Space Feeding: Big $$ Market

Air Force contracting with industries on four lines of space food with bulk of work being handled through Quartermaster Food and Container Institute

by James Baar

WRIGHT-PATTERSON AFB—When the first U.S. astronaut eats his dinner in space, he will be munching on products that may put millions of dollars in the pockets of the nation's food industry.

Both industry and government food experts expect that many of the special new products being developed for space travel will be highly adaptable for sale at the corner supermarket.

At present, four main lines of space food are being developed under the direction of the Aero-Medical Laboratory at Wright Air Development Center:

• Semi-solid food in tubes—A wide range of fruits, meat and vegetables. Some of these are junior baby food with some seasoning added.

• Bite-size solid food—These are such things as bacon tablets, cheese tablets and malted milk tablets.

• Solid-food "lipstick" rods—Many of these are highly-nourishing grain mixtures in a variety of flavors. A main course item: Cheese and smoky rye. Dessert: Chocolate peppermint.

• Dehydrated foods—A wide range of fruits, meat and vegetables. Even casserole dishes. Just add water and stir.

The Air Force also is attempting to develop space food containers that can be eaten. There are two varieties of these: those that can be eaten without harmful results and those that provide some nourishment as well.

Most of these items are being designed not for the first manned space flights but for the much longer space flights to come.

The first flights will be only a matter of days at most. Therefore, semi-perishable food can be used to make up the bulk of the first astronauts' diet. It is when flights lasting a week, a month or even years are taken that the new space foods will be needed.

• **Water recovery**—Moreover, their use—particularly the dehydrated foods—is closely tied to development of a water recycling system. Such a system would make possible the reuse of human liquid waste products and eliminate the need for carrying great quantities of water in storage tanks.

American Machine & Foundry Co. has found in a study contracted by the Air Force that in week-long flights involving one or two men water could be recovered by a vacuum distillation technique. Impurities not removed by distillation could be removed by an ion exchange system or absorption.

The Air Force now is planning further studies on which techniques would be most practicable for water recovery in flights involving two men over periods of more than a week.

At the same time, the Air Force has contracted with AMF to develop a waste collection unit and with the Massachusetts Institute of Technology for studies of methods for recycling solid waste products.

However, a number of scie close to the space food program not overly enthusiastic about the As Dr. Harry C. Dyme, chief of Aero-Medical Lab's Nutrition Sec put it:

"We all know that the recy process is what keeps the world g We use fertilizer to grow food tha eat. But to have the recycling goin in such a closed environment space ship might be a little disqui psychologically."

Still, Dyme said, such a sy might be essential in order to pr enough food for a crew during i planetary flights that could last than a year.

For example, algae might be g on waste products. Then, after p cation, it could be mixed with drated cereals.

• **Participation**—The bulk of Aero-Medical Lab's space food opment is contracted through the termaster Food and Container stitute. Much of the recent worl the Institute has been handle American Can Co., Gerber Pro Co., Colton Machinery Corp. Dryve Foods. Work also has been by such meat packing firms as and Armour.

American Can, Colton and G produced the tubes of space food rently being tested by the Air Fo

The sterilized tubes are lined

(Continued on page 32)

Martin Lacrosse Plays Deadly Game

Mobile as a chess queen, quick as a rapier thrust and as lethal as brass knuckles, the Martin Orlando Lacrosse is a handy weapon in a scrap. Developed, designed and built for the U. S. Army, the Lacrosse can flit like a ghost behind the battle area, fire in the general direction of the target and be pin-pointed by a forward guidance station.

The Lacrosse's ability to change its mind while in high velocity flight is another in the growing list of accomplishments by the men of Martin Orlando. Additional prime contracts include the Bullpup, air-to-surface missile, the Pershing, selective-range surface-to-surface missile and the Missile Master, electronic detection and control system for missile batteries.

Blue sky vision plus feet on the ground know-how has projected Martin Orlando to its place of leadership in electronics and missiles. Martin Orlando needs men with gray matter, the solid propellant needed to reach ever higher degrees of sophistication.

Immediate openings at senior level exist for Electronic Engineers, Physicists and Electrical Engineers in these areas: pulse circuitry, electronic packaging, transistor circuitry, electronic production test equipment, digital and analog computers. Also opportunities for men experienced in calculating solid state parameters, molecular distribution and quantum mechanics. Send confidential resume to: J. F. Wallace, Director of Professional Staffing, The Martin Company, Orlando 44, Florida.

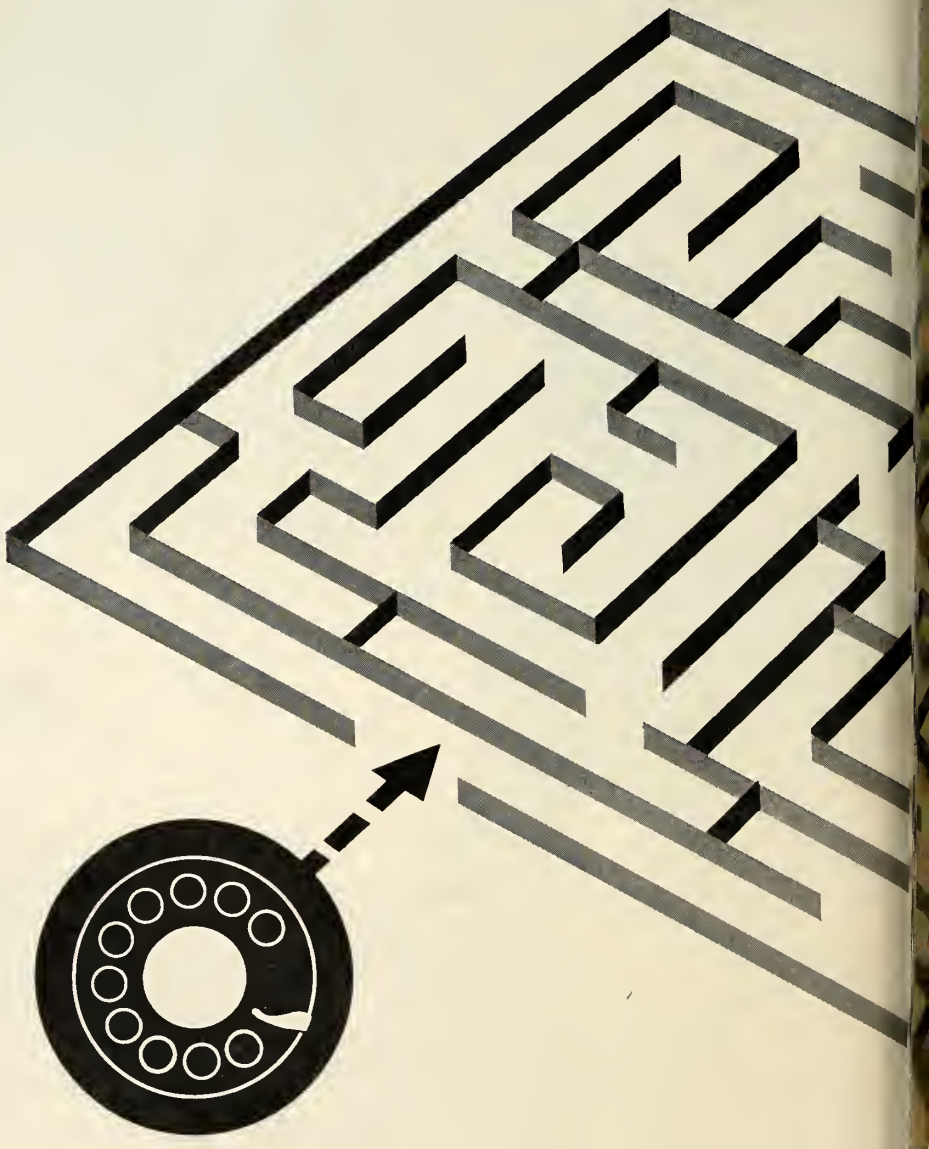


MARTIN
ORLANDO

Ft. Sill, Okla., June, 1959—The first two U. S. Army Battalions employing highly accurate Lacrosse surface-to-surface missiles will be activated this month. Martin Orlando is supplying all the material required for the activation, including maintenance, training devices, launchers and missiles.

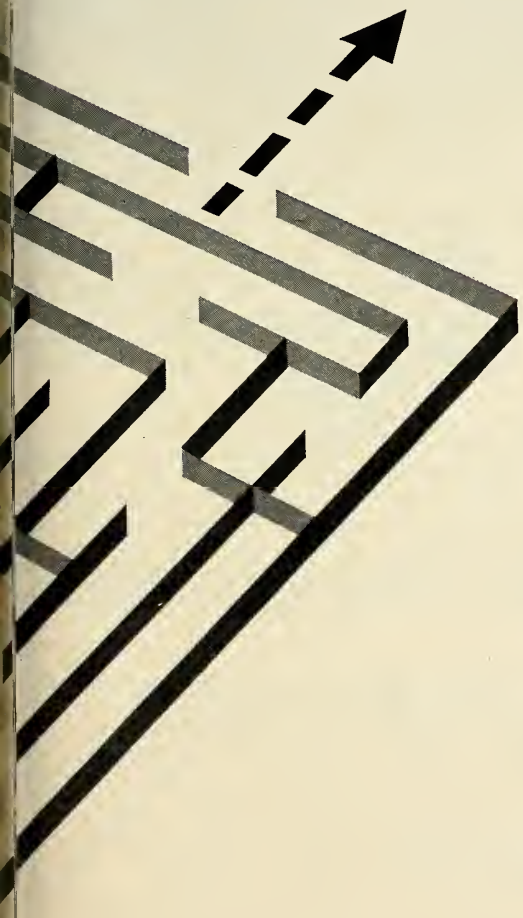
Automation cut its teeth on th

...how ITT's early work in telephony advance



elephone

e art of automation



The dial telephone exchange was one of the first examples! Today, automatic switching and new electronic techniques for automation are altering the operations of virtually every business and industry.

It was natural that ITT System companies, pioneers in the first, should be leaders in the second.

Customers have ranged from mail-order houses, railroads, libraries and oil companies to the air forces of several NATO governments.

There have been dramatic results.

One example is the automatic check-processing system developed by ITT System companies for one of the nation's largest banks. It codes, sorts and verifies checks. It performs all normal bookkeeping and accounting operations for demand deposits.

Another is the automation system for a large steel mill which records the program of requirements for every job, then feeds back information to production control centers as each phase is completed.

Still another: the first automatic U. S. post office, now under construction in Providence, Rhode Island.

Hundreds of others could be cited. Each required a complete understanding of automation from the design of a simple switch to the functioning of a fully-integrated electronic complex.

The ITT System has many specialists in this field. Among them: Intelex Systems Incorporated in retained-document automation; Kellogg Switchboard and Supply Company in automatic switching; Airmatic Systems Corporation in automatic-switch pneumatic tube and document-conveyor systems; ITT Federal Division in automatic test equipment, both military and industrial. ITT's European subsidiaries add to this experience.

To learn more about ITT's abilities in the area of automation, write for further information.



. . . the largest American-owned world-wide electronic and telecommunication enterprise, with 101 research and manufacturing units, 14 operating companies and 130,000 employees.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION 67 Broad Street, New York 4, N.Y.

IT COMPONENTS DIVISION • ITT FEDERAL DIVISION • ITT INDUSTRIAL PRODUCTS DIVISION • ITT LABORATORIES • INTELEX SYSTEMS INCORPORATED
AIRMATIC SYSTEMS CORPORATION • KELLOGG SWITCHBOARD AND SUPPLY COMPANY • ROYAL ELECTRIC CORPORATION • AMERICAN CABLE & RADIO
CORPORATION • FEDERAL ELECTRIC CORPORATION • ITT COMMUNICATION SYSTEMS, INC. • INTERNATIONAL ELECTRIC CORPORATION • INTERNATIONAL
STANDARD ELECTRIC CORPORATION LABORATORIES AND MANUFACTURING PLANTS IN 20 FREE-WORLD COUNTRIES

SPACE FEEDING

(Continued from page 28)

epoxy resin and hermetically sealed to prevent spoilage. They can be stored indefinitely. To use in the weightless environment of space, an astronaut would screw a specially-developed pipe to the top of the tube and press the food through it into his mouth.

The Air Force also is testing a special metal tube squeezer designed to make emptying the tube easier.

American Can and Gerber have provided the Aero-Medical Lab with nine varieties of tubed food. They include veal, pork, chicken, tomatoes, macaroni, peaches and beef soup.

The Bradley Tube Division of American Can also has done some work on putting oleomargarine and fresh water in tubes.

Dryve Foods of Kansas City, Mo. has developed about a dozen varieties of solid space food items in the shape of rods. An astronaut can feed these into his mouth through his helmet by using a rod container that operates as a lipstick.

The Institute itself has developed a number of the bite-size solid items such as cheese tablets.

• **On the shelf**—Actual Air Force investment in space food research has been small because of the eagerness of a number of food industrialists to explore the field for commercial development. Many contractors have paid for much of the work themselves. And some of the ideas developed are already appearing on store shelves.

Peanut butter is being packaged in tubes. So are a number of luxury items.

"Acceptability is the big thing," Dyme said. "We want to get items that will appeal to astronauts over long periods. Many such items, of course, would have commercial appeal also."

In order to achieve acceptability, the seven *Mercury* astronauts now in training as well as others will be called on to test space food items over various periods of time both for its appeal and for its nutritional qualities. Probably a training table will be set up.

In the end, the food put aboard the first U.S. manned space capsule will be tailored to the astronaut who will ride inside of it.

"It's of the utmost importance," Dyme said. "You know, this man will be under terrific stress. And the three things that relieve stress are women, liquor and food. We can't send any women or liquor along. The least we can do is give him food that won't add to his stress—or maybe will even lessen it a little."

more about the missile week

X-15 Has Dry Run; Powered Flight Next

Powered flight test of **North American's** *X-15* rocket plane is expected around July 1 following "100% successful" glide June 8. With Pilot Scott Crossfield at controls, *X-15* was dropped from B-52 at 38,000 feet with air speed 517 mph and landed at 185 mph after 310-second glide over the Mojave Desert, at Muroc, Calif.

First U.S. Post Office delivery of mail by missile was accomplished June 8 when a subsonic **Chance Vought** *Regulus I* carrying 3000 letters was dispatched from the submarine Barbero 100 miles at sea to Mayport Auxiliary Naval Air Station, Jacksonville, Fla. Envelopes bore pictorial cachet and the words: "First Official Missile Mail." Stunt was to demonstrate feasibility, but it is expected to be a long time before regular system is developed.

White House Press Secretary James C. Hagerty predicts an instantaneous, global telecast relayed by earth satellites will take place within 30 months. Hagerty says there is a "40% chance" the feat may be accomplished within the next 18 months—while he is still in the White House.

Saturn Blockhouse

Contract for domed, 9000-square-foot *Saturn* blockhouse at Cape Canaveral has been awarded to **Diversified Builders, Inc.,** Cocoa Beach, on a bid of $819,000. **Paul Smith Construction Co.,** Orlando, has $529,000 Corps of Engineers contract to erect a 22,000-square-foot engineer facility and other buildings at the Cape.

The Navy has named **Sperry Gyroscope Co.** navigation systems manager for four second-generation 608 class *Polaris* submarines . . . **Callery Chemical** has AF contract to supply boron-based high-energy HiCal for secret missile project . . . Special construction totalling about $4 million is underway at AOMC's White Sands Missile Range in preparation for *Nike-Zeus* tests.

Small business firms were awarded $79 million worth of government contracts during April under the Small Business Administration set-aside program. This was an increase of about $10 million over March.

Discoverer Back-Up

Back-up to *Discoverer III* mice-in-space attempt was complete bio-medical task force on wheels built by **Consolidated Diesel Electric Corp.** Six over-sized stainless steel trailers—air-conditioned—were brought to Vandenberg AFB as part of **Lockheed** missile systems division. Two trailers house identical laboratories, another contains altitude simulating chamber, fourth contains telemetry and data processing and the remaining two are service units.

Gladding, McBean Reveals Ceramic Brazing Jig

Brazing jigs from ceramic compositions have been fabricated successfully by **Gladding, McBean & Co.** The Los Angeles firm says the jigs, for use in making rocket motors, are of low thermal conductivity permitting tubes to be thoroughly brazed together. Moreover, the brazing material does not become brittle upon hardening because of too rapid cooling; the ceramic resists being wet by the brazing material; and the jig can be precision formed.

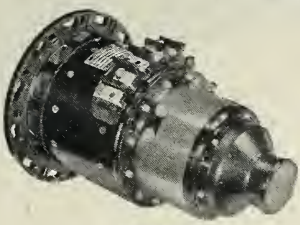
Equally suitable for furnace or torch burning, according to G-MB, the jig's original manufacturing costs are small and it can be used repeatedly because it does not lose its shape.

McDonnell has awarded **Burton Mfg.,** Santa Monica, a contract to produce hermetically sealed longitudinal accelerometers for *Mercury* capsule. Case will include air-damped seismic weight. Movement is transmitted through linkage for visual readout of gravity forces. Instrument has memory indicators showing maximum positive and negative g-forces, and operates over 32-g range.

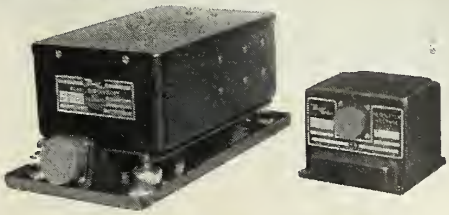
Closed-die forged turbine wheel 4 inches id and weighing 520 pounds—reportedly the world's largest—has been produced by **Wyman-Gordon** for use in 1500° to 1800°F range from high-temperature nickel-base alloys. Wheel is expected to open up possibility for higher-performance rocket engines.

The National Academy of Science elected as a foreign associate of the Academy Prof. V. A. Ambartsumian—noted Russian astrophysicist and director of the Burakan Observatory in Soviet Armenia. Ambartsumian is the fifth Russian to be named a foreign associate of the Academy. He is the third since the Russian Revolution. First Russian to be so honored was Pavlov.

HIGH TEMPERATURE AC GENERATING SYSTEMS



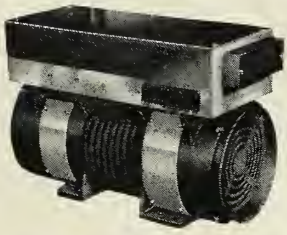
AC Generators



AC Voltage Regulators and SYSTEM COMPONENTS



SPECIAL ENVIRONMENTAL FREE INVERTERS

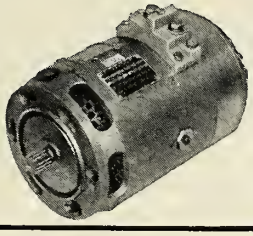


HIGH-ALTITUDE AND MISSILE INVERTERS

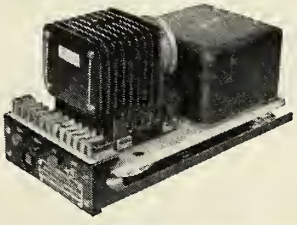


STATIC AC AND DC POWER SUPPLIES

HIGH TEMPERATURE DC GENERATING SYSTEMS



DC Generators



DC Voltage Regulators and CONTROL PANELS

BENDIX RED BANK—UNEXCELLED PERFORMANCE

AROUND THE  AROUND THE 

here's no questioning the quality of electrical ower equipment when it's made by Bendix Red ank. The proof is in acceptance—almost universal ceptance. Twenty-four hours a day, in countries round the world, equipment like that shown above proving that skillful design and expert engineering lus an almost unmatched quality control system) n build an international reputation for dependable performance. If you can use quality like this, call on us for recommendations. Write today for brochure detailing our engineering, production, and service facilities, RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Sales and Service. 117 E. Providencia Ave., Burbank, Calif.
Canadian Affiliate: Aviation Electric, Ltd., P.O. Box 6102, Montreal, P. Q.
Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N.Y.

Red Bank Division — Bendix AVIATION CORPORATION

WHY THE NAVY'S NEW A3J CAN CALL ITS SHOTS IN ANY WEATHER



The A3J—built by NAA-Columbus—is the fastest, most versatile attack plane the Navy has ever known. It can find targets at extended strike range, even if obscured by weather. A3J's accuracy comes from an extremely advanced bombing-navigation system created by Autonetics. It's a system that is ready and reliable today—because Autonetics started working in this field 12 years ago. This experience is available to you now. Please write for detailed information.

Autonetics

A Division of North American Aviation, Inc.,
Downey, California

Recorder Size and Weight Cut

Ampex AR-200 weighs one-third as much and is half the size of previous magnetic tape recorders

by Charles D. LaFond

REDWOOD CITY, CALIF.—The quan- of telemetered data acquired in missile efforts has been increasing ithmically—its complexity is as- ding. Since man's ability to process wealth of information reached an limit, recognition of the great ntial of magnetic recording tape only a matter of time. Its storage bility and its speed make an un- lled contribution to technical data isition. The development of better recording devices and steadily im- ed recording and analyzing tech- s has been continuous.

Almost all phases of missile check- launching, and subsequent moni- g involve the use of magnetic tape ding. Through the use of tape, tive space vehicles have been d the ignominy of failure; scien- theories and carefully engineered ns have been proved; the direc- for optimizing successor space sys- has been revealed; human error e performance of long and tedious ntial control operations has been nized.

ne of the problems associated with etic tape recording equipment in al was the large size and weight isting units, including the mobile Much progress was made in izing performance and increasing ility, but there still remained the y large physical size. In recent there has been steady progress in ing recorder size.

Transistorized model—Comple- ng standard recorders—and pos- the forerunner of future missile- tape devices—is a new airborne/- e magnetic tape recorder devel- by the Instrumentation Division npex Corporation.

ss than half the size and a third the weight of its predecessors, the system is fully transistorized, employs modular construction, and is fabricated from lightweight metals throughout most of its chassis.

Designated Ampex AR-200, the basic system is comprised of two units: the tape transport and the amplifier housing, in which different interchangeable amplifiers may be installed to achieve particular recording characteristics. An instrument-panel remote-control unit and a test unit (go/no-go type for complete checkout and alignment) are the two principal accessories to the system.

Considered by its developers to be extremely rugged and highly reliable, the tape transport unit utilizes a single-piece cast aluminum chassis and rigid cast cover which can be opened from either front or back, or removed altogether. Total weight is 90.5 pounds.

Although it is designed for normal operation in a lateral position, a change of shock-mount arrangement will permit operation in any position.

In environmental tests, the equipment has shown sustained satisfactory performance under shock tests up to 15gs and vibration to 10gs at altitudes of 10^4 feet, under temperature changes of from –65° to 160°F, and up to 95% relative humidity.

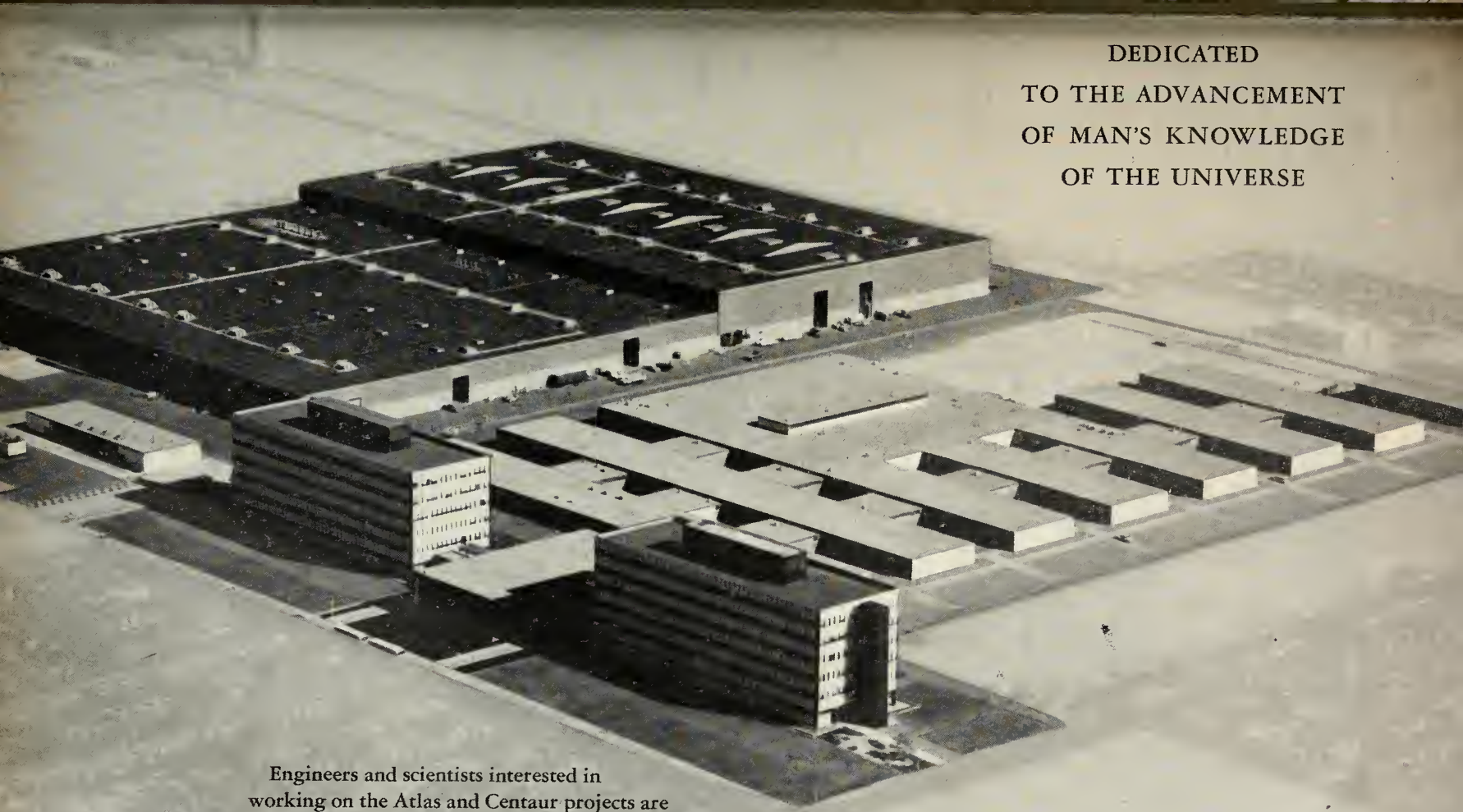
Many diversified factors have entered into the machine's high environmental adaptability. Summarized below are some of the features which combine to give the recorder its resistance to temperature extremes:

- Silicon transistors have been used throughout the system because of their extended operating temperature range (as compared with other available semiconductor materials).
- A special irradiated, thermally-



A COMPLETE airborne or mobile type AR-200 magnetic tape recorder system is shown from left to right: power converter, electronics box, remote control unit, AR-200 tape transport, and test unit. Design includes an alternate-opening transport cover permitting opening from front or back or complete removal. Total weight: 90.5 lbs.

DEDICATED
TO THE ADVANCEMENT
OF MAN'S KNOWLEDGE
OF THE UNIVERSE



Engineers and scientists interested in
working on the Atlas and Centaur projects are
cordially invited to submit a resume for professional evaluation to
Mr. G. N. McMillan, Engineering Personnel Administrator, Department 130-90

CONVAIR | ASTRONAUTICS Convair Division of GENERAL DYNAMICS
5518 Kearny Villa Road, San Diego, California

Table 1. AR-200 Recording Modes and Characteristics

Direct record amplifier (for highest frequency response)	± 1½ db from 50-80,000 cps; ± 1½ db from 50-200,000 cps at constant ambient temp. of 20°C; ± 3½ db from 50-200,000 cps over ambient temp. range of 0° to 75°C
FM-carrier record amplifier (for greatest signal amplitude accuracy)	± ½ db from DC to 10kc at 60 in./sec.
Digital (PCM) write amplifier (for max. number of data samples)	Input rate: 18,000 bits/sec/track (32 tracks—576,000 bits/sec) Transfer rate: 75,000 bits/sec.
Pulse duration modulation (PDM) (for quasi-static variables)	Pulse accuracy: ± 2m sec at 30 in./sec. Pulse length: 50-700 m sec at 30 in./sec.

ilized composition has been used some of the AR-200's electronic ng. The wiring for the power drive plifier is covered with a tough and atile polyethylene base composition. barded with gamma rays during nufacture, it later is exposed a few seconds to a temperature approximately 275°F. This causes material to shrink and form a re-kably tight mechanical bond with wire over which it has been placed. Resistant to chemical acids, bases, hydrocarbon solvents, including tion gasoline and oils, the covering apable of retaining stability under emely adverse conditions. It with-ds temperatures from −100°F to 0°F while maintaining flexibility strength. When subjected to these erature extremes, it will not melt, len, crack, run, or blister, accord-to company engineers.

• **System details**—Six standard tape ds are available: 1⅞, 3¾, 7½, 30, and 60 in./sec. Start and stop s of 0.5 sec. are attained in the transport and the speeds are con-ed by a synchronous motor for fidelity. Reel size is 10½ in. for accommodating ½- or 1-inch magnetic tape widths and up to 3600 feet of tape.

• Magnetic heads—To accomplish the various recording modes for the two tape sizes, improved plug-in, positive-contact surface, magnetic heads have been developed for each track configuration. Inter-track relief areas permit more efficient disposal of tape-oxide accumulation.

In track-to-track phase relationships, time displacement error among all tracks on one headstack is held to approximately 60 μsec. at 60 in./sec. To achieve this precision, total gap scatter for all heads in one stack is held, in manufacture, to 10^{-4} in. or better and azimuth of gap axis to 90°00′ ±1!

• Power requirements—Because of its designed airborne/mobile mission, the system operates from a 28v dc supply with a total power requirement of 150 watts. By using accessory power converters, other standard ac sources (115v, 400 cps; 208v, 400 cps; 117v, 48 to 63 cps) can be employed.

• Recording modes—Versatility of the AR-200 system is demonstrated in its recording-mode interchangeability. Four basic recording modes can be accomplished by changing the amplifier: direct record, FM carrier, digital, and PDM. (See Table 1.)

From 7 to 32 recording tracks are available, depending on tape width and recording mode. A ½-in. tape will accommodate either 7 analog-recording tracks or 8 digital recording tracks. A 1-inch tape offers 14 analog, 16 or 32 digital, or 16 digital and 7 analog tracks. By employing multiplex techniques, analog tracks could handle over 1000 data channels at one time.

A unique part of the circuitry in the tape transport is the tape speed sensing circuit (or logic circuit). The heart of the successful operation of any magnetic tape recorder is its ability to control its speed. In addition, the operator must be aware of proper performance at all times. The AR-200 employs an indicator light on its control section of the tape transport. Also, the remote control unit contains a similar light.

• Logic circuit—The tape speed sensing circuit located in the tape transport assembly is designed to monitor tape speed when the transport is in the operating mode and permit engagement of the pinch rollers on the capstan shaft only when the tape speed and capstan resolutions are compatible. Components necessary for this function are mounted on a printed circuit board.

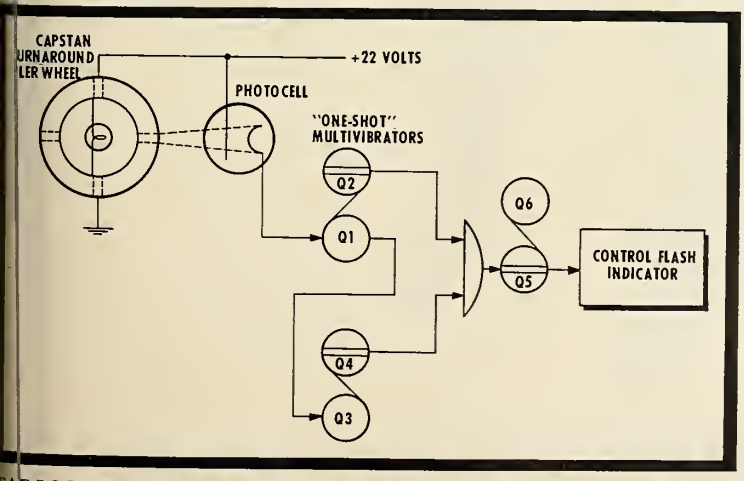
A 1-in. diameter turnaround idler on the tape transport has four windows through which light may pass onto a photo-cell. (Refer to the block diagram.)

At a tape speed of 60 in./sec. approximately 80 pulses/sec. are generated by the photo-cell. At a tape speed of 30 in./sec. approximately 40 pulses/sec. are generated by the photo-cell.

The pulse repetition rate represents periods of 12.5 and 25 m sec. respectively, only when the tape is at the correct speeds. Two uni-vibrators operate as coincidence gates that determine the instant the tape is up to speed for pinch roller engagement.

Pulses from the turnaround idler trigger the input uni-vibrator having a time constant adjusted to produce a 5-msec positive pulse for each photo-cell pulse. The negative-going portion of this pulse triggers a second uni-vibrator having a time constant adjusted to produce a 10-msec positive pulse for each trigger signal.

The output pulses from the input uni-vibrator and the second uni-vibrator are fed to a gate circuit clamped at a potential slightly higher than either output. When the tape is not up to speed, with insufficient pulse repetition rate present from the input uni-vibrator, the combined outputs do not over-



AE LOGIC block diagram of the AR-200 Record Indicator and Speed Sensing Device.

Circle No. 22 on Subscriber Service Card.



Lightweight Full Pressure Suit developed for U.S. Navy

1934 Stratosphere Suit

B.F.Goodrich

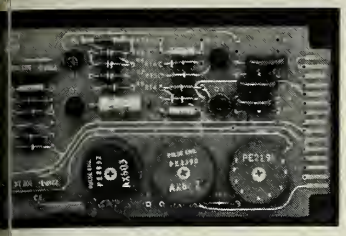
At B.F. Goodrich the space age started in 193

That was the year B. F. Goodrich dev oped the first rubber stratosphere flyi suit for attempts at setting altitu records. Through the years this suit h been constantly improved to meet t needs of higher-flying pilots. And wh the first man sets foot on the moon will probably be wearing a modificati of today's B.F.Goodrich Full Pressure Su

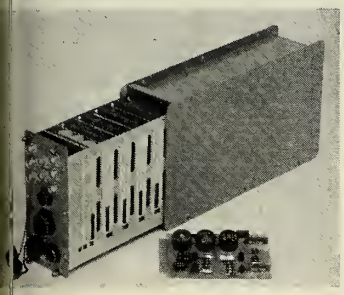
B. F. Goodrich engineers are worki in many ways to help man break t bonds of earth—and return safely. Miss nose cones, improved solid fuels, prop lant heaters, missile battery box heate instrument heaters, printed and etch circuits, stronger metal and plastic str tural materials, insulating materials, p cision rubber seals and gaskets, bl fasteners—these are only a few of t items that may help solve *your* sp age problems. For specific R & D inf mation, write: *B.F.Goodrich Aviat Products, a division of The B.F.Goodr Company, Dept. MR-69, Akron, O*

B.F.Goodrich *aviation products*

Circle No. 23 on Subscriber Service Card.



YPICAL fully solid-state and printed it direct-record amplifier consisting f wo stages of amplification and a bias s lator stage. All of the interchangeable h-in boards are installed in a card rack ne housings for seven (analog) or eight ital) amplifiers.



to produce a cumulative output in x ss of the clamping voltage.

As the tape speed increases, a point s eached where the input pulse repe- it n rate is sufficient to permit coinci- e e of a portion of the positive u es. At this instant, the cumulative o ntial is greater than the clamp e ntial. The pulse is steered through o he third uni-vibrator having a long time-constant of approximately 1 second.

With the first pulse steered through, a relay is energized whose contracts complete the circuitry for pinch roller engagement. At the same time, another relay, whose on-off cycle follows the uni-vibrator, is energized and the corresponding contacts complete the circuitry for the panel indicator light to show that correct tape speed has been attained.

While the tape is at correct speed, the light will blink at a rate of approximately once per second. For any other tape condition, it will not blink.

• **Reliability and maintenance**—Flutter, a problem present in all recording devices as a result of the many variations in component velocities, was the object of a long but fruitful design exercise during the development of the AR-200. In the final production model, cumulative flutter is negligible—less than 0.1% (60 in./sec. at a 300-cps cutoff frequency).

With its modular construction and easily removed access panels, all components in the recorder system are easily reached and quickly replaceable. Despite this accessibility, the units are dustproof when closed. All sensitive control and operating areas are sealed with gaskets. (For operation above 71°C a filtered connection is provided for an external cool-air source. The intake and exhaust parts are capped when not used.)

All bearings in the transport unit are life-sealed ball bearings, eliminating the need for lubrication.

ner Van Allen Radiation Belt Identified

IVERMORE, CALIF.—Positive iden- ifi ation of the inner Van Allen belt N R June 8, 1959; p. 11) was made y Drs. Stanley C. Freden and R. St hen White of the Lawrence Radia- ic Laboratory, University of Califor- ni As a result of their efforts, the de ity, flux, and energy distribution of apped particles in the earth's mag- ne field were described for particles pe trating more than 6 g/cm² of ma erial.

A stack of ten sheets of nuclear em lsions, Ilford K.5 emulsion—1⅜ in. x 1⅜ x 600 μ, were hermetically se d in a stainless steel box. This va installed within the nose cone of a *Thr-Able* and secured on the instru- ne t board, 1¾ in. from the side wall. Th plane of the emulsions was parallel o he normal to the wall.

On April 7, 1959, the missile was launched from Cape Canaveral, reaching a 1230-kilometer max. altitude. After travelling for 15 minutes above 1000 km between latitudes 20°N and 3°N, the cone re-entered the earth's atmosphere and was recovered in the South Atlantic. Then the emulsions were returned to Livermore for analysis.

The study of emulsions was limited to the identification of protons with energies greater than 75 Mev and electrons with energies above 12 Mev. An isotropic distribution was assumed since the nose cone was not oriented in space.

• **Results**—No evidence of electrons was observed. The analysis of observed proton energies was indicated roughly as follows: 700 Mev or higher—1%; 300 Mev or higher—10%; the bulk of the tracks were spread between 75 and 300 Mev. An omnidirectional flux, based on the observed data, was computed at 1300 protons/cm²/sec (which is consistent with previous data). Total radiation level at 1200 km altitude was calculated to be 1 roentgen/hour.

• **Conclusions**—Conclusions resulting from the experiment and subsequent analysis were directed by the scientists at the two principal theories concerning the origin of trapped particles in the inner belt: (1) solar injection and (2) earth neutron albedo.

Freden and White stated that the solar origin theory is unable to account for the high-energy protons observed.

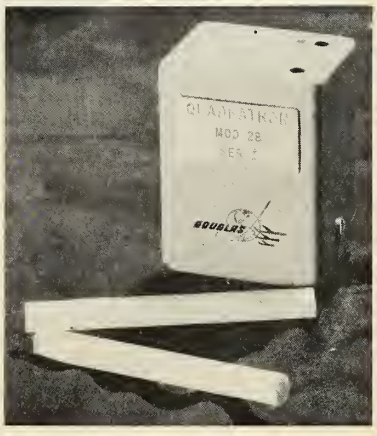
But in the neutron albedo theory, neutrons from upper-atmosphere cosmic ray interactions travel to the trapping region and decay into protons and electrons. The scientists believe this theory satisfactorily explains the experimental data, since sufficient high-energy neutrons are formed to provide a quantity of protons comparable to those observed.

Plug-in Computer Matches Systems 700 Times Bigger

EL SEGUNDO, CALIF.—A new miniature plug-in computing unit, called a Quadratron, is a passive non-linear device capable of performing nearly 25 of the basic, commonly used, nonlinear functions. Developed by the Douglas Aircraft Company here, the unit replaces systems 700 times larger and thousands of dollars more costly, said the company.

Designed to deal realistically with nonlinear mathematical factors, the Quadratron is expected to permit a precision not normally achieved in certain practical engineering problems.

First applications probably will be in control systems, automation, analog computing, instrumentation, simulation, and data reduction. Cost will be a few hundred dollars. Douglas has indicated the units should be available to industry later this year.



Radar Is Strongly Defended at AFCEA Convention

by Hal Gettings

WASHINGTON—In contrast to Sir Robert Watson-Watt's statement at the Missile Industry Conference last week that radar is obsolete, consensus of experts at the 13th annual convention of the Armed Forces Communications and Electronics Association here is that radar is capable of doing its job today and in the foreseeable future.

Described as the most successful convention to date, the AFCEA convention had 80 exhibitors and an attendance of close to 4000. Exhibits overran the Sheraton Park exhibit hall into adjoining rooms and the lobby and even onto the lawn. Special events included a tour of the Ft. Meade Missile Master site and a banquet at which Gov. Leo Hoegh, Director of Civil and Defense Mobilization, was the principal speaker.

• **Growth claims**—Speaking in a panel on space tracking, Dr. H. G. Weiss of Lincoln Laboratories said that radar capability had grown with need. He said the problem is definition of requirements, rather than inability to design capable equipment.

Dr. Weiss pointed out that over the past few years the sensitivity of radar had increased 10,000-fold—which yields an increase of ten times in detection range. Present technology allows creditable performance at ranges of several thousand miles. According to Dr. Weiss, a thousand-fold increase in sensitivity is foreseeable in the near future. This would make possible effective ranges of 5-10,000 miles for small targets and up to 25,000 miles for large targets. (The *Atlas* satellite would be considered a "large" target.)

Present radar satellite tracking antennas, with their associated computation facilities, can track a satellite for a few seconds and determine its orbit. Conceivably, such a system could also track a missile for a short period and determine its trajectory—a vital factor in anti-ICBM defense.

Radar development can progress by several different means within today's state-of-the-art: larger antennas, more power, and by taking advantage of low-sky noise temperatures.

Based on present techniques, tracking antennas up to 250 feet in diameter can be built within the required mechanical accuracy tolerances. Fixed multilobe antennas can be built of almost any size. Transmitted power can, of course, be pushed up to practically any reasonable limit required. Since received power decreases as the fourth power of range, receiver sensitivities, too, are especially important. The further development of low-noise parametric amplifiers offer considerable help in this area.

Other interesting aspects of space tracking were reviewed by members of the panel. R. L. Easton of NRL described the southern radar fence for detection of satellites, and Dr. H. L. Richter, Jet Propulsion Laboratory, discussed the facilities for tracking deep-space probes (*Pioneer III* and *IV*) using the TRAC(E) radioastronomy system. The present three probe-tracking stations will be supplemented soon by the establishment of overseas facilities by NASA.

Other systems described included the BRL-ARPA DOPLOC (locked-doppler) satellite fence, the world-wide Smithsonian optical tracking system, Minitrack, and Spacetrack programs.

• **Panels**—Problems and developments in space communications were covered by a panel moderated by Rear Adm. John Clark, of ARPA. Other panels discussed photography, R&D management, and men and machine reliability in space travel.

General Curtis LeMay, AF Vice Chief of Staff, said at the keynote luncheon that "communications could prove to be the 'Achilles heel' of our nation's defenses." He pointed out that communications are lagging behind the needs of our rapidly expanding operational requirements, and called for increased effort, radical thinking, and rapid development of equipment to meet the growing demands.

Examples of needed improvements cited by the General:

• Range extension and improvement in tropospheric scatter systems;

• Improved reliability and security in cryptographic devices for voice, data, and pictures;

• Increased speed for teleprinter communications—up to pages per minute;

• A reliable worldwide voice capability.



ARMY MOBILITY AND FIREPOWER NEW VOUGH STUDY AREA

Chance Vought has taken the vol teer's pace forward to work with Army in an important mission . . . bri ing new techniques to an ages- defense area – the battlefield.

For 42 years a developer of high-p formance aircraft and strategic missi this company has sharpened its fo on the needs of the new Army.

On its own initiative, Vought has gaged in new study and developm programs to meet requirements of Army of today and tomorrow. One concept, still classified, was tested e in 1959 at the Army's Redstone Arse

Design philosophies and an organ tion tailored to development of advan aircraft and superior missiles are be adapted to the battlefield needs of t mobility and devastating firepower.

Vought's talents will continue to be rected toward fulfilling the requirem of our modern Army.

Advanced weapons is just one in broad spectrum of Chance Vought f of activity. Other areas include: de and production of high-performa aircraft, astronautics, electronics, submarine warfare, range syst management, commercial process trol systems.

CHANCE VOUGHT DALLAS, TEXAS



STRAC STRIKES !

They left in 30 minutes. With them went field kitchens, mortars, new battlefield missiles, barracks bags. All went aboard swift transport planes and headed for trouble 4,000 miles away. They arrived the same day, for this is a battle group of the Strategic Army Corps – world's most mobile army and our "defense on the double" against limited war. STRAC's kind of war has flared 18 times since V-J Day. STRAC's mission is to put out these "brushfires," or keep them from spreading. By quickening U. S. reaction to limited war, this crack Army corps helps lessen the prospect of global war.

ADVANCED WEAPONS · ASTRONAUTICS · ASW · ELECTRONICS · MISSILES AIRCRAFT · G · RANGE SYSTEMS

CHANCE VOUGHT DALLAS, TEXAS



SPACE ORIENTED ELECTRICAL ENGINEERS AND PHYSICISTS

Vast new space and missile projects have created outstanding opportunities in research, development and design at Douglas. Here are some of the areas in which we have immediate openings for engineers and physicists with advanced degrees (B.S. also considered):

SPACE NAVIGATION — Utilize Bode and Nyquist techniques, root loci, Z plane, quasi linear, non-linear and other techniques in the analysis and development of guidance and control systems.

SPACE COMMUNICATIONS — Telemetry system research and development, research in wave propagation in ionized gas, high frequency breakdown and many other areas.

SPACE POWER — Unconventional power research and development to supply power in space stations and on other planets.

LOGICAL DESIGN — Solid state digital circuits as applied to automatic test and firing equipment, utilization of complex switching and logic circuitry, and utilization of computers in detailed circuit design.

ANTENNA DEVELOPMENT — Complete research, advance design and development of antenna and radome systems for use on space vehicles.

For full information write to Mr. C. C. LaVene, Staff Asst. Vice-president, Engineering, Box 620-R, Douglas Aircraft Company, Inc., Santa Monica, Calif.

DOUGLAS

The most respected name in aircraft, missile and space technology.



PHOTOCON ELECTRO-MAGNETIC COUNTERS

—compact, reliable units for telemetering readout and control

These Photocon counters add and/or subtract electrical pulses at speeds up to 20 counts per second. Each digit on each wheel has a contact, for remote indication or control. Counters available with precision resistors mounted between contacts. Counter provides an analog or digital output.

High accuracy—there is no gain or loss of counts over a life of 10,000,000 counts. A balanced armature insures accurate counting during severe vibration.

High reliability—contacts are made from precious metals to eliminate contact noise. Wearing parts are built of Nylon for long life.

Small size—only 1 13/16" high x 3½" wide x 3¼" deep. Weight is only 22 ounces. Available in 3-, 4-, and 5-digit counters...also in shaft-driven models. Units can be preset, and hand reset. Write for literature on Photocon Model MCP-1005.

PHOTOCON RESEARCH PRODUCTS
421 North Altadena Drive, Pasadena, Calif.

A Complete Line of Electro-Mechanical Counters and Digital Clocks

Circle No. 24 on Subscriber Service Card.

—people—


KISTIAKOWSKY

George B. Kistiakowsky, a Russi born Harvard ch istry professor, been named by President to succ **Dr. James R. K lian** as special sistant for scie and technology. K lian resigned M 28th "for com ling personal r sons." He will turn to the Massachusetts Institute Technology, where he was president u his appointment to the scientific advis post in November, 1957.

Kistiakowsky, 58, became a natu ized citizen of the United States in 19 after emigrating from Russia where fought against the Communists in White Russian Army from 1918 to 19 He was a member of the National A demy of Sciences' Atomic Energy Co mittee as early as 1941 and chief of Los Alamos Laboratory's explosives di ion in 1944-45. He also headed seve wartime projects sponsored by the N tional Defense Research Committee.

In accepting Killian's resignation w "very sincere regret," the President e phasized "the vital importance" of work to the future security of the Uni States.

Killian, whose resignation is effect in mid-July, leaves what has, in the l two years, become one of the most fluential positions in government. (S M/R, Dec. 22, 1958, pp 22, 23.)


WICKERSHAM

Robert O. Wickersham has been pointed director of Space Technology Laboratories, Inc.'s program management staff, Systems Engineering Div. Prior to joining STL in 1956, Wickersham was manager of military sales for Lockheed Missile Systems Division. From 1951 to 1953, he was assistant the vice president for engineering at B Aircraft Corp.

C. Robert Shaeffer was elected sec tary-treasurer of American Electro Laboratories, Inc. **Raymond S. Marl witz,** a senior engineer of the compa was elected assistant secretary.

The Board of Directors of Gene Applied Science Laboratories, Inc., nam **B. J. Driscoll** to the newly created p tion of vice president-general manag Driscoll comes to GASL from the N tional Academy of Sciences-National R search Council, where he was associ director of a special study of long-ra research and development trends of terest to the Air Force. He has h executive positions at the M.I.T. Linc Laboratory, the NATO Advisory Gr

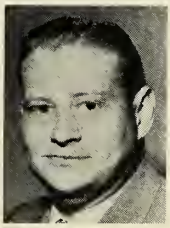
f Aeronautical Research and Development, and the Air Force Scientific Advisory Board.



HEBENSTREIT

William B. Hebenstreit has been named program director for communication satellites, Systems Engineering Division, of Space Technology Laboratories, Inc. He once was director of special programs for the Systems Engineering Division, and prior to that he headed Ramo-Wooldridge Corp.'s Computer Systems Division.

Maj. Gen. Otis O. Benson, Jr., Commandant of the Air Force School of Aviation Medicine, has been named president of the Pan American Medical Association's section on Space Medicine. **Dr. S. Fred Singer,** professor of physics at the University of Maryland and contributing editor of M/R, was named secretary.



LEWIS

David E. Lewis becomes assistant manager, applications engineering at Electronics, Borg-Warner Corp. A former USAF officer, Lewis headed the on-board recorder section, missile test track, at Holloman Air Force Base.

The National Academy of Sciences-National Research Council has announced appointment of a 14-man committee on the Scope and Conduct of Materials Research.

Dr. Clyde Williams, President of Clyde Williams and Co. of Columbus, Ohio, is chairman of the Committee. A former president and director of Battelle Memorial Institute, he served as chairman of the War Metallurgy Committee of the Academy-Research Council during World War II. Other members of the Committee are **Dr. Allen Astin,** director, National Bureau of Standards; **Dr. Harvey Brooks,** dean of Engineering and Applied Physics, Harvard University; **A. J. Herzig,** president of Climax Molybdenum Co. of Michigan and chairman of the Materials Advisory Board; **Dr. A. B. Kinzel,** vice president, Union Carbide Corp.; **Thomas H. Miller,** assistant director, U.S. Bureau of Mines; **Dr. John D. Morgan, Jr.,** consultant, Washington, D.C.; **Dr. Thomas B. Nolan,** director, U.S. Geological Survey; **Dr. Albert J. Phillips,** vice president, American Smelting and Refining Co.; **Dr. C. F. Rassweiler,** vice chairman of the board, Johns-Manville Corp.; **E. Duer Reeves,** executive vice president, Esso Standard Oil. Co.; **Professor Frederick Seitz,** Department of Physics, University of Illinois and chairman of the Committee on Perspectives in Materials Research; **Professor Cyril S. Smith,** Institute for the Study of Metals, University of Chicago, and **David Swan,** vice-president-Research, Lithium Co.



Aeronautical wind tunnel located at University of Michigan

FOR A SCIENTIFIC CLIMATE...

There's a devotion to creative thinking that you sense the minute you walk through the front door of the Bendix Systems Division.

Located in Ann Arbor, Michigan —a university town with big city advantages—you may enjoy all four seasons to the fullest. The year-round sports and outdoor recreation mean fun for you and your family. Within the buildings that house the Bendix Systems Division, the climate is scientific all year 'round.

If you are an able engineer or scientist seeking to apply your imagination and ingenuity to the problems involved in developing new weapons systems, you will enjoy the scientific climate at Bendix Systems Division.

If you are interested in doing advanced study, you will find the University of Michigan's fine Engineering College next door. Bendix encourages you to take advantage of this opportunity by attending daytime classes.

For information on a career in systems research and development, as well as a better way of life, you are invited to write for our new recruitment brochure. Bendix Systems Division, Dept. K6-15, Ann Arbor, Michigan.



Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix AVIATION CORPORATION

Circle No. 25 on Subscriber Service Card.

NEW PROGRAMS

have created

IMMEDIATE OPENINGS

for top quality engineers with experience in—

Preliminary Analysis
Aerodynamics
Flight Dynamics
Structural Dynamics
Aero-Thermodynamics
Flight Simulation
Space Communication
Space Instrumentation
Radar Systems & Techniques
Electronic Countermeasures
Guidance
Instrumentation
Electronics Test
Design
Computing
Reliability
Human Factors

Well paid jobs for qualified people.

Relocating expenses paid.

For information on these and other engineering positions, write:

B. J. Ralph, Dept. 451 M
Missile Division
North American Aviation, Inc.
12214 Lakewood Blvd.
Downey, California

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.

west coast industry . . .

BY FRED S. HUNTER

Youngest corporation president . . .
in the industry is Tom Jones, Northrop Corp.'s new chief. At 39, Jones is two years younger than Donald Douglas, Jr., who previously held this distinction. Jones is highly regarded, both as an engineer and company executive. He has vision, a quality that's very important in today's product competition. In this connection, keep your eye on Northrop developments in boundary layer control.

There's another Tom Jones . . .
who is president of a company in the industry, Thomas Roy Jones of Daystrom, Inc. On the coast not long ago, Jones observed his company is likely to lose money on its Daystrom Systems division in San Diego for the next three years. But he looks for a fine future. One of the Division's newest products is a 2000-point monitoring system for tests of a nuclear aircraft engine.

Fast-growing Daystrom, Inc., which had sales of $81,713,986 in Fiscal 1958, is shooting for annual sales of $200 million five years from now. "We hope to do it through internal growth and some acquisitions," said Jones. And to insure future growth, Daystrom this year will spend about 10¢ of every sales dollar on research, of which 4¢ will come back from the government.

Cost of an *Atlas* ICBM . . .
was estimated at $10 million during Senate hearings this spring, and ever since this has been the generally accepted figure. Convair's portion, however, comes to something under $2 million. This represents the cost of producing the missile frame and assembling the complete *Atlas*. It does not include the cost of engines, guidance system, nose cone or nuclear warhead. These are government-furnished. Only figure ever made public about the cost of nuclear warheads was $240,000 for a warhead for the Douglas *Genie*, an air-to-air rocket. *Atlas* warhead, of course, would cost much more. Launching sites also add up to a pretty penny. It's when you crank in all these costs that you get to $10 million.

Lockheed surveyed Santa Barbara . . .
before finally deciding the Newport Beach area would be a better location for the general and engineering offices of its new Electronics and Avionics Division. Newport Beach is closer to such soul-satisfying attractions as the Dodgers and Disneyland and this is an important factor to employment managers. It may be a couple of years, however, before the move is made since the Maywood plant provides an ample temporary facility.

The Air Force ALBM award . . .
to Douglas is a six-months development contract after which the government can take another look. The Air Force wanted to award a production contract on the ALBM, but William M. Holaday, Department of Defense director of guided missiles, decided it would be wiser to take a more conservative approach. There's little doubt that the Douglas contract will be extended into production. Support for the mobile platform concept keeps growing.

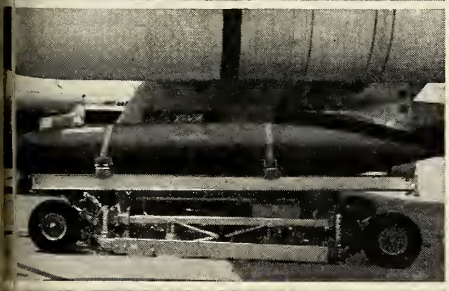
Aeronutronic Systems, Inc. . . .
the Ford Motor Co. subsidiary, is developing computer components that are 10 times as fast as those currently in operation. Computers with "learning" capabilities is another project. People learn by trial-and-error methods. "Why not a computer system which detects errors and corrects them?" says Dr. Ernest H. Krause, vice president and general manager of Aeronutronic's computer and range systems division.

...NEWS IS HAPPENING AT NORTHROP



For the Hawk missile, Nortronics supplies Raytheon Manufacturing Co. with the loaders, launchers, and auxiliary handling equipment. Throughout concept, design and production, Nortronics has kept this program on – or ahead of schedule.







Shown above: Northrop's T-38 Talon, F-89 Scorpion and SM-62 Snark – all served by Nortronics' mechanical, electronic and servo-hydraulic GSE applications.

NORTRONICS TOTAL GROUND SUPPORT – KEY TO DEFENSE READINESS!

By integrating mechanical, electronic and servo-hydraulic skills into a wide variety of ground support equipment applications, Nortronics demonstrates an understanding of the total weapon system.

Nortronics conceives, designs and manufactures GSE around a knowledge of the weapon's mission, its operational and maintenance concepts, and the facilities and skills of its field operators.

Twenty years of specialized experience gives Nortronics the ability to get the job done – to translate your most complex GSE requirements into reliable hardware – on time – and at minimum cost.

For immediate help with your GSE requirements, call Nortronics today. Or write: Chief Applications Engineer, Dept. 2003-G3, Nortronics, 500 E. Orangethorpe Ave., Anaheim, California.

NORTRONICS
A Division of
NORTHROP CORPORATION

Circle No. 26 on Subscriber Service Card.

high temperature
PLASTICS



Continuing research in the field of high temperature plastic molding has enabled Olympic to create fiberglass missile components such as nose cones, radomes and heat reflective shields.



High strength, heat resisting structural parts and exhaust deflectors, insulators and nozzles have been produced that perform as high as 5000° F.



Standard electrical terminal strips now adopted as NAS 1066, as well as special design terminal blocks, have been developed to withstand continuous service to 600° F.

OLYMPIC
Plastics Company, Inc.
3471 S. La Cienega Blvd., Los Angeles, Calif.

Circle No. 27 on Subscriber Service Card.

propulsion engineering

New high-temperature material . . .

Carborundum Company offers for nozzles and nose cones combines advantages of both silicon carbide and graphite—and each cancels the other's disadvantages. Silicon carbide has excellent erosion, oxidation, and heat resistance characteristics. Thermal shock resistance is good, but not good enough for many missile applications. Graphite, on the other hand, offers only fair erosion resistance and poor oxidation resistance. However, graphite has outstanding thermal shock resistance.

The new material consists of small graphite particles embedded in a dense silicon carbide matrix. The SiC shields the graphite which absorbs uneven expansion. Carborundum calls the material GRB silicon carbide. It can be tailored to meet different uses by changing the composition. Carborundum says thermal shock and erosion resistance over the full range of compositions—20% to 45% of graphite by weight—is excellent. However, generally speaking, maximum erosion and oxidation resistance comes in low graphite compositions. Thermal shock reaches a max in the high graphite compositions.

Physical properties of GRB SiC of interest to missile makers:

Thermal conductivity, high of 700 BTU/°F at 400°F down to 350 BTU/°F at 1600°; coefficient of thermal expansion, about 2.70 inches/°F over the range 70° to 2460°F, controlled by varying the SiC matrix; density, controlled by graphite composition, 2.3 to 2.8 grams/cm^3; flexural strength over a wide temperature range is "much higher" than that of standard graphite bodies.

Nozzle and nose cone shapes . . .

machined from GRB SiC have passed tests with flying colors. Carborundum says: "In highly erosive environments, under conditions of extreme thermal shock and temperatures in excess of 4500°F, this composite body of silicon carbide and graphite has consistently shown negligible or minor erosion and no evidence of thermal stress failure."

Almost any shape can be fabricated from the new high-temperature material. The free graphite bodies can be machined to tolerances of plus or minus 0.010 inches, the high free graphite bodies within 0.015 inch. By diamond grinding, it's possible to come within 0.003 inches of specification. At present, Carborundum says, fabricated sizes of GRB are limited to about 13 inches to 20 inches. However, a company official says larger sizes will be available soon.

The material will be turned out in a new plant getting under way at Niagara Falls. The $750,000 facility will be a pilot plant, but it will produce GRB at a commercial rate. Other products to come from the new plant, due on stream about the turn of the year, include boron nitride and a KT grade silicon carbide.

Here's a safer method . . .

of melting reactive metals. U.S. Bureau of Mines researchers have developed a way of reducing the risk of explosion that accompanies melting of zirconium and other reactive metals. They use air-cooled molds to catch the molten metal. The Bureau says some explosions have occurred in plants where water-cooled molds have been used. In studies at the Metallurgical Research Laboratory, Albany, Ore., Bureau scientists found that the air-cooled molds offer "a significant reduction in explosion hazard" and will perform as efficiently as water-cooled molds. The technique is applicable also to titanium, columbium, tantalum, and hafnium. Full details are available in Report of Investigations 5443, "Air Cooled Crucibles for Cold Mold Arc Welding." Write: U.S. Bureau of Mines, Publications Distribution Section, 4800 Forbes Avenue, Pittsburgh 13, Pa. The Bureau gives credit for the development to physicist M. M. Kirk and electrical engineer P. C. Magnusson, both with the Albany lab, and G. L. Schmidt, former Albany engineering aide who is now with Atomics International.



EW ROCKET BLAST PROTECTION — by Swedlow

w a ative/insulative wrapping by Swedlow protects Atlas missile nch tubes from direct rocket blast up to 5000°F. The materials and thod developed to meet this extreme demand hold great promise for ny ther applications requiring resistance to elevated temperatures.

To m t the rigid standards for this CONVAIR missile Swedlow has velo l methods of:

(1 Impregnating a refractory silica fabric with a Swedlow modified high temperature phenolic resin, and

(2 Covering the ¼" to 1" tubes and pressure vessels shown above, by tension winding with augmented pressure—a highly skilled operation, and

(3) Special heat treating or curing for maximum shock temperature resistance.

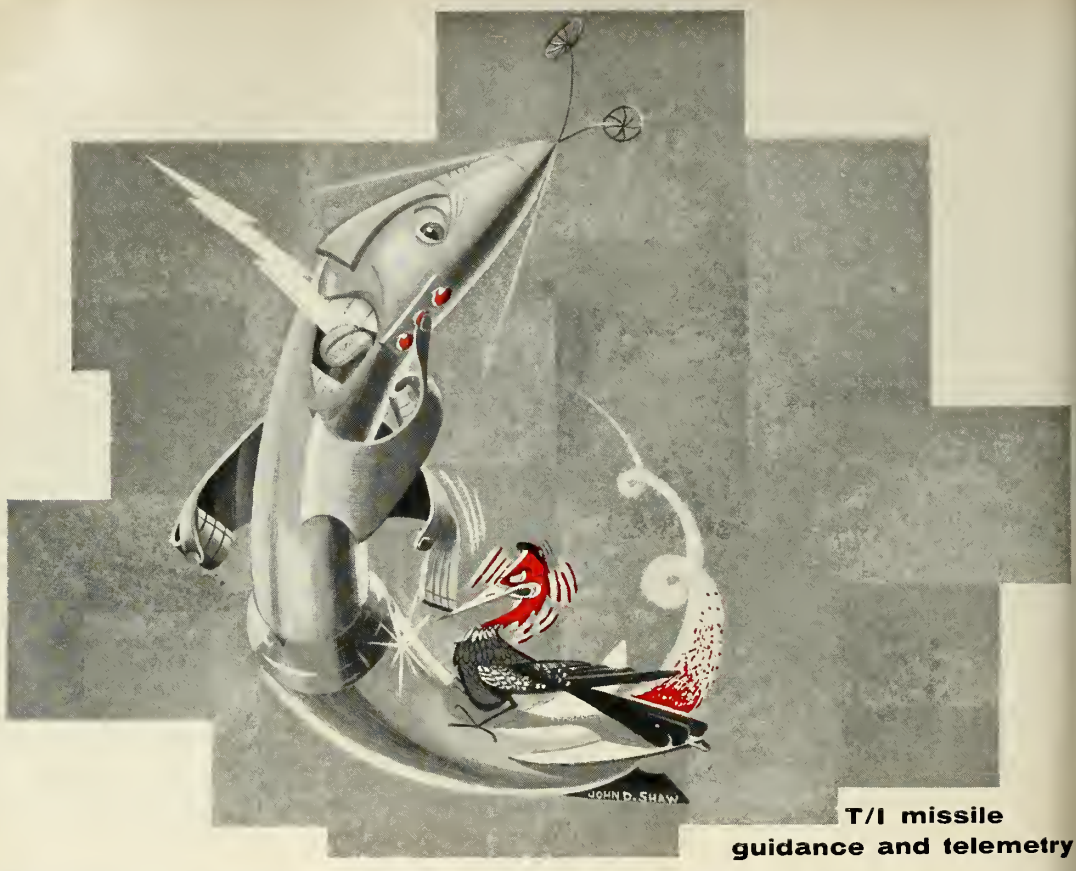
Here is another of Swedlow's contributions to industry, including high temperature resistance welded honeycomb core products, high temperature materials, heat reflective laminates, stretched acrylic transparent glazing materials and others.

Write for technical bulletin "S" entitled "High Temperature Phenolic Laminates." Please refer to Dept. 21.

vecow

SWEDLOW Inc. Los Angeles 22, California / Youngstown 9, Ohio
Formerly Swedlow Plastics Company

Circle No. 5 on Subscriber Service Card.



T/I missile
guidance and telemetry

BEEPS WITH A HIGH IQ

...for missile sensing, guiding and telemetering

Electronic signals that report the truth, the whole truth, and nothing bu . . . wring the best performance from missile systems. By pushing beyon known capabilities in sensitivity and accuracy, Texas Instruments is producin "high IQ" systems and equipments for a dozen guided vehicles used in ever basic mission: air-to-air, air-to-surface, surface-to-air, surface-to-surface - IRBM and ICBM—plus drone sensors and satellite instrumentation. T exceeds tough specs against tight deadlines, regularly . . . specs askin solutions to problems never posed before. For detailed discussion, cleare personnel please write or call: SERVICE ENGINEERING DEPARTMENT.

RESEARCH/DESIGN/DEVELOPMENT/MANUFACTURING of systems for: *Air traffic control • Airbo early warning • Antimissile • Antisubmarine warfare • Attack control • Countermeasures • Missile syste Navigation • Reconnaissance • Space electronics; and on detector cells, engine instruments, infrared, interc microwave, optics, radar, sonar, telemetry, time standards, timers, transformers and other precision devi*

APPARATUS DIVISION

TEXAS INSTRUMENT INCORPORATED

6000 LEMMON AVENUE
DALLAS 9, TEXAS

Circle No. 6 on Subscriber Service Card.

reviews

EDICAL SCIENCE AND SPACE TRAVEL,

illiam A. Kinney, Franklin Watts Inc., ew York, 149 pp., $3.95.

One of the generally overlooked areas f space research is the medical pro- ssion's attempt to fit man into the space nvironment. Though such research repre- nts only a small part of the $7 billion issile and rocket industry, it holds the ey to the industry's ultimate goal—flight space.

This book is a narration of the air nd lab experiments presently being con- ucted by flight surgeons. Weightlessness, iet and solitude, radiation, meteors, and mperatures of outer space are some of e problems discussed, with conjecture to what some of the eventual solutions ay be. An interesting analysis of man's tempt to chart his unknown reactions the totally alien environment of spacc.

IGH ALTITUDE AND SATELLITE ROCKETS,

he Philosophical Library Inc., New York, 6 pp., $15.00.

A compilation of papers given at a e-*Sputnik* symposium on British high- itude and satellite rockets by the Royal ronautical Society, the British Inter- anetary Society, and the College of ronautics. The papers are by both nerican and British experts in the vari- s areas of rocket research.

WASHINGTON—The May issue of U.S. *overnment Research Reports* lists a mber of reports of interest to the ssile industry which are available to the blic. Subjects include Astronomy, Chem- ry, Earth Sciences, Engineering, Engines d Propulsion Systems, Materials, Me- anics, Nuclear Physics, Physics, Radia- n, and others. The monthly listing may obtained from the Dept. of Commerce, U.S. Government Printing Office. An- al subscription fee is $6.

WASHINGTON—Two articles of partic- ar importance to the missle industry ear in the April issue of the monthly val Research Lab report of progress.

The first describes in detail the tech- ques and equipment used in the first ccessful photography of the solar disk radiation from the Lyman-Alpha line of drogen. The March flight of the *Aero- b-Hi* rocket climaxed four years of ort to get such photographs.

A second article describes the com- te data-reduction system (ARRF) used reduce *Vanguard* telemetry data. The tem, one of the fastest and most pro- ssive of any missile program to date, s completed in 1958 and has been nificantly successful in operation.

The report also contains notes on the gress of various unclassified NRL re- rch studies now under way.



look for the professional challenge ... *available only to those who possess the creative initiative to explore, in thought, beyond what is known about space travel, and return with the serendipity that only the few would recognize. If you are one of those exceptional individuals who is seeking a challenge such as this, communicate with N. M. Pagan, Director of Technical and Scientific Staffing, Martin-Denver, P. O. Box 179, (F-3), Denver 1, Colorado.*

MARTIN
DENVER DIVISION



A candle in a dark room?

Transverse and/or Visible electromagnetic waves?

A universal constant?

How many wave lengths in a photon?

Is light affected by gravity?

A full appreciation of light and all its phenomena is essential to the successful completion of our energy conversion mission.

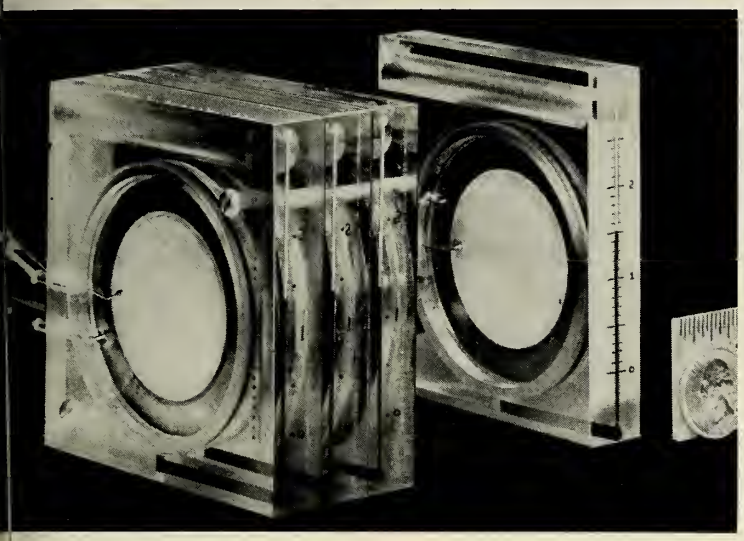
We use this knowledge constantly—as, for example, in our recent development of a photo-voltaic conversion system and a mechanical-optical system to convert light energy to electrical energy.

To aid us in our inquiries we call on the talents of General Motors Corporation, its Divisions and other individuals and organizations. By applying this systems engineering concept to new research projects we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business

ALLISON

Division of General Motors, Indianapolis, Ind



Electrostrictive Discs Measure Voltage

Prototype models of a new type of cage meter have been built by the **Electronics Department, Mullenbach Division, Electric Mfg. Co.,** using electrostrictive ceramic discs as the dynamic moving elements.

Each meter consists of a small transparent block enclosing two opposing metal discs on which smaller discs of white ceramic have been bonded. Each ceramic wafer is coated on both sides with silver frit, forming a capacitor. When an electric potential is applied, the ceramic contracts, cupping the metal disc.

Colored fluid contained in the reservoir between the two plates is forced to rise in a capilliary tube at the front of the meter, providing a visual indication of the voltage being measured. A surge chamber at the top of the block prevents the building up of back pressure.

The prototype models constructed by Mullenbach measure less than ¾ths of an inch in width, allowing a number of units to be mounted in the space normally required by a single voltage meter of conventional design. Even smaller units could be built, following the same basic concepts.

The new electrostrictive ceramic that makes possible the new meter design is the result of Mullenbach's continuing research in the field of ceramic materials for electronic applications.

Circle No. 225 on Subscriber Service Card.

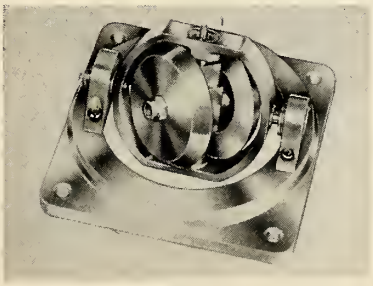
Split Rotor, Solid Bar Gimbal Gyro Ready

Clary Dynamics has announced the production of a split rotor, solid bar gimbal gyro which combines accuracy with economy.

The spring wound gyro is designed for use in small, short range missiles and drones.

The two-axis Clary instrument will resist shock to 100 G's, acceleration to 10 G's and vibration to 10 G's while attaining drift accuracies of 0.1 degrees per second.

An uncaging method cuts total time to speed and uncage to 0.1 seconds maximum. The optimum performance running time is 4 minutes with an 8 minute rundown time. The gyro may be kept in wound condition indefinitely



and may be rewound and used as many times as required without loss of accuracy.

The flexible design is said to offer a choice of resistive, commutator or selsyn pickoffs for custom specifications.

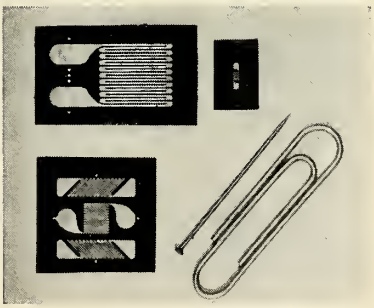
Circle No. 226 on Subscriber Service Card.

Strain Gages Feature Rosette Shape, Minature Size

Three high accuracy MetalFilm strain gages are going into full production at **Tatnall Measuring Systems Co.,** a subsidiary of **The Budd Co.**

The gages are tiny. The smallest one measures 1/32 in. wide, 5/32 in. long and 1/1000 in. thick; the largest is 1/2 in. square and also 1/1000 in. thick. Weight of the gages ranges from 1.1 mg. (.00003883 oz.) to 9.3 mg. (.0003282 oz.). Two of the three gages are fully temperature-compensated for four alloys.

Features of the three gages are: rosette gage to determine magnitude and directions of principal strains;



miniature gage for use in areas of very steep strain gradient; high fatigue life gages for structures undergoing severe dynamic strains.

Rosette MetalFilm gages (top, left), whose geometry is of the three-gage, 45° type, are generally used for determining the magnitude and directions of principal strains.

This gage, designated 121 R3A, is temperature-compensated for four alloys; steels, 19.8 stainless steels, magnesium alloys and aluminum. A prefix before the gage designation specifies for which alloy a particular package of gages is intended.

Rosette gage specifications include resistance of each section—120 ohms; resistance tolerance of each section—± .2 ohms; gage factor tolerance—± .5%; length of each gage section—1/8 in. All gages are epoxy-backed and

at least 1/16 in. of border material is supplied on all sides of the rosette pattern. Reference marks on the gage establish two center-lines to bisect the pattern, which is symmetrical in both planes.

Miniature Metal Film gages, (bottom, left) with a working area only 1/32 in. long, are being produced for use in very steep strain gradient areas such as exist around fillets, cut-outs or holes.

Designated 1X1-321, this miniature unit incorporates the same four-alloy temperature compensation feature as the 121-R3A rosette gages.

Specifications for the 1X1-32A gages include: resistance—60.0 ohms; resistance tolerance—±.2 ohms; gage factor tolerance—±1%. All gages are epoxy-backed.

Dynamic strain measurement Metal Film gages (top, right) has a fatigue life 5-10 times that of an equivalent gage made of advance alloy.

Dual advantages of the gage are: high gage factor (approximately 3.2) and maximum endurance limit.

Tatnall's dynamic strain measurement gages are manufactured from an iso-elastic type alloy and have been designated the 301 series; they cannot be supplied in temperature-compensated types. The 301 series are not recommended for static measurement because of their high positive temperature coefficient.

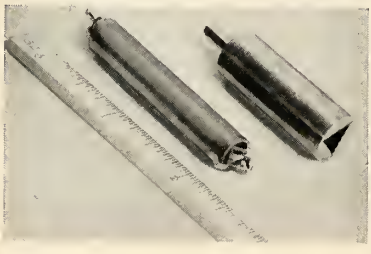
Specifications for the type 341-500 gage in the 301 series include: resistance—500 ohms; resistance tolerance—±1 ohm; gage factor tolerance—±.5%. Dimensions of the gage are ¼ in. square excluding tabs. The 301 series are also epoxy-backed and can be applied with the same standard technique used for Tatnall's 101 series MetalFilm gages.

Circle No. 227 on Subscriber Service Card.

Current Sensitive Relay Can Withstand 100 G's

A current sensitive relay of the "Powrmite" micro-miniature relay series has been produced by **Filtors, Inc.**

Known as the "S" type, this new



addition to the rotary "Powrmite" series meets shock tests of 100 G's for 11 milliseconds and vibration tests of 10-55 cps @ .06 double amplitude, 55-2000 cps @ 30G's.

Other specifications: contact arrangement: 2C (DPDT); ambient temperature range: −65°C. to 125°C., dielectric test: (at sea level) 1000V. (750 V. between open contacts); contact rating: 2 amps resistive; pull-in time: 5 milli-seconds maximum; drop-out time: 5 milliseconds maximum; 0.5 oz. maximum weight. Coil resistances from 185 to 10,000 ohms are available as standard values.

Circle No. 228 on Subscriber Service Card.

Portable Device Measures Nonmagnetic Metals

A new portable eddy current instrument has recently been made available by the **Magnaflux Corporation.**

By accurately measuring electrical



conductivity, the battery-powered Magnatest FM-110 Conductivity Meter performs a variety of testing jobs, including the determination of hardness, alloy, and heat treat condition; sorting mixed nonmagnetic metals; checking tensile strength of aluminum; investigating fire damage to aircraft, and many others. Readings can be taken on a comparative basis using known samples, or in absolute electrical conductivity units as a percent of the International Annealed Copper Standard.

The FM-110 induces eddy currents within the test piece by means of a ½" diameter hand-help probe. These currents affect the impedance of the probe coil as a function of the conductivity of the material. With the probe on one side, the large knob is turned to zero the meter and conductivity is read on the left-hand scale.

This compact 3⅜" x 8¾" x 6 instrument, weighing only 4½ pou can be used for both product and on-site testing. Total range 8% to 107% I.A.C.S., with an curacy better than ± 3% of sc reading, and usually better than ± when used on a comparative basis.

Three volts from two stand flashlight batteries power the self-c tained unit. A built-in battery chec indicates whether the batteries m the required operating voltage ran

Circle No. 229 on Subscriber Service Car

Low-Cost Chemical Pump Produces High Vacuum

A simplified titanium getter pump utilizing the chemical react between gases and titanium vapor produce vacuums in the 50 micror 1 x 10^{-9}mm Hg range has been veloped by engineers at **NRC Equ ment Corp.**

Said to cost less than 25% as m as equipment previously availa the pump has applications in resea testing and production when it is ne sary to avoid even a trace of b streaming fluids that might cont nate a vacuum chamber, and/or w it is desirable to pump down and m tain either an open system or a cl chamber, such as a demountable t at high vacuum for long periods.

The unit consists of a stainless s cartridge 7⁵⁄₁₆ inches long and than ½ inch in diameter. Inside tungsten filaments overwound titanium wire. When the cartridg connected to a source capable of plying 60 amp, 3 volt power, titanium is vaporized and form highly reactive layer on surroun surfaces.

A large percentage of the gas m cules striking this layer are abso and chemically bound. Thus, pum is accomplished by gettering. The no pump fluid to contaminate chamber that is being evacuated, periodic firings of the filament sufficient to maintain a high vac in chambers with slow out-gassin materials or slight in-leakage of

The frequency of firing depend



Armco PH 15-7 Mo Stainless elected for the B-70 Valkyrie and F-108



It's the primary sheet metal for construction of newest air weapon systems being developed and built by Los Angeles Division of North American Aviation, Inc.

he B-70 Valkyrie and the F-108, Mach 3 aircraft sig ed for 70,000 ft. altitudes, will add powerful ng range weapons to America's air armor. Both the ar tically-new intercontinental bomber and the in- rc tor being created by North American, in col- bo tion with a team of major defense firms, are to constructed primarily of stainless steel.

Because Armco PH 15-7 Mo Stainless maintains its rength at the high temperatures caused by speeds ceding 2000 mph, it has been specified for the major rts of the airframes.

This special stainless steel, in foil and sheets, will be fabricated into high strength, honeycomb panels for wings, fuselages, and control units. It will also be used for other key structural elements of both aircraft.

Selection of Armco PH 15-7 Mo, newest of Armco's widely used family of precipitation-hardening stainless steels, demonstrates the superiority of this high strength, heat and corrosion resistant metal. For complete information on the properties and fabrication of Armco PH 15-7 Mo Stainless Steel, write Armco Steel Corporation, 2539 Curtis Street, Middletown, Ohio.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Circle No. 21 on Subscriber Service Card.

The INSIDE Story of Cape Canaveral and the Air Force Missile Test Center



By the author of *Vanguard* and former Consultant to the Commander of the Air Force Missile Test Center. Here's a complete history not only of Cape Canaveral but of Air Force missile development, including the ATLAS, NAVAHO and SNARK programs. Packed with *dozens of facts never before published*, including controversial testimony by top Air Force and Army commanders. Many photographs and diagrams.

$4.95 at all bookstores

DUTTON

300 Fourth Ave., New York 10

Circle No. 28 on Subscriber Service Card.



Rx FOR INTERNAL INSPECTION

● **0.10" AND UP** . . . That's the point of entry requirement . . . to provide your inspectors the chance to use the outstanding National Fontar Borescope and thus give them the brightest, distortion-free, close-up view of the defect in "inaccessible" interior surfaces of the cast, drawn, welded or molded product . . . from inches deep to many feet.

Find out how its use can be a time and cost saver while it up-grades your Quality Control. Just send for our "Borescope Catalog."

ENGELHARD INDUSTRIES, INC.
NATIONAL ELECTRIC INSTRUMENT DIVISION
92—21 Corono Avenue • Elmhurst 73, New York

Circle No. 29 on Subscriber Service Card.

the system. The longer the power is applied, the more the titanium that is vaporized and the greater the pumping action—up to, the design limits of the pump. Unlike that of mechanical or diffusion pumps, the action of the titanium adsorber cartridge continues after the filament is turned off.

Pumpdown speed is approximately 5 liters per second. Pumpdown times are dependent on the size and nature of the chamber, sealing method and bakeout and other operating techniques.

Filament life is about 500 evaporations of 1 minute, or equivalent, at 1 micron or less, based on tests to date. A complete filament assembly can be replaced in less than 2 minutes and new filaments can be overwound with titanium wire in under 5 minutes.

No provision for ionization is required. Essentially all of the pumping is by gettering action.

The pump may be used directly following mechanical pumping to the 10 micron level or below.

It can be used following pumping by trapped oil or mercury diffusion pumps or molecular drag pumps where pressures in the 10^{-4} or 10^{-5} mm range are first attained.

In either case the volume to be evacuated, including the titanium pump, is completely isolated by UHV valves or seals prior to final pumping. With suitable initial pumping and bakeout, and careful technique, pressures in the 10^{-9} mm range are attainable and these can be maintained by intermittent evaporations of short duration at increasing intervals.

Circle No. 230 on Subscriber Service Card.

Economical Track Antenna Is Highly Mobile

A tracking antenna which combines maximum economy with utility is now available from **D. S. Kennedy & Co.**

The transportable tracker has three important features: a folding 28-foot reflector, hand-operated elaz drive system and self-contained trailer m and tower.

The reflecting surface is a sp reflective cloth which folds compa and the ribs of the reflector are hi around the center section. When reflector is collapsed into a con bundle and the supporting lowered onto the flat trailer bed antenna is easily towed to an location by a light truck or st wagon.

While the elevation and azi drives are intended to be operate hand, motors and selsyns can be added if desired.

Circle No. 231 on Subscriber Service C



Carcinotrons Eliminate Frequency and Power H

A new family of eight electr compatible carcinotrons is being duced by the **Electron Tube Di** of **Litton Industries.** The carcin are the first such group to use bands sole tuning without frequer power holes when a tube is op into as much as a 2-to-1 mismat

With wider-than-normal-ban output couplers, the Litton ca trons minimize other component as antennas, waveguide plumbin load isolators. Tuning rates are siderably faster than on any tube viously obtainable, with size weight the smallest to date.

Circle No. 232 on Subscriber Service

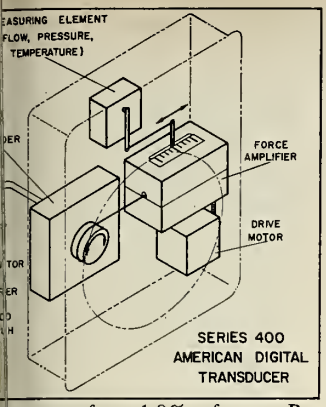
Process Variables Meas by New Digital Transc

A new Series 400 transducers measure process variables and p digital encoding for flow, liquid pressure or temperature has bee duced by the **American Meter C**

The new transducers empl completely mechanical American Amplifier—actuated directly by ard measuring elements, to positi shaft of a precision encoder (to digital converter).

The use of the Force Ar eliminates the need for ele servos, vacuum tubes, magnetic fiers or electronic component resultant reduction in initial cost maintenance cost, and an incr reliability.

The Series 400 transduce available in vacuum and p ranges to 10,000 psi, temp ranges to 600°F, and in merc bellows type manometers for level or flow applications. The ducers are conservatively rate



curacy of ± 1.0% of span. Re- cibility is better than ± 0.5% in. Linear or square root encoders available. The transducers are d in standard all-weather meter

No. 233 *an* Subscriber Service Card.

ro Plotter Eliminates ual Data Reduction

n electronic device which auto- ally checks out servo systems and luces the test results in graphic has been brought out by **Republic on Corporation.**

e unit, an automatic Servo r, is said to eliminate long hours nual data reduction required for outs with non-automatic systems. lic says its plotter produces a on of 40-point curves within 12 es from the beginning of the

lieved to be the only automatic plotter on the market, the Re- analyzer can be used with vir- any electronic servo system. It and plots phase and amplitude nships in the data-frequency from .3 to 30 cycles. Harmonic ions are compensated for auto- lly.

ilt of standard modular rack nel construction, the Servo Plot- ive feet high by two feet square. rketed by Republic, the Plotter omplete unit requiring no ac- parts. It utilizes conventional plot paper and provides, among Bode, Nichols and Nyquist

No. 234 *an* Subscriber Service Card.

mic Capacitor Touted place Paper Varieties

kard Bell Electronics announces application on a new capacitor olutionary design which is ex- to eventually replace most paper ors in the .01 and .25 micro- ange and mica capacitors in no-

drift capacities of 300 micro-microfarad to .01 microfarad.

The capacitor is made of ceramic in two forms: extruded and molded. The extruded model is a tube with a triangular cross bracing which performs double duty as a structural core and as a surface area to increase capacitance. The molded type is of solid construction which may be manufactured automatically in one piece without the use of leads or terminals. Both types are suitable for high temperature. The molded type is capable of withstanding extreme temperatures due to its elimination of soldered terminals.

In the 300 micro-microfarad to .01 microfarad range a no-drift capacitor can be made for values of NPO up to N6000 for temperature compensation. The capacitors are non-inductive and have indefinite life since no active elements are used in their manufacture. They reduce mounting area, cost and installation time, and are suitable for printed circuitry and dip soldering techniques without price penalty.

Circle No. 235 *an* Subscriber Service Card.

Transducer Measures Pressures to 10,000 psi

A precision pressure transducer designed to measure gauge or absolute pressures in the 100-10,000 psi range and give exceptionally high performance under severe environmental conditions was announced by the Components Division of **Fairchild Controls Corporation,** a wholly owned subsidiary of **Fairchild Camera and Instrument Corporation.**

The Model TPH-175 is a dynamically balanced pressure transducer which employs twin spring linkage to eliminate pivots or bearings thereby eliminating friction points and giving the unit excellent repeatability characteristics.

The pressure sensing elements are twin bourdon tubes which actuate the wiper of a precision wire-wound potentiometer giving either linear or nonlinear outputs. Overall accuracy including linearity, friction and hysteresis is ± 2% with resolution as low as 0.25%.

Utilizing the new design, the unit can withstand 55 to 500 cps at 10g's vibration with less than 1% error and 2000 cps at 25g's without permanent shift in calibration or damage.

The TPH-175 can withstand an acceleration force of 25g's in each of the three mutual perpendicular axes and shock up to 25g's without damage. Over-pressure up to 100% of the unit's range is possible with negligible calibration shift.

Circle No. 236 on Subscriber Service Card.



Miscues and accidental exposure to dangerous propellants and other chemicals can occur with shocking suddenness. Adequate water irrigation is an important key to minimizing such injuries and subsequent claims. HAWS Decontamination Bath is the answer . . . a complete safety station for immediate first aid.

HAWS MODEL 8600 DECONTAMINATION BOOTH

is made of durable, lightweight reinforced fiberglass plastic, and features Haws Eye-Face Wash Fountain, eight lateral body sprays and overhead spray unit. All are simultaneously activated by weight on the base-mounted foot treadle! Contaminated victims are instantly "covered" with water that floats away foreign matter from body and clothing.

At aeronautical and astronautical installations everywhere, HAWS Safety Facilities are important in boosting air-age safety programs. Find out what this equipment can mean to your operation. Full details sent on request, with no obligation.

HAWS DRINKING FAUCET CO.
1443 FOURTH ST. • BERKELEY 10 • CALIFORNIA

EXPORT DEPARTMENT • 19 COLUMBUS STREET
SAN FRANCISCO 11, CALIFORNIA

Circle No. 30 on Subscriber Service Card.

contract awards

WASHINGTON—The Pentagon's Advanced Research Projects Agency awarded contracts totalling more than $400 million to private industry and other government agencies during Fiscal Year 1959.

Here is an official breakdown, giving a description of the work, the participating government agency, the principal contractor(s) with whom a contract has been placed or is being negotiated, and estimated project funding through FY '59.

Military Space Technology Satellite Systems

Project *Discoverer*, Sec/AF, Lockheed Aircraft Corp., $106,000,000; Project *Midas*, ARDC, Lockheed, $10,800,000; Project *Score*, ARDC & ASC, Convair, Div. of General Dynamics, $704,000; Project *Sentry*, Sec/AF, Lockheed, $96,600,000; Delayed repeater system (*Courier*), ASC (Primarily in-House), $3,000,000; Doppler navigation system (*Transit*), BuOrd., Johns Hopkins Lab., Lockheed, $1,383,000; Subsystems for meteorological project, ARDC, $1,151,000; Launch vehicles, ARDC, Douglas Aircraft, $18,300,000; Active repeater communications satellite (launch and control), ARDC, $1,000,000; Active repeater communication satellite (payload), ASC, $1,000,000.

Propulsion and Launch Facilities

Project *Saturn*, AOMC, in-house with engines from Rocketdyne Div. of North American Aviation, $24,508,000; Project *Centaur*, ARDC, Convair, Div. of General Dynamics, Pratt & Whitney, $16,000,000; Static Test Tower and Launch Stand construction (*Saturn*), AOMC, $9,492,000; Large thrust test stand, EAFB (1 million lb. thrust single chamber engine), ARDC, $240,000.

Tracking and Ground Environment

Project *Spacetrack*, ARDC (Primarily In-house), $1,299,000; JPL ground space surveillance, AOMC, JPL, $226,000; Spain and Japan tracking installations, ASC, $7,601,000; Instrumentation ship PVT. Joe E. Mann (PMTR), Philco Corp., $1,100,000; 2 VC-2 vessels (PMTR) BuAer., $2,300,000; Minitrack modifications and extensions, NRL (Primarily In-house), $11,740,000; Doppler system installation, BRL (Primarily In-house), $6,875,000.

Exploratory Research

Stagnation point ballistics, Army, R&D, Metallbau Semler, Munich, Germany, $290,000; Properties of materials at low temperatures, NBS, In-house, $184,000; Nine studies in space power research, ASC, $961,000; Study in space power research, BuShips, $200,000; Research in high temperatures and pressures, NOL, Bjorksten Research Labs, Inc., $115,000; Feasibility Studies (space propulsion and power sources), ONR, Princeton University, Curtiss-Wright, Republic Aviation Corp., University of California, $413,000; Feasibility studies (Project *Orion*, Adv. space propulsion and power sources), ARDC, General Atomic, Div. of General Dynamics, Aerojet-General, Reaction Motors of Thiokol, Plasmadyne Corp., Experiment, Inc., Aeronutronic Systems, Inc., Atlantic Research Corp., AVCO Research Lab., Rocketdyne Div. of North American Aviation, Fairchild Aircraft, Aero-Chem Research, Vidya Associates, RCA, $2,809,000; Feasibility studies (Heat rejection from space vehicles, advanced power sources), AOMC, Electro-Optical Systems, $182,000; Magnus effect study, BuAer, Flettner Aircraft Corp., $28,000; Plasma electron study, Army, R&D, Batelle Memorial Institute, Frankfurt, Germany, $307,000.

Ballistic Missile Defense (Project *Defender*)

Info. center on high altitude weapons effects, ARDC, Rand Corp., $144,000; Reentry physics studies, ARDC, Mass. Inst. of Tech., $4,646,000; Omni-Range Digital Radar, ARDC, Columbia University, $1,328,000; Electronically Steerable Array Radar, ARDC, Bendix Aviation Corp., $2,144,000; Missile Range measurements, ARDC (Primarily In-house), $3,435,000; ACANIA assignment to AMTR, ARDC, Stanford Research Institute, $575,000; H.F. ionospheric radar research, ONR (Primarily In-house), $535,000; Ballistic missile defense system studies, ARDC, Convair, Div. of Gen. Dynamics, $1,375,000; Atmospheric and ionization studies, ARDC, A.D. Little Co., Convair, Div. of Gen. Dynamics, $1,435,000; Radar discrimination, ARDC, Raytheon Corp., $680,000; Down range ship operation, AOMC, Radio Corp. of America, $2,700,000; High power radar research, AOMC, Cornell Aeronautical Lab., $1,361,000; Advanced radar research, ARDC, Mass. Inst. of Tech., Lincoln Lab., $515,000; Vertical probe launching, ARDC (In-house), $397,000; Decoy sorting radar, ARDC, Raytheon Corp., $1,180,000; Microwave radar, ARDC, RCA, $850,000; Artificial electron clouds study, ASC, Itek Corp., $39,000; Catalytic effects in discharges, BRL (In-house), $80,000; Design of hypersonic intercept system, ARDC, Convair, Div. of General Dynamics, $1,033,000; Hypervelocity impact research, BRL (In-house), $525,000; Hypervelocity impact research, BRL (In-house), $300,000; Photodetachment cross-section studies, NBS (In-house), $30,000; Digital phased array radar, AOMC, Sylvania Electric Products, Inc., $1,434,000; Transmission of ion and atomic beam studies, ASC, American Machine & Foundry, $100,000; Feasibility studies (Primarily GLIPAR) ONR, Gen. Atomic, Div. of General Dynamics, Stanford, Research Institute, Westinghouse Corp., Aeronutronic Systems, Inc., Allied Research Associates, University of Chicago, Convair, Div. of Gen. Dynamics, General Electric Tempo, General Mills, Inc., Houses Aircraft Co., Industrial Research Assoc., Ramo-Wooldridge, RCA, Republic Aviation Corp., Technical Operations, Inc., $1,780,000; Feasibility studies (satellite defense systems, missile phenomenology), ARDC, RCA, Convair, Div. of General Dynamics, General Electric, Lockheed, Gen. Atomic, Div. of Gen. Dynamics, Republic Aviation, Dikewood Corp., Allied Research Associates, $3,805,000; Feasibility studies (Space intercept, re-entry, and target studies), AOMC, Solar Aircraft Corp., Bendix Aviation Corp., AVCO Research Lab., Raytheon Corp., Convair, Div. of Gen. Dynamics, $3,257,000.

Solid Propellant Technology

Studies of light element compounds, NBS (In-house), $500,000; Solid propellant research, BuOrd., Minnesota Mining & Mfg. Co., American Cyanamid, Aeronutronics Systems, Applied Physics Lab., Magna Propulsion, Atlantic Research Corp., Olin Mathieson, New York University, Navy (In-house), Allegany Ballistics Lab. (In-house), NOTS, NOL (In-house), $5,201,000; Solid propellant research, ONR, Ohio State University, Princeton Univ., Aerojet-General Corp., Aerochemical Research Lab., Univ. of Calif., Polytechnic Inst. of Brooklyn, Penn State Univ., $700,000; Solid propellant research, ARDC, Dow Chemical, Gallery Chemical, Monsanto Chemical, Pennsalt, Borden, Penninsular Chemresearch, Ethyl Corp., Atlantic Research Corp., National Research Corp., Univ. of Texas, Stanford Research Institute, Aerojet-General Corp., Univ. of Calif., Materials Research Corp., Materials Laboratory, WADC (In-house), Air Force (In-house), $3,910,000; Solid propellant research, AOMC, Esso Research & Engineering, Allied Chemical, Olin Mathieson, Army (In-house), Rohm & Haas (In-house), $3,267,000; Solid propellant research, OOR, University of Chicago, Duke Univ., A.D. Little, Vanderbilt Univ., Univ. of Florida, $630,000; Solid propellant research, BuMines (In-house), $215,000.

Civilian Space Programs Transferred to NASA

2 lunar probes; cosmic ray experiment; 12 ft. sphere, AOMC, $18,820,000.

3 lunar probes, ARDC, $7,600,000.

Ground scanning for lunar probes, NOTS, $400,000.

Meteorological payload, ASC, RCA, $6,711,000.

Other announced awards included:

NAVY

The Sperry Gyroscope Co. has been selected as the prime contractor for the development and assembly of navigational equipment for the new version of the *Pol* missile-firing submarine. (Initial con ls for $2 million.)

Sylvania has received $10 million in tracts for the development of munications systems for the *Polaris* gram.

$1,195,386—West Bend Aluminum Co., Bend, Wis., for *Zuni* rocket launcher

AIR FORCE

$63,000,000—General Electric Co., Del Systems Dept., for radio-command g ance systems for the *Atlas*.

$15,326,000—Hercules Powder Co., Wilm ton, Del., for research and develop of a third-stage engine for the *Min man* ICBM.

$12,458,351—Douglas Aircraft Co., Inc., S Monica, for components, ground sup equipment, spare parts and technical engineering data on *MB-1* rocket.

$11,000,000—Westinghouse Electric Aircraft Equipment Dept., for elec power generating system for the AF bomber. (Prime contractor **Convair Di General Dynamics.**)

$7,000,000—Melpar, Inc., Falls Church, for production of F-101B weapon sy simulators. (Initial amount of this tract $2,500,000, the ultimate value cess of $7,000,000.)

$5,000,000—General Electric Co., Flight pulsion Div., Cincinnati, for turbojet craft engines, data and bill of mat for German, Lockheed designed F-10 craft.

$3,000,000—Hughes Aircraft, Culver Calif., for aircraft and weapons co systems, engineering services, mat and data.

$1,843,944—General Precision Labor Inc., Pleasantville, N.Y., for addi procurement of components for AN/APN-81 Doppler Navigation syst

$525,000—Lockheed Aircraft Corp., G Div., for research in connection with newly-developed titanium alloys.

$398,944—RCA, Harrison, N.J., for v electron tubes.

$179,069—Bomarc Laboratories, Beve Mass., for various electron tubes.

ARMY

$22,200,000—Martin-Orlando, for addi *Lacrosse* missiles and related g equipment.

$2,961,000—Martin-Orlando, for contin of engineering services for the *La* system.

$1,868,404—Paul Hardeman, Inc., Los les, for missile launch complex "H P.L.S. equipment for ODTF at Va berg AFB.

$1,038,000—Rocketdyne Div., North can Aviation, Inc., Canoga Park, fo sified contract.

$977,941—Cubic Corporation, San Die an electronic measuring system for tracking research and developmen missiles and to assist in further de ment of missile systems at White

$755,000—Douglas Aircraft Co., Santa M for *Nike* adapters and research a velopment (two contracts).

$629,155—Autonetics Div., North Am Aviation, Inc., Downey, Calif., for computers.

$500,000—Olin Mathieson Chemical for exploring uses of an advanced propellant for the *Nike-Zeus* missi

$402,765—Montgomery Ross Fisher, In Angeles, for silo launch test co Phase III, static test facility at E AFB.

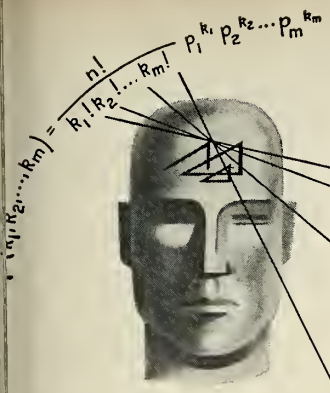
$280,072—Parish Pressed Steel, Div. o Corp., Reading, Pa., for rocket wa

$260,483—Gilfillan Brothers, Inc., Los les, for engineering services.

$165,236—Carrier Corp., Cambridge C Lowell, Mass., for container for sto 28,000 gals. of liquid oxygen or nitrogen.

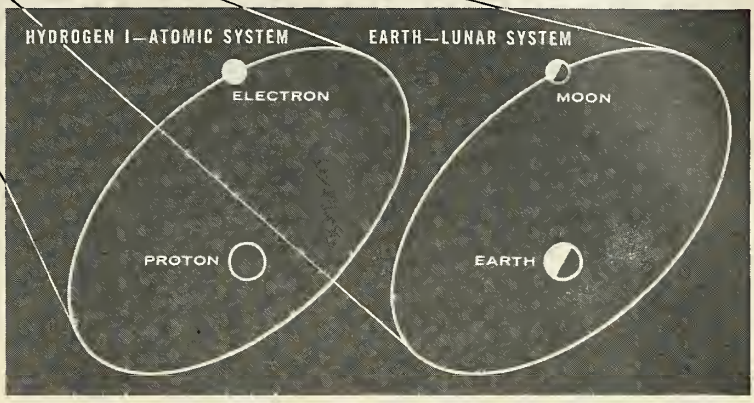
$151,365—Brown Engineering Co., Hun Ala., for additional continuation c with the Army Ballistic Missile

ENGINEERS—SCIENTISTS



Is order and organization in MACROCOSM and MICROCOSM an underlying principle of the universe... or does a fundamental state of randomness prevail in the cosmos, as might be expressed by the multinomial formula at left?

BOLD MINDS



THROUGHOUT HISTORY..... BOLD MINDS have sought to understand the forces at work in the universe, and as they developed working hypotheses, endeavored to turn all knowledge to their own purposes, devising philosophical and mechanical systems of their own.

As old hypotheses become inadequate or untenable, thinking men devise new ones. So the concept of a "flat" world has changed to an oblate orbiting spheroid—mere speck in a vast and expanding universe; so "empty" formless space is regarded as a curved continuum occupied by random knots of turbulence (creating the new branch of mechanics—hydromagnetics).

Today new horizons of discovery and surmise arise before the speculative mind.

ENGINEERS AND SCIENTISTS AT REPUBLIC FEEL KINSHIP WITH ALL BOLD MINDS OF PAST AND PRESENT, AS THEY FACE THE EXHILARATING CHALLENGES OF CREATING VEHICLES TO FLY IN ENVIRONMENTS WHERE NEW APPROACHES IN THERMO/AERODYNAMICS MUST BE MADE...AS WELL AS APPROPRIATE PROPULSION AND ELECTRONIC SYSTEMS TO POWER AND GUIDE TRANSIT IN SPACE

Groups of Research, Development and Experimental Engineers and Scientists at Republic Aviation are now working on projects over the whole range of aeronautics and astronautics—from supersonic and hypersonic weapons systems, both manned and unmanned, to plasma propulsion and space electronics.

Imaginative professional men at many levels of experience are invited to inquire about opportunities indicated below:

ELECTRONICS
- Inertial Guidance & Navigation
- Digital Computer Development
- Systems Engineering
- Information Theory
- Telemetry-SSB Technique
- Doppler Radar
- Countermeasures
- Radome & Antenna Design
- Microwave Circuitry & Components
- Receiver & Transmitter Design
- Airborne Navigational Systems
- Jamming & Anti-Jamming
- Miniaturization-Transistorization
- Ranging Systems
- Propagation Studies
- Ground Support Equipment

THERMO, AERODYNAMICS
- Theoretical Gasdynamics
- Hyper-Velocity Studies
- Astronautics Precision Trajectories
- Airplane/Missile Performance
- Air Load and Aeroelasticity
- Stability and Controls
- Flutter & Vibration
- Vehicle Dynamics & System Designs
- High Altitude Atmosphere Physics
- Re-entry Heat Transfer
- Hydromagnetics
- Ground Support Equipment

PLASMA PROPULSION
- Plasma Physics
- Gaseous Electronics
- Hypersonics and Shock Phenomena
- Hydromagnetics
- Physical Chemistry
- Combustion and Detonation
- Instrumentation
- High Power Pulse Electronics

NUCLEAR PROPULSION & RADIATION PHENOMENA
- Nuclear Weapons Effects
- Radiation Environment in Space
- Nuclear Power & Propulsion Applications
- Nuclear Radiation Laboratories

A new $14,000,000 Research Center—to be completed this year—is part of Republic's far-ranging R&D programs aimed at major state-of-the-art breakthroughs in every flight regime & environment.

Send resume in complete confidence to:
Mr. George R. Hickman, ENGINEERING EMPLOYMENT MANAGER— DEPT. 4F-3

REPUBLIC AVIATION
FARMINGDALE, LONG ISLAND, NEW YORK



Circle No. 31 on Subscriber Service Card.

Advertiser's Index

Aeronca Mfg. Corp. 7
Agency—Penn & Hamaker, Inc.

Allison Div., General Motors Corp. .. 50
Agency—Kudner Agency, Inc.

American Bosch Arma Corp. 12
Agency—Doyle, Kitchen & McCormick, Inc.

American Machine & Foundry Co., Leland Airborne Products 20
Agency—Cunningham & Walsh, Inc.

Armco Steel Corp. 53
Agency—N. W. Ayer & Son, Inc.

Bendix Aviation Corp.
Bendix Systems Div. 43
Red Bank Div. 33
Agency—MacManus, John & Adams, Inc.

Bristol Aircraft Ltd. 16, 17
Agency—Young & Rubicam, Ltd.

Brunswick-Balke-Collender Co. 6
Agency—McCann-Erickson Inc.

Chance Vought Aircraft, Inc. 40, 41
Agency—Tracy-Locke Co., Inc.

Colvin Laboratories, Inc. 58
Agency—Black, Little & Co., Inc.

Consolidated Electrodynamics Corp. . 4
Agency—Hixson & Jorgensen Inc.

Convair, Div.-of General Dynamics Corp. 36
Agency—Barnes Chase Co.

Cooper Development Corp., Sub. of Marquardt Aircraft Co. 13
Agency—Allen, Dorsey & Hatfield, Inc.

Douglas Aircraft Co., Inc. 42
Agency—J. Walter Thompson Co.

Dow Chemical Co., The 10
Agency—MacManus, John & Adams, Inc.

E. P. Dutton & Co. 54
Agency—Franklin Spier, Inc.

Electro Instruments, Inc. 60
Agency—Clyde D. Graham, Adv.

Engelhard Industries, Inc. 54
Agency—Stuart Sande Adv.

B. F. Goodrich Aviation Products, Div.-The B. F. Goodrich Co. 38
Agency—Batten, Barton, Durstine & Osborn, Inc.

Goodyear Aircraft Corp. 3
Agency—Kudner Agency, Inc.

Grove Valve & Regulator Co. 59
Agency—L. C. Cole Co.

Haws Drinking Faucet Co. 55
Agency—Pacific Adv. Staff

International Telephone & Telegraph Corp. 30, 31
Agency—J. M. Mathes, Inc.

Martin Co., The 29
Agency—Henry Quednau, Inc.

Martin Co., The 49
Agency—E. M. Halvorson Co.

Non-Linear Systems, Inc. 2
Agency—Barnes Chase Co., Inc.

North American Aviation, Inc.
Autonetics Div. 34
Missile Development Div. 44
Rocketdyne Div. 18
Agency—Batten, Barton, Durstine & Osborn, Inc.

Northrop Corp. 45
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Olympic Plastics Co., Inc. 46
Agency—The Rouse Co.

Photocon Research Products 42
Agency—Balsam Adv. Inc.

Ramo-Wooldridge, Div.-Thompson Ramo-Wooldridge, Inc. 27
Agency—The McCarty Co.

Raytheon Mfg. Co. 14
Agency—Donahue & Coe, Inc.

Stromberg-Carlson, a Div. of General Dynamics Corp. 11
Agency—The Rumrill Co., Inc.

Swedlow, Inc. 47
Agency—Willard G. Gregory & Co.

Texas Instruments, Inc., Apparatus Div. 48
Agency—Don L. Baxter, Inc.

Western Gear Corporation 8
Agency—Adams & Keyes, Inc.

EMPLOYMENT SECTION

Republic Aviation Corp. 57
Agency—Deutsch & Shea, Inc.

when and where

JUNE

United Nations Educational Scientific and Cultural Organization, UNESCO House, Paris, June 15-20.

Michigan Aeronautics and Space Association, Industrial Missile and Space Conference, Sheraton-Cadillac Hotel, Detroit, June 16-17.

Cornell University Industry Engineering Seminars, Ithaca, N.Y., June 16-19.

Institute of the Aeronautical Sciences, National Summer Meeting, Ambassador Hotel, Los Angeles, June 16-19.

Institute for Practical Research on Operations, The University of Connecticut, Storrs, June 21-July 3.

American Institute of Electrical Engineers, Air Transportation Conference, Olympic Hotel, Seattle, June 24-26.

Nuclear Industry Division, Instrument Society of America, Second National Symposium, Idaho Falls, Idaho, June 24-26.

Institute of Radio Engineers' Professional Group on Military Electronics, Third National Convention on Military Electronics, Sheraton-Park Hotel, Washington, D.C., June 29-July 1.

Pennsylvania State University, Summer Seminar on Plastics—Its Mechanical Properties, Design and Applications, University Park, Pa., June 29-July 3.

JULY

Tenth Annual Basic Statistical Quality Institute, University of Connecticut, Storrs, July 12-24.

Radio Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Third Biennial Joint Meeting, Ambassador Hotel, Los Angeles, July 16-17.

Second Annual Institute on Missile Technology, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 26-Aug. 7.

The Denver Research Institute of the University of Denver, 6th Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 30-31.

AUGUST

Institution of Investigation of Biological Sciences, sponsored by Air Force Office of Scientific Research-Aeromedical Div., World Health Organization and United Nations Educational, Scientific and Cultural Organization, Montevideo, Uruguay, Aug. 2-7.

William Frederick Durand Centen Conference, Problems of Hypersc and Space Flight, Stanford Univers Stanford, Calif., Aug. 5-7.

Institute of Radio Engineers' Professic Group on Ultrasonics Engineering, F National Ultrasonics Symposium, S ford University, Stanford, Calif., A 17.

Institute of Radio Engineers, West Electronic Show & Convention, C Palace, San Francisco, Aug. 18-21.

American Rocket Society, Gas Dynar Symposium, Northwestern Univer Evanston, Ill., Aug. 24-26.

International Astronautical Federat 10th Annual Congress, Church Ho Westminster, London, Aug. 31-Sept

SEPTEMBER

Air Force Office of Scientific Research General Electric Company's Missile Space Vehicle Department, Confere on Physical Chemistry in Aerodynar and Space Flight, University of P sylvania, Philadelphia, Sept. 1-2.

Air Force Association and Panora send reservations to AFA Hou Bureau, P.O. Box 1511, Miami Be Sept. 3-6.

Standards Engineering Society, Bo Section, Eighth Annual Meeting, H Somerset, Boston, Sept. 21-22.

SUBSCRIBER SERVICE
missiles and rockets

or additional information about any product or service advertised ntioned in the editorial pages of this issue of Missiles and s:

se the attached prepaid reply cards. Circle numbers shown on ply card that correspond with numbers appearing beneath items ed. If no circle number accompanies the article or advertise- give page number (and advertiser's name) on line provided at of the card.

our requests for information will be forwarded promptly to the nies concerned.

NEW PRODUCT BRIEFS

RELAY. A small rugged SPDT eloped for use in printed cir- ere relay is self-supporting. on has been modified to allow duction of a low-priced, re- y for use in radio sonde, mo- unications and commercial ap- r. Standard operating voltage 24 VDC, DC resistance range ms, DC power requirement— t Standard contact rating is up ere 50 VDC, resistive.

240 on Subscriber Service Card.

FR HOSE. Fluoroflex-T(eflon) se, said to be chemically in- a jet and missile fuels and oxi- h been developed by Resisto- r. The abrasion-resistant rubber is inforced with a spiraled high- w to prevent crush or collapse. e of Fluoroflex-T is carried e hose and over the face of n fluids being transferred can- m in contact with or be con- d y the metal flanged fittings or o ring. The non-adhesive surface te on permits rapid flow of fluids tt or no buildup of corrosive l nonaging characteristic in- on service life. Current produc- f luoroflex-T chemical transfer r round handling equipment use 1½", 2" and 3" diameters to e engths. Larger diameters will il e shortly.

No. 241 on Subscriber Service Card.

NT METER. A 25-turn potenti- r, urnished in a length only y l ger than most 10-turn units, ce y been introduced by Litton rie Potentiometer Division. Desig- th MD20-25, the unit meets or ls l military specifications for ior ters, with .0075% linearity 005 resolution a Litton produc- an rd for this 2-inch model.

No. 242 on Subscriber Service Card.

DE ASSEMBLY. Resolving shaft ons o l part in 10,000 can be wit the CG-701 Geared Encoder bly now available from Datex rat n. Designed for use where um ze and weight are important, sen y uses two Datex shaft posi- nco ers and a gear box. The en- use on the input shaft provides pos ons of the least significant per 60° rotation. Because the disc s e oder is coupled directly to put haft, accuracy is that of the er ed. This input unit is then geared 10:1 to a 10-position encoder. The low-speed encoder utilized double-brush, lead-lag logic to eliminate ambiguities due to gear inaccuracy and backlash. Hence, the accuracy of the CG-701 is determined only by the accuracy of the encoder attached to the input shaft. The CG-701 is 3" in diameter, 3" long (exclusive of shaft), and weighs 19 ounces.

Circle No. 243 on Subscriber Service Card.

PRESSURE SWITCH. Now available for use in all types of systems is a ¼ oz. transistor-size pressure switch designed for surge, leak, and variance detection which has been produced by Century Electronics and Instruments Co. Now in use as automatic leak detectors on missile programs, the unit has the following capabilities: setting limits, 1 to 100 psig; proof pressure, 3000 psig; operating range, 1 to 500 psig; burst pressure, 5000 psig; temperature, −65°F to +250°F; vibration, 0 to 2000 cps at 10g.

Circle No. 244 on Subscriber Service Card.

NEW ALLOYS. A new magnesium-rare earth metal alloy for missile applications has been developed by The Dow Chemical Company. Sand castings in the new alloy, designated EK31XA, are being produced by Dow for evaluation by prospective users. EK31XA sand castings combine room-temperature tensile properties with tensile strength at elevated temperatures up to about 600°F and also exhibit creep resistance at these elevated temperatures for times up to 10 hours, according to Dow. In long-term properties, including creep strength up to 1000 hours, EK31XA sand castings are serviceable to about 450°F, Dow said. Composition of the alloy is 3.2% rare-earth metal, 0.6% zirconium, balance magnesium.

Circle No. 245 on Subscriber Service Card.

CERAMIC COATING. An organic-ceramic coating developed by Dyna-Therm Chemical Corp. is reportedly capable of resisting extreme temperatures and adhering to almost any type of metal surface. Termed L-154, the material features gas-erosion characteristics of ceramics while requiring only standard industrial spray equipment for application. No enameling or curing ovens are needed. L-154 offers high dielectric strength, according to the manufacturer, as well as thermal shock resistance as low as −100°F.

Circle No. 246 on Subscriber Service Card.

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD
First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

MISSILES and ROCKETS
17 EAST 48th STREET
NEW YORK 17, N.Y.

SUBSCRIBER SERVICE DEPT.

POSTAGE WILL BE PAID BY ADDRESSEE

NAME_____
TITLE/POSITION_____
COMPANY_____
Product Mfg./Service Offered_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____
Card cannot be processed unless all information is given.
Please limit requests to ten items.

MISSILES AND ROCKETS
JUNE 15, 1959
Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

● ● Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

● ● Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

● ● New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers: _____

MISSILE LITERATURE

HYDRAULIC TEST CART. A 2-page, technical bulletin, No. 1373, describing a portable, self-contained hydraulic test cart for missile field test procedures is now available from the George L. Nankervis Company. Illustrated with photographs, dimensioned line drawings and a circuit schematic, this bulletin discusses various operational characteristics and specifications of the Nankervis Model 9462 test carts for field use. These carts supply 10-gpm of clean, tempered oil at up to 3000 psi. They are mounted on four-wheel axles with automotive type steering and are easily moved by one person. Oil is filtered to 2-5 microns and system components are of stainless steel to minimize contamination.

Circle No. 200 on Subscriber Service Card.

SWITCHES. A four-page catalog describing eight high-temperature thermal and seven waterproof switches, is available from Control Products Inc. Photographs, dimension drawings, specifications and characteristics are included of these plug, probe, and surface types of thermal controls for governmental and industrial applications and waterproof switches for use in applications requiring conformance to government standards or military specifications.

Circle No. 201 on Subscriber Service Card.

SEQUENCE INDICATIONS. The Opad Electric Company has released a two-page catalog sheet describing their new line of panel mounting Phase Sequence Indicators. Designed for integretion in test stands and panel boards, these instruments permit rapid determination of the order in which the voltage peaks of a three-phase power supply occur. Bulletin 1551 covers seven standard models and includes dimensioned outline drawings of the instruments.

Circle No. 202 on Subscriber Service Card.

ELECTRICAL CONNECTORS. A fully-illustrated catalog describing the complete line of Joy electrical connectors for industry has been issued by the Electrical Products Division of the Joy Manufacturing Company. In addition to orienting the reader by means of an illustrated nomenclature of terms and references used in the description of electrical connectors, the literature also lists electrical current ratings for cable, as based on wire gauges and number of wires.

Circle No. 203 on Subscriber Service Card.

TEST CHAMBER. A new 12-page catalog covering their line of environmental test chambers has been published by the American Research Corp.

Circle No. 204 on Subscriber Service Card.

FIELD EMISSION CATHODES. A paper giving results of research conducted by the Linfield Research Institute for the U.S. Air Force on field emission cathodes is available from the Office of Technical Services of the U.S. Department of Commerce. The program was undertaken in two phases, one of which led to improvement of stability of the field emission cathode and the other involving study of the electrochemical behavior of refractory metals used to meke field emitters.

Circle No. 205 on Subscriber Service Card.

RADIO SIGNALS. A paper on the theoretical mathematical considerations of varying strengths of radio signals by H. Bremmer of the National Bure... Standards has been released b... Office of Technical Services of th... Department of Commerce. A stuc... made of a constant signal and a ... ating signal of the same freq... which reached the receiver by a ... ent path. The properties investigat... the composed signal are the di... tion functions of both the am... end phase, as well as the average... ber of crossings for either q... through any given level.

Circle No. 206 on Subscriber Servic...

TECHNICAL LIBRARY INDEX. ... fourth edition of a volume listi... subject headings used in the ... system of the Armed Services Te... Information Agency is available ... the Office of Technical Services, ... ment of Commerce. The listing ... rent to January, 1959. Each h... represents one or more reports ... search actually in the collecti... ASTIA or available to it.

Circle No. 207 on Subscriber Servic...

TITANIUM FORGING. Two ti... studies, one dealing with impact ... and the other with the thermal ... of several alloys, are available fr... Office of Technical Services, U. ... partment of Commerce. Three gr... titanium—commercially pure RC-... RS-55, RC-130A, and Ti-150A, w... pact-forged by researchers fro... U.S. Army Ordnance Corps at t... atures from 1300 to 2100°F. Stu... the effect of temperature indicat... the flow stress of RS-55 de... rapidly up to 1700°F; thereafter, ... crease was very small. In RC-13... Ti-150A, the flow stress was a... mately 20% less for each inc... of temperature above 1700°F. ... behavior of RC-130A and Ti-15... similar.

Circle No. 208 on Subscriber Servi...

RF MASS SPECTROMETER. A re... a new sampling system for the ... spectrometer which permits its ... studying combustion processes a... in batch analysis of gases is a... from the Office of Technical S... U.S. Dept. of Commerce.

Circle No. 209 on Subscriber Servi...

TEMPERATURE EFFECT. The eff... temperature on the magnetic pr... of six well-known end comn... available nickel-iron alloys are gra... illustrated in an Air Force rep... leased through the Office of T... Services, U.S. Department of ... merce. The temperature effects ... a-c magnetic properties of ... Hipernik V, Deltamax, Hymu 80 ... malloy, and 4-79 Mo-Permalloy ... ported for the temperature r... —60 to 250°C. Results of the st... reported in the form of curves ... ing the variation of core loss ... of weight and rms exciting volt... per unit of weight as tem... varies.

Circle No. 210 on Subscriber Serv...

ALUMINUM-IRON ALLOYS. H... minum-iron alloys have magneti... cal, and mechanical propertie... provide the potential for vari... netic applications, according to ... available from the Office of T... Services, U.S. Dept. of Comm...

Circle No. 211 on Subscriber Serv...

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD

First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

POSTAGE WILL BE PAID BY ADDRESSEE

MISSILES and ROCKETS

17 EAST 48th STREET

NEW YORK 17, N.Y.

SUBSCRIBER SERVICE DEPT.

NAME_____

TITLE/POSITION_____

COMPANY_____

Product Mfg./Service Offered_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

Card cannot be processed unless all information is given.
Please limit requests to ten items.

MISSILES AND ROCKETS

JUNE 15, 1959

Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	283	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers: _____





REVOLUTION IN DESIGN

Grove Regulators... As revolutionary in design and engineering as the technological transition from flying machine to space vehicle... Achieved a quarter of a century ago, the only regulators which could be used for the first missile experiments in the Navy Experimental Station at Annapolis ... still today the standard for the critical control of high pressure fluids... Now on the threshold of space, Grove is uniquely prepared—through advance research and development—to meet the challenge of even higher pressures ahead.

GROVE POWREACTOR DOME REGULATOR MODEL GH-408-50-6000 PSI INLET...5-3000 PSI REDUCED PRESSURE

GROVE VALVE and REGULATOR COMPANY

6529 Hollis St., Oakland 8, California • 2559 W. Olympic Blvd., Los Angeles 6, California

Offices in other principal cities

Subsidiary of Walworth

Circle No. 32 on Subscriber Service Card.

New, Electro Instruments all-electronic, totally transistorized digital voltmeter

50 conversions per second • 1000 megohms input impedance • Fully automatic ranging



Model 8409 Voltmeter and Ratiometer

all the features you want in a medium-speed digital voltmeter

- 3 ranges, 9.999/99.99/999.9 volts
- Automatic, manual and remote ranging
- Automatic polarity
- One digit accuracy
- 4 digit in-line visual readout
- BCD and decimal electrical output
- Direct printer operation—local/remote control
- New 5¼" x 19" front panel
- Modular construction throughout
- Provision for external reference voltage

Plus accessory modules for every application



AC: All transistorized Model 110; considerably faster AC/DC conversion than presently available models. Fully automatic ranging and direct AC voltage readout on the Model 8409.

Ohmmeter: All transistorized Model KIM-000. Provides constant current through test resistor with negligible power dissipation. Voltage measurements made across resistor and read out directly in ohms with fully automatic ranging.

Also scanners, code converter modules, print control modules and many others to solve all digital problems—from simple voltmeter applications to complex data logging systems.

Ask your  *representative for complete information.*

Electro Instruments, Inc

3540 Aero Court San Diego 11, Califo

Circle No. 33 on Subscriber Service Card.

JUNE 22, 1959

JUN 1959
HOUSTON PUBLIC
LIBRARY
Houston, Texas

MARINE AND TERRIER MISSILE



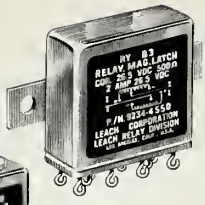
missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

upport Catalogue—How Big? 13
aing Notch Sensitivity 15
's Satellite Drag Brake 18

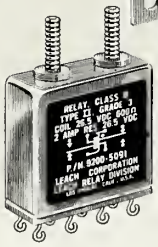
AN AMERICAN AVIATION PUBLICATION

TYPE 9234-4550 2POT, 2AMP, MAGNETIC LATCH RELAY



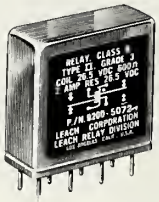
(BRACKET MOUNTING, SOLDER HOOK TERMINALS, HERMETICALLY SEALED)

TYPE 9200-5091 2POT, 2AMP, RELAY



(STUD MOUNTING, SOLDER HOOK TERMINALS, HERMETICALLY SEALED)

TYPE 9200-5072 2PDT, 2AMP, RELAY



(PLUG IN OR PRINTED CIRCUIT MOUNTING, HERMETICALLY SEALED)

LEACH SUBMINIATURE

CRYSTAL CAN RELAYS

(SHOWN ABOVE...ACTUAL SI

torture-tested to perfection for big relay performance

These sensitive Leach subminiature relays deliver big relay performance . . . in a crystal can size that makes them ideal for use in missile control circuits in airborne or ground equipment and in computer and printed circuits.

Torture-tested to perfection in the Leach Production Reliability Center, these subminiatures are designed to meet the critical extremes of vibration, shock and other stringent environmental requirements in military and commercial applications.

They meet the specifications of both MIL-R-25018 and MIL-R-5757C—as well as MIL-R-6106C, *including the minimum current test requirements.*

Uniform contact pressure and overtravel are guaranteed for the life of these balanced-armature relays. They are available in a wide range of socket, stud and bracket mountings to meet specific customer requirements.

Write today for Leach Crystal Can Relay Brochure containing specifications, typical ratings and other information on these subminiatures! Or contact your nearest Leach sales representative to discuss your specific subminiature relay requirements.

RELIABILITY

LOOK TO LEACH

RELAY DIVISION...LEACH CORPORATION

5915 AVALON BOULEVARD, LOS ANGELES 3

DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA • EXPORT: LEACH CORP., INTERNATIONAL DIVISION



The Mission is Simulated—the Experience is Real!

l the complex, split-second action of modern all-
ather and night missions, the experience and trained
lexes of a pilot spell success or failure. And today,
e only practical, economical way to build such experi-
ce is with electronic flight and weapons system simu-
lors that create and re-create every situation of an
tual mission itself.

At Curtiss-Wright, the art of simulation has reached
beyond representing the aircraft alone. Curtiss-
right builds equipment for simulation of all-weather
erations, complete tactical missions, and entire
apons systems, for the most advanced fighters, bomb-
and heavy bombers, as evidenced by simulators built
the U.S. Navy's F4H1 and A4D, and the B58 for
U.S. Air Force.

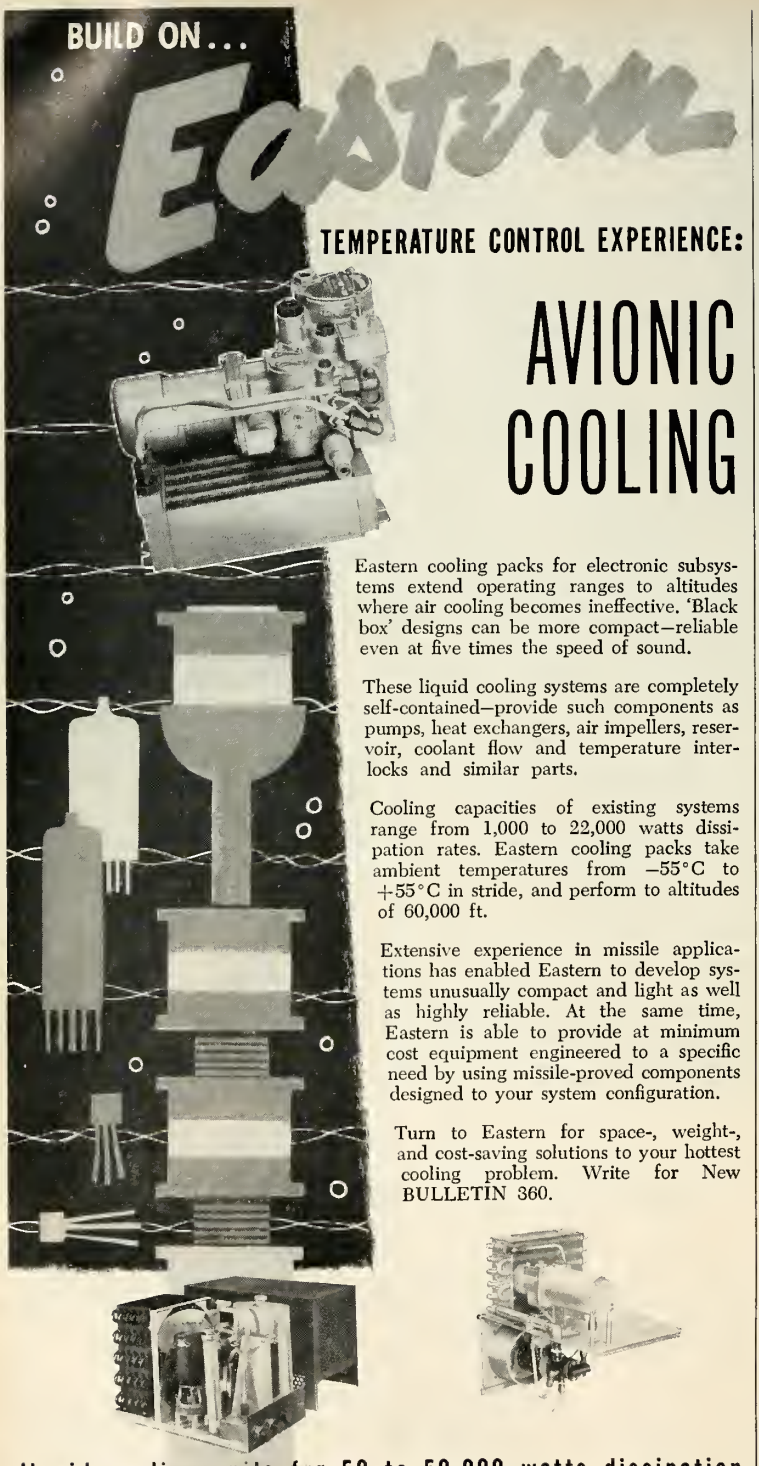
Tactical simulators include such sophisticated functions as simulation of radar fire control systems, search and bombing radar systems, electronic countermeasures simulation, and action of the airborne armament missiles themselves.

With these skills and capabilities, Curtiss-Wright is prepared to design and produce complete training equipment for a single aircraft or entire weapons systems — providing the priceless experience that only this modern training equipment makes possible.

ELECTRONICS DIVISION

CURTISS-WRIGHT

CORPORATION • CARLSTADT, N. J.



Executive Editor .....CLARKE NEWL
Managing Editor .....DONALD E. PE

EDITORIAL STAFF

News Editor .....REED BU
Military & Defense .....BETTY OSV
JAMES I
Electronics/Support Equipment ..HAL GETT
Electronics Engineering ....CHARLES D. LAF
Missile Manufacturing .....WILLIAM E. HOV
Missile Business .....ERICA M. I
NASA .....PAUL MI
Los Angeles .....FRED HU
RICHARD VAN O
FRANK MCG
London .....G. V. E. THOMI
Paris .....JEAN-MARIE R
Geneva .....ANTHONY VA
Art Director .....WILLIAM MA
Ass't Art Director .....BACIL GU

CONTRIBUTORS

Propulsion Engineering .....MICHAEL LOR
Industry .....JAMES J. HAGGERTY
Soviet Affairs .....DR. ALBERT P
Space Medicine .....DR. HUBERTUS STRUG
Astrophysics .....DR. I. M. L
Research .....HEYWARD CANNEY

ADVISORY BOARD

DR WERNHER VON BRAUN ROBERT P. HAVI
DR. PETER CASTRUCCIO DR. ARTHUR KANTRO
KRAFFT EHRICKE DR. EUGEN SA
R. F. GOMPERTZ ALEXANDER S

BUSINESS STAFF

Assistant Publisher .....E. D. MUH
Advertising Sales Manager .....W. E. B
Circulation Director .....L. L. BRE
Promotion Manager .....J. E. MU
Advtg. Service Manager ..MRS. GLADYS BU
Production Manager .....J. F. W
Ass't Production Mgr. .....ELSIE
New York .....17 East 48 S
Eastern Advtg. Mgr. .....P. B. KI
P. N. ANDI
A. B. SCHE
Detroit .....201 Stephenson
K. J. V
Chicago .....139 N. Cla
G. E. Y
Los Angeles .....8929 Wilshire
J. W.
C. R. MART
Miami .....208 Almeria A
R. D.
Toronto .....12 Richmond
ALLIN ASSO
London .....28 Brut
NORALL &
Paris .....11 Rue Con
Geneva .....10 Rue G

Missiles and Rockets Volume 5 Number

Published each Monday by American Av
Publications, Inc., 1001 Vermont Ave.,
Washington 5, D.C.

WAYNE W. PARRISH .....*President & Pu*
LEONARD A. EISERER ...*Executive Vice Pre*
& General Ma
A. H. STACKPOLE .....*Vice Pre*
FRED HUNTER .....*Vice Pre*
ERIC BRAMLEY .....*Vice Pre*
ROBERT R. PARRISH .....*Vice Pre*

Printed at the Telegraph Press, Harrisbu
Second class postage paid at Washington
and at additional mailing offices. Cop
1959, American Aviation Publications, I

Subscription rates: U.S., Canada and P
Union Nations—1 year, $8.00; 2 years, $1
3 years, $14.00. Foreign—1 year, $10.0
years, $18.00; 3 years, $26.00. Single
rate—$.75. Subscriptions are solicited
from persons with identifiable comm
or professional interests in missiles
rockets. Subscription orders and chang
address should be referred to Circul
Fulfillment Mgr., M/R, 1001 Vermont
Washington 5, D.C. Please allow 4 w
for change to become effective and en
recent address label if possible.

AUDITED PAID CIRCULATION ABC NBP READERSHIP Eastman RESEARCH BUSINESS

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

JUNE 22 HEADLINES

Avco Proposes Drag Brake for Manned Satellite
Company says ICBM research and aero-medical development has made possible designs with advantages of simplicity, less expense and lightweight 18

Lab Duplicates Re-entry Heat and Temperature
Everett, Mass., facility uses 10-megawatt high-pressure arc plasma generator developed for ICBM nose cone tests 22

NASA Space Lab Plans Outlined at ARS Meeting
Gathering also hears debate on merits on Project *Mercury* "holding facility" and reports on ion engine, ramjets and APU developments 24

ASTRONAUTICS ENGINEERING

Notch Sensitivity Barrier Can Be Crossed
Large diameter rocket motor cases with 300,000 psi min-yield strength may be in production within a year through promising metallurgical techniques 15

MISSILE SUPPORT

How Long A List of AF Support Items?
Viewpoints differ on a desirable size for Technical Information File which could run to 100,000 items but will be considerably smaller at least in the beginning 13

MISSILE ELECTRONICS

The Promise of Thermoelectric Power
With 837 companies searching for materials and methods, a few years might see development of a generator to power an inter-space plasma propulsion engine 29

Anti-Multipath Equipment (AME) Unveiled
Page Communications' gear tested in North Atlantic is expected to find more use on ionoscatter circuits and offers potential for increased channel capacity 33

THE MISSILE WEEK

Washington Countdown 9
Industry Countdown 11
More About the Missile Week 39

DEPARTMENTS

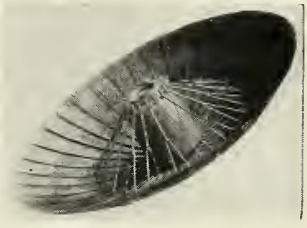
Editorial	7	Propulsion Engineering ...	45
Moscow Briefs	40	People	47
Missile Business	42	Contract Awards	48
Reviews	44	When and Where	50



COVER: Leatherneck is backed by Convair's *Terrier*, used for ground support as well as at sea.



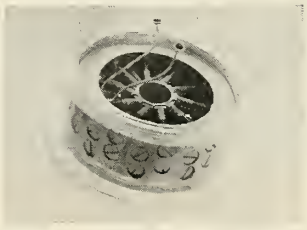
EXAMPLE of brittle failure in hydrotest of solid rocket motor case (see p. 15).



MODEL of satellite drag brake proposed by Avco as alternative to retro-rockets (see p. 18).



RE-ENTRY heat and temperatures are duplicated at Avco's Everett, Mass., Laboratory (see p. 22).



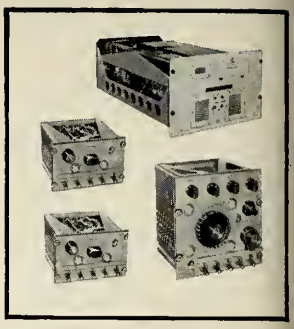
SNAP III generator offers hope that small electrical sources can live long in space (see p. 29).

COMMUNICATIONS...

Radio Set AN/ARC-57 . . . designed and developed by *The Magnavox Company*, in conjunction with the Air Force, is an essential UHF communications system, providing the utmost in performance and reliability for the CONVAIR B-58.

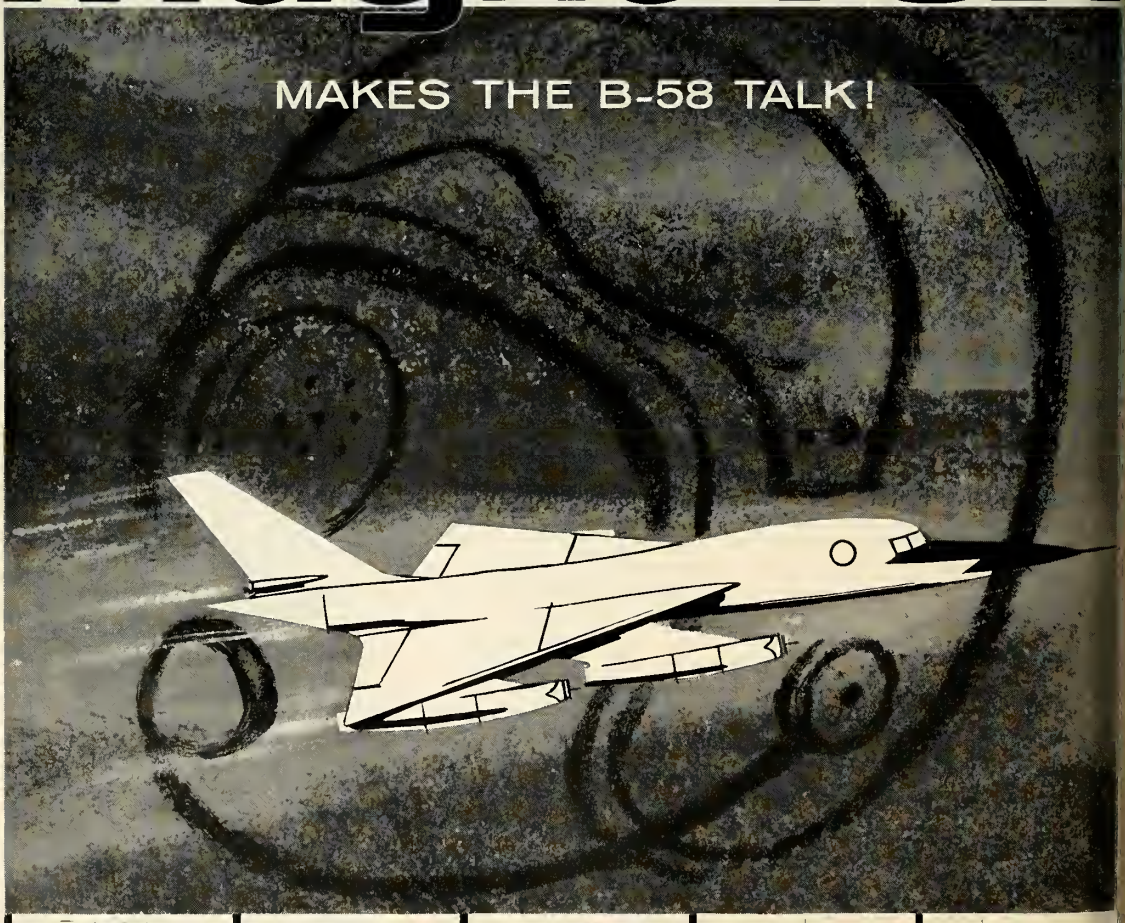
It clearly demonstrates *The Magnavox Company's* ability to produce and work as a prime contractor on a complex weapons system.

MAGNAVOX capabilities are in The Fields Of Airborne Radar, ASW, Communications, Navigation Equipments, Fusing and Data Handling . . . your inquiries are invited.



PRODUCTS
THAT SPEAK FOR
THEMSELVES

Magnavox



COMMUNICATIONS | RADAR | DATA HANDLING | ASW | MISSILES

THE MAGNAVOX CO. • DEPT. 82 • *Government and Industrial Division* • FORT WAYNE, IN

Wake Up and Live

These are troubled days for the aerospace industry, once known as the aircraft industry. Individually and collectively its member companies are taking a beating on Capitol Hill, in the Pentagon and in their once-excellent public relations to the point where they are now being alluded to by the President as a munitions lobby.

And it is largely their own fault.

They have only recently witnessed the embarrassing sight of one of the most powerful men in Congress, Chairman Carl Vinson of the House Armed Services Committee, mercilessly chastising the industry in a relentless attack on their renegotiation position.

The military leaders, once staunch allies, have not rallied to the industry's support. The daily press has played the news straight from government releases and the result has not been kind.

The truth is that the aerospace/aircraft industry is no longer the protected darling of the gods in Washington and it is time that its members faced up to this fact.

The days when an aircraft company president—if he didn't like the way things were going for his company—called up the chief of staff and set matters right, are gone forever. So are the days when the aerospace/aircraft industry didn't have to fight its battle on the Hill because the military fought it for them.

The aerospace industry is the biggest manufacturing industry in the world (753,500 employees against 741,900 for automobile at last count) and its members must learn that it's a tough world with very tough competition for the breaks. Most other major segments of U.S. industry faced up to it a long time ago.

The aerospace industry will probably not always remain largest as an employer, because the articles it makes tend to become more expensive in cost and fewer in numbers. (What effect this will have on the national economy is worth thinking about.) But most certainly in the foreseeable future it will rank among the most important, both in dollars and national security.

From a position not quite so close to the forest, we would like to suggest to the industry that it consider certain actions:

Take active steps to avoid being classified as a chosen, favored, captive or kept industry. The once-accepted fact that the country had to maintain a base for mobilization is a lot less true in these days of instantaneous warfare. Companies stay alive these days only on their competitive skill, diversification, ingenuity and courage.

Agree on a legislative program and unite behind it. Congressional battles can be won on the home front a lot easier than in Washington. Renegotiation appears to be a lost cause for the moment. Indemnification for unusual risks is bottled up in Congress and probably won't emerge at this session. Revision of the NASA patent inequities will come only when Congress is convinced they are really inequitable. Look to Washington for guidance and cohesion, but don't leave it all up to the people there.

Forget the fact that relationships with the Pentagon were once a matter of personal friendships forged in the canvas-winged biplanes of World War I combat or in the barnstorming days of the Twenties. There's a new crop of men making the decisions these days in the Pentagon and at Wright Field, Huntsville, BuAer and BMD. And a new crop flying your planes and guiding your missiles. Most of them don't know the company presidents and don't expect to. But these are the men who have to know your product and believe in it, because they are the ones who, in the long run, really dictate the purchase and use of it.

As for Congress, getting industry's story over to them is a matter of proper communication. And in this field, whether it involves Congress, the military or the public, perhaps the most important requirement visibly lacking is a strong central policy or philosophy. What is the industry's philosophy on the team concept, especially, if two or more major primes must join on a contract to achieve the best possible product? What is the industry's position on government versus private ownership of facilities? What has the aerospace industry done about explaining the financial and economic facts of life to its biggest customer—the military, especially the younger generation of military officers? Has a real effort been made to inform Congress of industry's position on the negotiated versus the advertised contract and the reasons therefore? Or that negotiated contracts are really based on competitive bids, with the losers forfeiting time, work and tremendous sums by competing?

Right now, many of the decisions themselves are no more important, it seems to us, than the fact that the industry must unite on them. And match its philosophy with the needs of a changing world.

Clarke Newlon

HOW SAC's "HOUND DOG" SCENTS ITS TARGET



The crew of the B-52G starts up the jet engine of the sharp-nosed GAM-77 Hou Dog missile hung under its wing... gives its inertial autonavigator the location of the targ

On a "for-real" mission, the Hound Dog would leap toward its target at supersonic spe —very likely a ground-defense center hundreds of miles away. Its guidance system can't jammed... can't be decoyed.

Purpose of the GAM-77 air-to-ground jet-powered guided missile is to increase the striki power of Boeing's B-52. Sling a pair of Hound Dogs under the wings of the new B-52G—a you have what amounts to a brand-new weapon system.

The GAM-77 program was started in August, 1957. The missile has been put into accelerat development. It already is in its early flight test phase... will be deployed by 1960.

Weapon system contractor: the Missile Division of North American Aviation.

MISSILE DIVISION NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA

washington countdown

The Navy has decided to go along with development of a medium range ALBM—probably with a *Polaris* second-stage configuration.

Leading frame manufacturers are being asked or will be asked to submit proposals. Already under consideration are **Martin's** *Bold Orion* (M/R Dec. 1, 1958) and **Lockheed-Convair** and **McDonnell** proposals submitted to AF during ALBM competition won by **Douglas.**

Insiders are speculating on whether the Office of Secretary of Defense will allow two almost parallel programs.

The **Douglas** ALBM will have a range of from 1000 to 1500 miles. The 750-mile range Navy ALBM would be launched from carrier-based-jets—possibly the Mach 2 Vigilante A3J under development by North American.

IN THE PENTAGON

The long-range significance . . .

of the compromise "master plan" for U.S. air defense is that the advocates of the offense have won a victory. They have contended that the Soviet bomber threat is on the decline and the ICBM threat is rapidly mounting. Therefore, they argue that every available dollar must be spent on the one defense-in-being against the ICBM—the offensive power of SAC.

• • •

Both the Western Electric . . .

Nike-Hercules and the **Boeing** *Bomarc* suffered with greater acceptance of offense advocates' viewpoint. But *Nike-Hercules* suffered less because it is already here. *Bomarc-B* is about two years away. Therefore, it took the bigger slashing.

• • •

The Pentagon sought . . .

to sweeten the "master plan" with the extra $137 million for *Nike-Zeus.* And more sweetener may be on the way in the form of Pentagon agreement to spend extra millions on ICBM's—specifically the **Convair** *Atlas* and the **Boeing** *Minuteman.* But the mood of Congress is still sour. The end of the battle is nowhere in sight.

• • •

The next shot . . .

in ARPA's *Discoverer* series is expected this week—the second shot this month. The *Discoverer IV* will not carry animals in its biomedical capsule. But an attempt is expected to be made to recover the capsule from orbit.

• • •

Australian observers believe . . .

the Woomera range may soon become second only to Cape Canaveral in the firing of satellites and rockets. Already, British, American and Australian scientists are gathering in Salisbury, near Adelaide, South Australia, for more *Black Knight* tests and what may be Britain's first satellite launching attempt within several months.

ON CAPITOL HILL

The big congressional furor . . .

over the so-called "munitions lobby" is expected to grow warmer with the summer. But whether it will stay warm enough to be served up during the 1960 presidential campaign will depend on the forthcoming House investigation into the hiring of retired military officers by defense contractors.

• • •

Meantime, here are a couple of . . .

related developments to watch for on capitol hill:

. . . Rep. Leonard Wolf (D-Iowa) is considering introduction of a bill that would ban private industrial patents on inventions developed with Federal defense funds.

. . . The Hébert Subcommittee probably will complete hearings on its weapon system concept investigation before beginning the new investigation about July 6. But don't look for a report until after the retired military men are heard.

AT NASA

An attempt to launch . . .

Vanguard III is scheduled for sometime this week. The 20-pound satellite will carry instruments to measure the effects of lightning and the radiation-heat balance between the earth and the sun.

AROUND TOWN

Some of the reports . . .

that are being passed as the "latest" in the nation's capital:

. . . Rep. Victor Anfuso's House Space Subcommittee which was set up to look into space developments in foreign parts won't be doing any travelling for a long time.

. . . The Russians may have tried but failed to launch a space vehicle to Venus during the optimum period early this month.

. . . The White House is reverting to its old pre-Sputnik attitude toward science.

AEROJET

for

ASW

Navy's

New

Torpedo



BuORD's advanc

torpedo is now und

development by Aeroje

Anti-Submarine Warf

Division at Azu

Californ

The Division specializ

in ASW systen

underwater weapo

and power pla

hydrodynamics,

marine engineer

AEROJET-GENERAL CORP®

THE GENER TIRE

A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPA Y

Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, C)

industry countdown

STRUCTURES

Construction is about . . .
to begin on second hardened *Titan* base at Lowry AFB, Denver. Low bidder to build the nine-silo complex within 770 days was **Morrison-Knudson & Associates** at $26.9 million. M-K is building the first base. The two contracts total $69 million.

• • •

There are reports . . .
second stage of the **Lockheed** *Polaris* is being seriously studied by Navy as an air launched ballistic missile. System would have aircraft carrier capability.

• • •

Navy has publicly confirmed . . .
that it is developing the nearly 20-foot long *Astor* torpedo. It forgot to mention that the **Westinghouse** development has more than twice the 10,000-yard range of the Mk. 39 and that it's a real achievement in wire-guided torpedos because some of the wire's negative buoyancy characteristics have been eliminated. The 20-knot *Astor* has more range than sonar capabilities of detecting submarines. Density layers still can't be penetrated to detect subs beyond 4000 yard range even though Navy is experimenting in low frequency and one report has it that 30-foot transducers (which slows one target ship considerably) still won't transmit an appropriate signal.

• • •

In-house study . . .
of launcher and other MSE to fire *Minuteman* from mobile railroad car (M/R June 1, p. 18) is underway by **American Machine & Foundry.** AMF called in **American Car & Foundry** to develop design of the missile train cars, which may be camouflaged as standard-appearing freight trains.

• • •

DOD will be responsible . . .
for NASA industrial security. Idea behind agreement worked out by the two agencies is to eliminate duplication and unnecessary confusion in contractor plants.

PROPULSION

Replacement of metal nozzles . . .
on solid-fueled rocket motors with plastic is being actively considered by **Aerojet-General.** Possible switch comes from A-G's own research in plastics and partially from "breakthrough" on *Nike-Zeus* plastic rocket nozzle disclosed recently.

• • •

New design for missile . . .
auxiliary power units by **Garrett Corp.'s Air-Research Division** uses single block to house all operating valves and reduces valve number from 18 to seven. Turbine APU operates on either ethylene oxide, hydrozine or, with modification, a solid propellant. The 85-pound unit can deliver 5 hp for 7½ minutes.

ELECTRONICS

A 100 million-mile . . .
digital communication system reportedly has been developed for use in deep space probes. **Space Electronics Corp.'s** "Digilock" more flexible and sophisticated—though smaller—than others presently in use, reportedly can vary sample rate from 100 to 25,000 sps and trade off between transmitter power and amount and accuracy of data. With addition of demodulation circuitry, existing telemetry receiving equipment can be used with the system. Built for JPL, system should provide communication efficiency close to maximum possible under information theory.

• • •

For *Atlas* guidance . . .
General Electric has come up with "Hi-Fi" precision radar tracking antenna capable of measuring an angle of one foot at 25 miles. Tolerances in mechanical components of antenna and its pedestal and driving mechanisms are comparable to those in a fine watch and unprecedented in manufacture of large units.

• • •

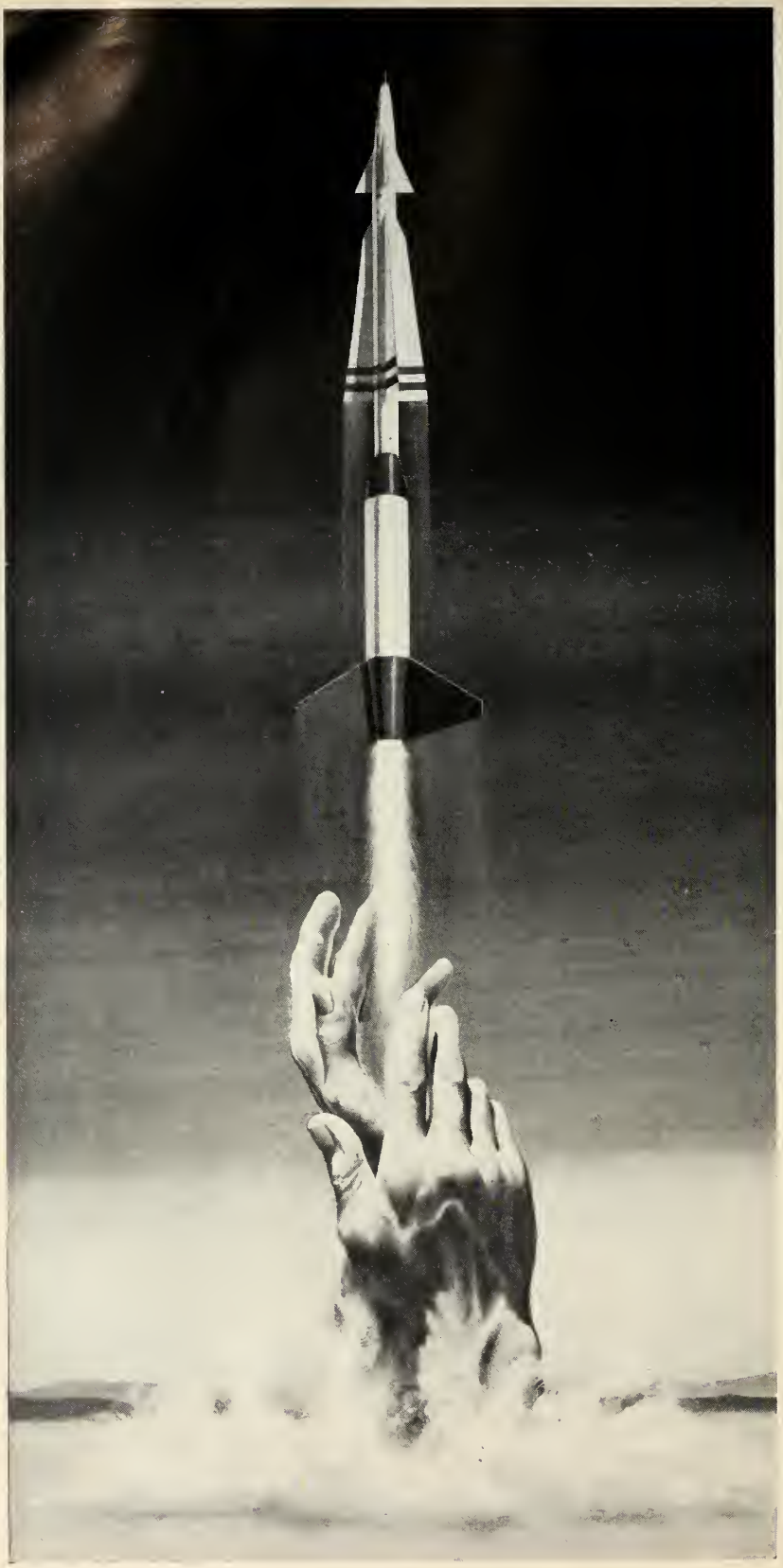
ARPA $600,000 contract . . .
for comprehensive study of feasibility of tracking and intercepting enemy space satellite is in hands of **RCA.** Scheduled for completion in six months, study will provide information on requirements for further R&D to design system for operational capability in 1965-70 time period.

ASTROPHYSICS

Study contract for $50,000 . . .
has been awarded **Republic Aviation** by ARDC to find efficient means of keeping track of man-made satellites. Study will analyze trajectory of dog-carrying *Sputnik II,* which was launched Nov. 3, 1957, and came down April 14, 1958.

• • •

"Space trainer" is proposed . . .
by **Convair,** using *Centaur* rocket to orbit a four-room satellite. Two-man glide rockets would ferry crewmen to the trainer for conditioning and orientation to prepare for long space trips.



rockets and missiles

Componentry capabilities of the Kelsey-Hayes Company as a supplier of precision propulsion assemblies, structu parts and exotic high temperature materials for first and second generation rockets and missiles include—

Swivel nozzles, hydraulic control system and auxiliary power supply systems for thrust vector control; weldments, rocket and combustion chambers for liquid and solid propellant propulsion systems; inner cones, exhaust cones, rotating wh assemblies; vacuum induction melted alloys to withstand corrosive and extremely high temperature atmosphere advanced design, research and develop- ment in gas dynamics, internal ballistics transient heat and thermal stress analy

Kelsey-Hayes Company,
General Offices: Detroit 32, Michigan

KELSEY-HAYES COMPANY

Automotive, Aviation and Agricultural Parts
Hand Tools for Industry and Home

18 PLANTS: Detroit and Jackson, Michigan; Los Angeles, Philadelphia and McKeesport, Pennsylvania, Springfield, Ohio; New Hartf and Utica, New York; Davenport, Iowa, Windsor, Ontario, Canada.

How Big A Missile Support File?

AF list will start with some 2500 data sheets but opinions differ on how much longer it will get

by William E. Howard

WASHINGTON—Air Force supply nnels are bulging with roughly 1.5 ion pieces of equipment—from ominiature transistors to multi-mil- dollar LOX generators. Each day to 500 more items are being added upport new missile/aircraft, com- ications and warning systems. (In 2 there were 725,000 items in the ly system.)

This enormous quantity, reflecting inually changing strategic require- ts and advancement in state-of-the- ile-art, is creating a king-size prob- for AF compilers of the "Technical Information File"—a first attempt to catalogue the fast-expanding missile/aircraft support equipment field.

Last in a Series on Missile Support

The first installment of this unusual reference guide being published July 1 will contain nearly 500 data sheets describing equipment in inventory. Later sheets will include equipment under development. But the question that is confronting TIF editors already is: How big should TIF be when complete?

A prime goal of the catalogue is to stem the birth rate of unnecessary equipment. For new weapons coming along, the AF wants gear listed in TIF to be utilized whenever possible by contractors, either as it stands or with modifications, rather than continue on with wasteful duplication that has already bloated AF inventories (M/R June 15, page 21.)

Can TIF become a really useful instrument in bringing about some order and standardization in the missile support field without listing the hundreds of thousands of handling, test and checkout items that already exist?

TIF Data Sheet

MIL-D-19731A

(ITEM NAME)
(TYPE OR MODEL DESIGNATION)
(Date of this Data Sheet) (Approved Nomenclature, if Available)
(Functional Classification)

Cognizant Service

FEDERAL STOCK NUMBER

	USA	USN	USAF	USMC
TATUS OR TYPE CLASSIFICATION				

anufacturer(s): Name or Code Number

ILLUSTRATION

(Include Approximate Over-All Dimensions and Weight)

UNCTIONAL DESCRIPTION:

Give a brief functional description of the item.

This information shall be presented in paragraph form and shall escribe specifically what the equipment does, what it is used for, hat it is used with, application, and where it is used.

The description shall support the functional class assigned nd include general operating and design characteristics.

R PRODUCTION of a typical TIF data sheet, to be inserted n oose-leaf volume. Pages will number 2500—for a beginning.

(ITEM NAME)
(TYPE OR MODEL DESIGNATION)

MIL-D-19731A

RELATION TO SIMILAR EQUIPMENT:

Describe differences and/or similarities to other equipment of the same general type and function.

This information shall be presented in paragraph form and include the nomenclature and type or model designation of the equipment discussed.

TECHNICAL DESCRIPTION

The following information, as applicable, shall be listed in tabular form:

Frequency range.
Power output and/or input (to include amperage, KVA, number of wires, phase, type of receptacle or plug, length of cable, etc).
Output signal characteristcs, range as rated, accuracies, sensitivities.
Pertinent electrical and mechanical characteristics and individual units of major importance (such as calibration, size, accuracy, type, etc of test indicators).
Dimensions (if for fixed installation, give necessary data for installing; for example, 1 in. lag bolt at each corner for concrete imbedment, etc).
Wheel size(s) and type(s).
Towing capabilities or restrictions.
Lifting capacity, rated and ultimate.
Lunette details.
Weight (dry and ready for operation).
Tie-down provisions.
Hydraulic and/or pneumatic characteristics (to include input/output pressure, flow, fluid/gas type and characteristics, receptacle or connector type, hose length, etc)
Other equivalent information applicable to special or unusual equipment.
If self-propelled automotive type equipment, include dimensions, tread, wheel base, turning radii, angles of approach and departure, minimum ground clearance, data relative to fuel system, clutch, transmission, transfer case, axles, frame, suspension, steering, brakes, electrical system, performance, cab, winch, etc.
List, in tabular form, the types and quantity of each type of electron tube, crystal and/or transistor used in the equipment.

REFERENCE DATA AND LITERATURE:

To the extent known, list the following information in tabular form:

Service and/or commercial instructional publications (give title and publication numbers).

Engineering test report (report number and date).

Specification: (number) - Drawing: (number) - Etc.

REVERSE of the same page, giving more detail space. An EIA spokesman says some sales sheets might be made identically.

No restraint on trade likely . . .

Both AF and industry officials who collaborated on the creation of the file firmly believe it is an important step forward, although viewpoints may differ as to what and how many items TIF should include.

Air Materiel Command officials assembling TIF at Wright-Patterson AFB believe that to achieve its goal of standardizing equipment in use, the contents must be highly selective, and restrictive. Accordingly, they are proceeding—with the approval of industry steering groups—to limit TIF initially, at least, to 2500 data sheets.

On the other hand, some industry experts believe that eventually the book will have to get much bigger—perhaps listing 100,000 or more items.

"We feel that the catalogue will lose its value to the contractor if it is too big," says one high official in AMC's Office of Cataloguing and Standardization. This officer explains that TIF is being put together as a "designer's guide." Its objective is to let contractors know what is in AF inventories, and flag them on what the AF wants designed into new weapons.

• **Sales effect?**—AF officials hasten to make clear that TIF is in no way likely to act as a restraint on trade.

Information given on TIF data sheets relates only to performance specs of the desired equipment. Also listed are makers of an item who have previously sold to the AF.

However, OCS authorities say that TIF will not be utilized as a procurement directory. Buying of spares and re-procurement of items will be done in the customary fashion.

In some respects, perhaps, TIF will amount to a sales brochure for the companies whose products are contained in it because their names will be continually before contractors, who are buyers. Unique specifications of one piece of equipment listed in TIF also might be designed into a weapon system, giving one supplier an advantage over competitors.

In its initial listings, OCS is limiting TIF to items of equipment which were designed specially to military specs and which cost $2000 or more per unit. As the number of data sheets approaches the 2500 total, AF and industry representatives from AIA, EIA, SAE and NSIA will make an evaluation as to proceeding further.

The $2000 minimum criterion is expected to be relaxed to permit the inclusion of items—particularly electronic—which have a unit cost lower than that figure, but which are purchased in large quantities.

TIF listings fall now strictly into the first of four AF procurement categories or classifications. These are: 1) military-designed equipment now in use or under development; 2) commercial-designed (off-the-shelf) items in the military supply system; 3) commercial items suitable, but not yet being procured; and 4) equipment which must be designed new.

Class two items may be included later.

• **EIA viewpoint**—In the opinion of Henry E. Bernstein, military engineering coordinator of EIA, TIF will have to be comprehensive—reaching around 100,000 entries. Otherwise, he says, contractors will not have enough information at their fingertips to keep them from redesigning an already existing piece of hardware.

"The cost of cataloguing is small compared to the cost of redundant redesign," observes the retired Navy captain.

On this point, however, AMC officials say they don't want TIF to become a catch-all with the AF footing the bill for what they believe would amount to a lot of free advertising.

Bernstein suggests that as an alternative manufacturers of items in the third procurement category—those without status—make up their sales sheets in a format identical to TIF data sheets (see illustration).

TIF is to be loose-leafed. Pages will be removable and inserts can be made to keep the file up to date.

Manufacturers who follow Bernstein's suggestion would send their equipment sales sheets directly to contractors—leaving it up to the contractors to evaluate the product and decide whether they should insert it in TIF for consideration by their designers.

Bernstein points out, for instance, that one firm may make a cathode ray oscilloscope designed in-house that is several grades better than anything listed in current AF performance specs. The present system for inclusion in TIF would keep the piece out. But suppose a new weapon system required precisely such a 'scope?

"The contractor wouldn't know that it exists and would proceed to design it at a waste of money—just what we don't want to happen," says Bernstein.

He adds: "Improper standardization is the enemy of progress. There is a danger of retaining something beyond its obsolescence. TIF can be a help to progress if it is kept up to date and is kept fluid."

Fluidity will, as a practical matter, be largely in the hands of contractors. They will be the medium of contacti suppliers, who will be requested to f out TIF data sheets on equipment th is being incorporated into a missil aircraft support system. Any changes the system eliminating equipment changes in the equipment will neces tate updating of TIF data sheets.

On equipment that is under develo ment, data sheets, must be revised the item progresses to the operatior stage. Printing and distribution to abo 2600 contractors and AF procureme officials is handled by OCS.

AMC officials feel that TIF shou have a chance to be tried for seve months before any revisions are ma in the approach, particularly as gards the number of listed items.

"The reason we got together on T in the first place," comments one, that contractors complained that stock lists were too unwieldy to wo from. Let's keep the catalogue sm and see what happens."

X-15 Is Powered by Two Novel Generators

SCHENECTADY, N.Y.—Two unus 40-hp generators furnish the o power aboard the *X-15* space resea plane during glide tests. The u operate completely independent of plane's rocket engine and furnish p er to keep the pilot alive and cont the vehicle during descent and landi For fuel, they use hydrogen peroxi which decomposes into steam and o gen to drive a high-velocity turb producing both electric and hydra power.

Electric power from the Gen Electric units is used to energize plane's instrumentation, provide ca and pressure suit heat, power inertial guidance system and comp ers, and operate communication, t metering, and recording equipm Hydraulic power operates speed bra landing flaps and control surfaces.

Whirling Gas Gouges Nose Cones, Meteorites

SCHENECTADY, N.Y.—A Gen Electric scientist has come up wit convincing explanation of why s iron meteorites contain deep cavi that appear to have been made v a cutting tool.

Dr. R. H. Johnson says that stu of nose cones at hypersonic spe show that whirlpools of hot gas f in imperfections in the surface of cone (or meteorite) and cut like h speed tools to gouge out deep cavi

He contends, too, that this could count for the fact that some meteo fly apart during atmospheric entry.

Notch Sensitivity Wall Will Crack

Large diameter rocket motor cases with 300,000 psi min-yield strength may be in production within a year through use of promising metallurgical techniques

WASHINGTON—If claims could fly, e'd be all manner of high-strength, -wall solid rockets in the air—each a motor case strength-to-weight o in excess of 1 million inches. Not that, but there'd be a free and al choice of materials including doz- of alloys of aluminum, titanium steel—each better than the others. nd the fabrication methods! All ld be "best" and would include d and welded, girth welded, stacked s, deep drawn, deep drawn and ded, hogged out, cold spun, hot , convolute wrapped, spiral pped, press extruded, sprayed metal, We'd be in missile heaven if claims d fly.

But they can't. And, by themselves, can't win contracts either. It used e that a company with a name, a n and an adeptness at the fine of pitchmanship could almost be red of a development contract to eve that shining 240,000 psi mini- n-yield-strength "next goal"—which , in those days, more than we ded, "just for good measure."

Now, as many a sadder (cancelled and wiser motor case manu- rer can attest, those days are gone ver. Years and millions of dollars , the "next goal" is down to a erate 220,000 psi. Yet the need is er to 300,000 psi. We're talking imum yield strength in large di- ter production cases—flight hard- e—not midget motors or the occa- al research program freak.

• **200,000 psi to be exceeded**—The 000 psi min-yield barrier to solid et motor case development is going e cracked within months. After that 000, 230,000 and 240,000 will fol- in rapid succession. And, before her year is passed, large-diameter 000 psi min-yield cases may well noving into the production phase.

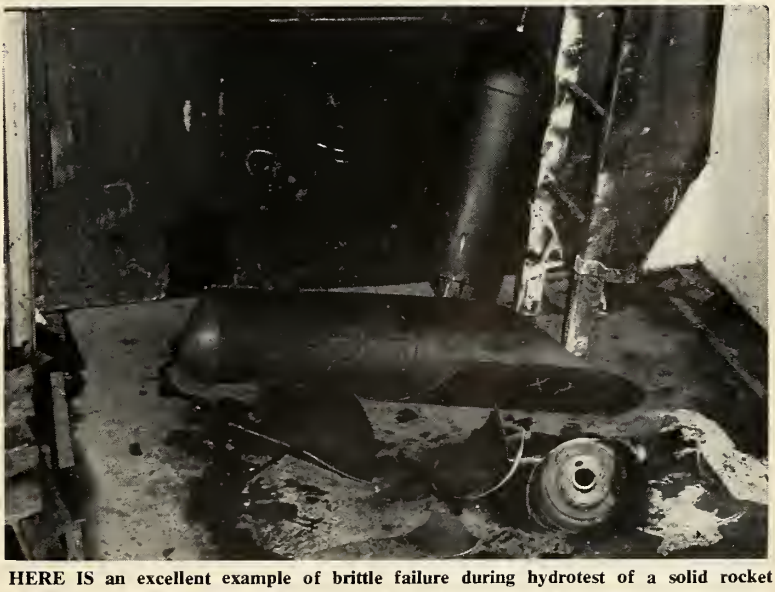
Claims, tricks and fancy talk won't what does it. Rather, it will be ac- plished with a sound understanding of the problems involved; by a better-than-ever knowledge of the finer points of metallurgy; and with a craftsman-scientist-artist's approach to fabrication.

It won't be job-shop metal-working or a big-dollar scatter factor that turns the trick. Gone are the days when the gross approach to technology was all it took to cop new honors in metallurgy. Instead it will take the same intimate understanding of this art as that which has enabled such great strides to be made in other phases of missilery, such as guidance, control, re-entry, etc.

No one can detail for sure just what form the breakthrough will take when it comes, even though the alloy(s), treatment and fabrication method(s) may now be in the development stage. There are promising results already, but nothing has been proved out.

Importantly, however, the arsenal of basic do's and don't's and promising metallurgical concepts is not only growing rapidly, but beginning to take coherent form and point the way to a breakthrough.

• **Notch sensitivity concept**—Perhaps the most elementary of these is the concept of notch sensitivity (M/R, June 8). This says, in effect, that high-strength alloys heat-treated to their optimum high strengths will have a very low tolerance for even very small flaws. It goes on to say (based now on a great variety of experimental research and testing) that if, on the other hand, an alloy is heat-treated to a lower smooth tensile strength (and more ductile condition), its toler-



HERE IS an excellent example of brittle failure during hydrotest of a solid rocket motor case. Failure in this case was at less than one-half the values of the tensile coupons that accompanied the chamber through heat-treat. It burst at 1000 psi hydro pressure. The material, a 5% chrome hot-worked die steel, exhibits all the characteristics of a notch-sensitive failure.

ance to flaws will be greater, and the material in the notched condition will be stronger. It is against this basic concept that current motor case development is proceeding.

No material tested so far shows a notch strength in excess of 210,000 psi. Most are below 200,000 psi. The mean is 190,000 psi. This would seem to rule out any chances of breaking the 220,000 mark without developing materials that either weren't notch-sensitive or had notch strengths in excess of that mark. Fortunately, however, this isn't so.

• **Two assault forms**—The assault on notch sensitivity takes two basic routes:

The assumption is made that, on a production run, flaws are inevitable, and efforts are being made to design and fabricate accordingly.

Considerable effort is being expended both by steel-makers and motor case manufacturers to develop basic materials and fabrication techniques to minimize the possibility of flaws in the finished product. Simultaneously, efforts are being made to develop inspection techniques (unavailable now) to reliably detect these flaws—which take many forms and need not exceed a maximum dimension of 0.010" to prove fatal.

Accepting notch sensitivity as inevitable requires a more highly refined approach to stress analysis, if the 200,000 psi mark is going to be topped. This is the first step in designing to high notch sensitive strength in motor cases, and is an approach that apparently is still not too widely appreciated.

Most material min-yield and ultimate tensile strengths are stated on the basis of results obtained from pull tests on straight strip samples of the material—notched or not, depending on the test. In this test, the strip is grabbed by jaws at either end, and tensile stress is applied until (a) the material exceeds its elastic limit (min-yield stress) and (b) it fractures (ultimate tensile strength).

Traditionally, motor-case design procedure had been to take these simple coupon strengths and put them into the formula $s=pd/2t$, where s is the hoop stress; p, the hydrostatic test pressure; d, the motor case diameter: and t, the motor case wall thickness. (Formula for longitudinal stress is $s=pd/4t$, which makes longitudinal stress just half of hoop stress). Motor case wall thickness is determined by hoop stress only.

With a certain chamber pressure dictated by propellant chemistry and burning geometry and with a material of a given min-yield strength (based on the simple pull test), the motor case designer for the most part has simply added his safety factor (say, 20% higher pressure) and solved for wall thickness. And that's how his specifications have gone to the case manufacturer.

• **Why it costs**—But this is the gross approach to both motor case design and stress analysis, and, in part, it's one of the things that has cost us so much money, time and frustration.

It also may be why so many cases that were heat-treated to a hardness of $R_c=53$ burst as though they had been heat treated to $R_c=74$. The condition of the material is not the same under bi-axial stressing as from the combination of hoop and longitudinal stress—as it is under uniaxial loading, as in simple pull test stress. Under stress a material tends to strain (stretch). This means the cross-sectional area is reduced. However, apply a second stress 90° (normal) to the first, and it resists natural strain tendencies.

In effect, biaxial stressing appears to have the same result as a te porary embrittlement. Though this not a conclusive fact yet, work date supports the concept, and mo case development work is proceed accordingly.

For example, in comparative t between uniaxially loaded pull-test c pons and biaxially loaded cylindri pressure vessels, cylinder min-yi strengths have consistently excee those of the coupons. Also, the yi to-tensile strength ratio of the cylin has increased, meaning that the cy der's min-yield strength has gone more than its tensile strength—a ch acteristic of embrittlement.

• **Here's secret**—It is in this hig min-yield strength for cylinders t the secret of designing around nc sensitivity lies. It makes use of the Mises-Henckey Maximum Strain ergy Theory which, in effect, says the minimum yield strength of a cy der will be 1.15 times that of a test sample of the same material h treated to the same unstressed hard as the cylinder. The formula for thi $s_0^2 = (s_1 - s_2)^2 + (s_2 - s_3)^2 + (s_3 -$ where s_0 is the coupon min-y strength; s_1 is hoop stress; s_2 is lo tudinal stress ($s_1 = 2s_2$); and s radial stress (and in a thin-wall ch ber equals zero).

What all this means is this: If take a material with a maximum n

Steels Researched for Solid Cases

Here are various steel alloys now being researched as best candidates for use as solid rocket case materials. Note the generally low carbon content of most of them; and the often-high silicon tent—both representing approaches to low notch sensitivity.

Alloy and Stainless

	C	Mn	Si	Cr	Ni	Mo	W	Co	Al	Cu	V	Cb	Ti	N	P
Vascojet 1000	.40			5.0		1.30					.50				
Lapelloy	.30	1.05	.30	11.5	.25	2.75					.25				
12 MoV	.25	.50	.50	12.0	.70	1.0					.30				
422 MOD.	.27	.85	.25	12.0	.20	2.25	1.75				.50				
301	.15*	2.0*	1.0*	17.0	7.0										
201	.15*	6.5	1.0*	17.0	4.5									.25	
Tenelon	.10*	14.5		17.0										.40	
TRC	.08	16.0	1.0*	16.0	1.0									.20	
16-1-17	.12	17.0		16.0	1.0									.15	
2021	.10	15.0	.62	16.0	1.0						.23				
Am 355	.12	.95		15.5	4.5	2.75								.10	
Ph 15-7 Mo	.09*	1.0*	1.0*	15.0	7.25	2.50			1.15						
AFD 183	.35	18.0	.60*	12.5		3.0					.80			.20	
Stainless W	.10*	1.0*	1.5*	17.0	7.0				.50*				1.50*		
Armco 1	.07	.60	.48	11.0	7.0	5.5			1.15	.75					
Armco 2	.07	.60	.40	15.0	6.0	2.5			1.15	3.0					
Armco 3	.05	.40	.40	13.0	4.0		3.0			3.5					
HNM	.30	3.5		18.5	9.5										.23
HTX	.45	8.5		21.0	8.5	1.50									.23

*Max.

Carbon and Low Alloy

	C	Mn	Si	Cr	Ni	Mo	V
AISI 1055	.55	.60-.90					
AISI 4130	.30	.40-.60	.20-.35	.80-1.10		.15-.25	
AISI 4135	.35	.70-.90	.20-.35	.80-1.10		.18-.25	
AISI 4340	.40	.60-.80	.20-.35	.70-.90	1.65-2.00	.20-.30	
AMS 6434	.35			.80	1.80	.35	.20
Air Steel X-200	.40		1.5	2.0		.50	.03 Min.
MBMC *1	.45		1.5	1.0			.01 Min.
Hy-Tuf	.25	1.30	1.5	.35	1.80	.40	
UHS 260	.35	1.25	1.5	1.25		.35	.20
Tricent	.38	.80	1.5	.84	1.80	.35	.10
17-22 AS	.30	.55		1.25		.50	.25

gth of 200,000 psi (of which there several), fabricate it into a motor , and then heat-treat it to a maxi- n notch coupon min-yield strength),000 psi), you will have a 230,000 yield motor case (1.15 times 200,-). This comes from substituting 200,- for s_0 in the above formula and ng for s_1.

• **Choice is steel**—In choosing ma- ls to meet high-strength motor requirements, with certain specific- ication exceptions, the big choice eel—any one of over two dozen s (see accompanying tables). Of e maybe half a dozen have usable h strengths in excess of 200,000 None has been proven to exceed 000 psi.

Aluminum for the most part hasn't considered for large diameter rocket motor cases because of its ively low modulus. However, on trength-to-weight ratio basis it's st an even-Steven competitor with . And Alcoa's new X-2020 alloy bits very favorable strength prop- ts at elevated temperatures. With fabrication techniques being pro- d, aluminum may yet get in the ing.

Titanium apparently is way out of field, not only due to the diffi- y in fabricating it, but also be- e it is very inconsistent in its re- se to heat-treatment. And, at the gth levels being considered, all als must be heat-treated.

Two of the most promising alloys being tested in solid rocket motor s are X-200, a low carbon air- ening steel, and MBMC 1. Both U.S. Steel developments, and give minary promise of much improved h sensitive characteristics, i.e., high h strengths.

One thing to watch out for: make ain heat-treat temperature exceeds designed environmental operating erature of the motor case. This ns, almost without exception, heat- ing to a hardness of under R_c=50, s desirable in obtaining high notch gths.

Efforts to eliminate flaws, and thus around notch sensitivity by ending with no notches, concentrate pri- ily around fabrication techniques. erally speaking, the more a ma- l is worked, as in rolling or spin- , the more flaws tend to be worked It's rather like getting large air les out of bread dough by knead- it. If the metal is worked enough, usions and inclusions, local brittle s and other discontinuities can be ded out and made homogeneous the parent metal.

• **Success in spinning**—This is the n reason such marked successes e recently been achieved by spin-

Rate of Change

This table shows typical rate of change of the notch tensile to smooth tensile strength with increased strength in the smooth coupon test sample. X-200, 300-M and UHS-280 are three typical steels being tested now for use in solid rocket motor cases.

Yield Strength —psi @ 0.2%	Sharp Notch to Tensile strength ratio	Test grain Direction	Tempering Temperature
	X—200		
180,000	0.95	L & T	1175°
210,000	0.81	L & T	1075°
225,000	0.43	L & T	975°
240,000	0.31	L & T	830°
	300—M		
180,000	1.00	L	1160°
210,000	0.41	L & T	850°
225,000	0.47	L & T	775°
240,000	0.49	L & T	700°
240,000	0.40	L & T	500°
	UHS—280		
180,000	0.89	L & T	1100°
210,000	0.41	L & T	650°
225,000	0.39	L & T	650°
240,000	0.36	L & T	500°

ning motor cases. Typical procedure here is to start with a forged (and perhaps machined) blank whose inside diameter equals that of the finished case, whose length is half and whose wall thickness is twice that of the finished product. Then, in one-to-three passes with spinning equipment (Hydrospin, Hydroform, Flo-Turn, etc.), the metal is literally pushed into the desired configuration. Though greatest success so far has been achieved with cold spinning, impressive results have recently been reported by at least one contractor with hot spinning—where the blank is heated before each pass.

Spinning used in combination with other fabrication techniques (which unfortunately cannot be detailed at this time) has produced the best results. One Navy (*Polaris*) engineer is convinced the best cases for both *Polaris* and *Minuteman* will be spun.

The old, well established technique of either cold or hot working welds goes a long way towards minimizing the notch effects of under-bead cracks and normal cracks in welding.

Care should be taken to determine the cracking tendency of the material being welded (whether under-bead or normal), in order to align the crack direction normal to the longitudinal (lowest) stress vector and design the case (or pick materials) accordingly.

Insofar as notch sensitivity is concerned, a notch is any discontinuity in the body of the material or in its contour. For this reason, it is almost mandatory in welded cases that the weld bead be ground flush with the rest of the case.

Sharp corners in design should be avoided wherever possible. Anything that tends to produce a bending moment when the case is pressurized is dangerous. This includes ovality in the unpressurized case, which wants to "bend" into the round configuration under pressure, or a dent. The latter can cause local stresses double those in the undented case.

In some instances the material supplier tries to take the notches out before it ever gets to the fabricator. One approach to this is U.S. Steel's sandwich rolled sheet where several layers of plate are rolled as a laminate. Advantages claimed for this technique are: cross rolling; reduction in directional differentiation of grain structure; minimization of inclusions in any direction; high surface density; freedom from normal surface flaws; better decarburization control; closer tolerance control (thickness held to 0.0205" to 0.0215" in 130" wide sheet). Burst tests with small welded cylinders are being conducted now.

Controlled decarburization has, itself, been suggested as a means of minimizing notch sensitivity—particularly due to surface flaws and scratches. Theory here is that more ductile surface makes it easier for stress relieving plastic deformation to take place.

• **Here are "buts"**—One final word of caution: minimize hydrotesting. If there is any tendency towards notch failure—crack propagation—hydrotesting will intensify it. Ideally, it would be best to inspect all flaws out of a motor case and thus make even one hydrotest cycle unnecessary.

But this not being possible, the compromise generally being adopted is three static tests of three minutes each. Value of a dynamic (surge) test is seriously questioned, since materials at the strength levels being considered generally are not strain-rate-sensitive.

Obviously, a lot more is being done to eliminate or get around notch sensitivity. But basically all specific approaches fall within the general parameters outlined above. Little has been said about strip (spiral) wrapping with very thin (0.015" thick), high-strength (300,000-to-500,000 psi ultimate) strips, since serious problems remain in attaching forward and aft closures, and current organic bonding techniques make spiral wrap cases subject to strength failure under aerodynamic heating.

Drag Brake Proposed for M-I-S

Avco says ICBM research and aero-medical progress have made possible design with advantages of simplicity along with lightweight and reduced production expense

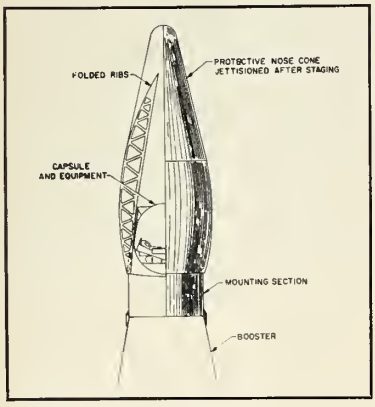


FIG. 2—Drag brake satellite vehicle mounted on *Atlas* booster for launching.

EVERETT, MASS.—Details of a manned satellite design based on a drag brake—rather than retro-rockets as planned under NASA's Project *Mercury*—have been revealed by Avco's Everett Research Laboratory.

Under Avco's system, which has been under research for three years, the drag brake would perform all functions now in a retrorocket system: orientation of vehicle, retrorocket with autopilot, heat shield, and a sequence of decelerating parachutes.

In announcing the system, Avco scientists pointed out that manned satellite designs which have been discussed publicly are adaptations of airplane or nose cone technology, and that the re-entry heating problem and the deceleration which must be faced by a human passenger have domina most manned satellite discussion.

However, Avco said that prog made during the ICBM program allowed the company to design a hicle without over-emphasizing re-e heating considerations. Furthermor added, progress in aero-medical search makes it clear that the 8 g celerations which must be faced i tangential constant drag re-entry not a serious problem either, should not dominate the design.

While the retro-rocket design proach to Project *Mercury* was cited in research details furnished Avco, retro-rocket systems were u as a comparison.

• **Advantages**—In summarizing advantages of the drag brake sate recovery system and its space fl potential, Avco said its "multipli of functions" leads "to several ad tages over other recovery syst which all require separate subsyst to perform each function."

These advantages were cited:

1. The system—when operati —will, because of its simplicity, s a greater reliability because the ability of any system can be onl large as the product of the reliabil of all its subsystems.

2. Since there is only one m component, the development will quire less time and will be less c than the development of the sev subsystems of other satellite reco systems.

3. The operational aspects of orbital flight with a drag vehicle be far less complicated. Avco p out that a retro-rocket system requi a device which maintains accurate entation of the vehicle; a retro-ro plus its auto-pilot; a heat shield w may or may not need to be jettiso and a final landing system consis of a sequence of parachutes which



FIG. 1—Model of Avco drag brake. Mechanical engineering and structural design by All American Engineering Co. in cooperation with the Avco-Everett Research Laboratory.

ving the vehicle down at about
)00 ft.
4. Control aspects of a drag brake
cle will not require accurate
wledge of the orbit, and the track-
requirements are much reduced
n those of a retro-rocket system.
5. The drag brake has inherent use-
ess in the circularization of highly
tic orbits, and
6. The vehicle will have a distinct
ght advantage over other re-entry
cles. Avco said the weight required
a drag brake vehicle to recover a
n payload is less than half that
uired by a retro-rocket system, and
use of a good ablating heat shield
the retro-rocket design would re-
e the drag brake vehicle weight
ntage by 100 to 200 lbs.

• Details—Here are design details
urnished by Avco:

The manned satellite design is built
nd a stainless steel drag brake (Fig.
Opening and closing the structure
rbit results in a 20:1 drag varia-
This variation causes a corre-
nding change in the rate of descent
rbital lifetime.

Controlled variation of the drag
rding to a preset program will
nit landing at a pre-selected point
an accuracy of ± 150 nautical
s. The extended structure has a low
ing, 1½ #/ft², and consequently
vehicle decelerates high in the at-
here, radiating the heat away at
eratures which never exceed
ent gas turbine practice.

The drag brake also yields a ter-
l velocity low enough so that no
ional parachutes are required for
ing at ground level.

During launch the drag brake satel-
is mounted on the booster in the
d position (Fig. 2). The man lies
e recommended supine position on
ntoured couch inside the capsule.
flexible drag brake covering ma-
l is folded inside the ring of ribs.
ractor type escape system is
nted at the forward end of the
The drag brake is covered by a
ective nose cover. At staging, when
vehicle is essentially out of the
e part of the atmosphere, the nose
r and escape system are jettisoned.

• 105-mile orbit—The booster ve-
accelerates the satellite until the
er velocity vector has been
ved. At this point the satellite
booster are separated and the drag
e vehicle starts its journey in space.
The satellite would be launched
a 105-n. mile near-circular orbit,
ing a lifetime of two days in the
drag or closed position of the
brake—and permitting emergency
ery in two hours.

Avco pointed out that emergency
ery times of less than the orbital

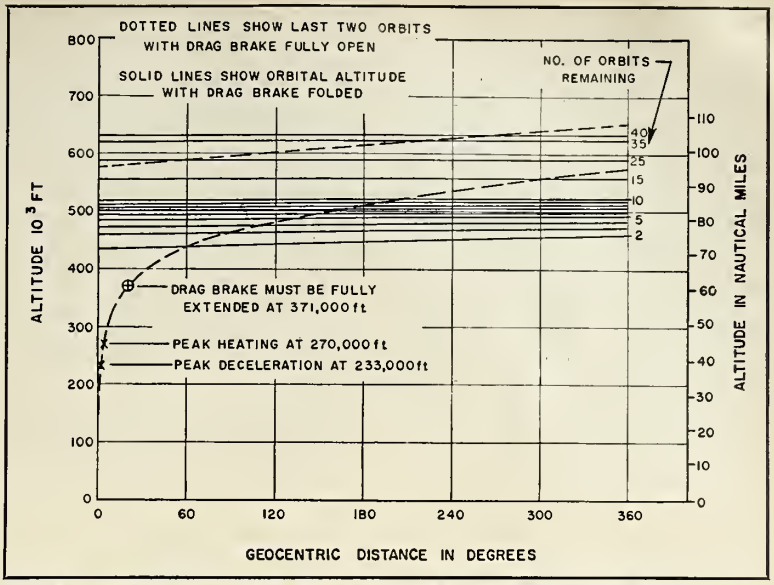


FIG. 3.—Landing point control by drag variation. The difference in descent rate or orbit decay is shown for a 20:1 drag variation from $W/C_DA \pm 1.5$ to 30.

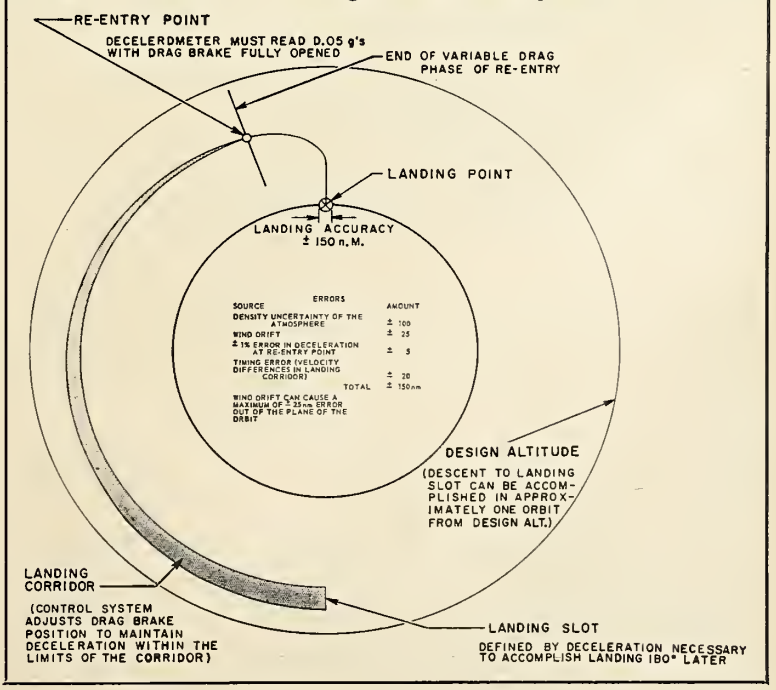
period "do not make sense" because recovery must be effected at a specific point in every orbit in order to minimize the vast problem of location after landing.

At 105 n. miles, the small but distinct amount of residual atmosphere will exert forces on the vehicle. Because of the large extended structure, even in the closed position these forces are sufficient to exert the necessary movements to orient the vehicle into the air stream, Avco said. The period of this motion at 105 n. miles altitude is several minutes.

For a drag brake satellite, re-entry is made up of a number of distinct phases. First, the satellite descends from the orbital altitude to the region from which a controlled re-entry is made.

Next, the drag is controlled accord-

FIG. 4—Landing Point Control System



ing to a preset program for about ½ orbit in order to achieve a given velocity vector at a particular point. Finally, the drag brake is fixed in the open position at the onset of serious heating and the vehicle passes through the heating and deceleration peaks and achieves terminal velocity at about 200,000 ft. From here down the vehicle drifts at terminal velocity and lands at 50 ft./sec. at sea level.

The principal of operation of the variable drag landing point control is shown in Fig. 3. Concept is that the descent rate or lifetime of decaying satellite orbits can be changed significantly by changes in the vehicle ballistic parameter, W/C_DA.

For instance, from an altitude of about 90 n. miles one can re-enter in as many as 15 orbits or in less than one orbit, depending on the drag brake position, i.e., ballistic parameter, W/C_DA.

In fact, Avco said, in the geometric mean drag brake position, and only 3000 n. miles from the landing point, the landing point can be altered by approximately plus 2000 and minus 1500 n. miles.

• **Control philosophy**—A detailed control system philosophy which operates on the above-stated principle has been developed. The system depends on two simple measurements: time and acceleration. The time serves to locate the vehicle with respect to the landing point.

As long as the satellite is still in a nearly circular orbit, the orbital period is essentially invariant with the small ellipticities due to drag and drag variations. Thus the timing from either th insertion point or from a later fix lo cates the satellite accurately. This rela tionship holds until the onset of larg deceleration forces. Thus ideal or nom inal drag variation with time can b established for the controlled dra phase of re-entry.

A body-mounted accelerometer measures this drag and compares it t the measured drag and to the nomina value desired. The control system ca thus sense whether the drag is correct too high, or too low, and can produc signals which vary the drag brake posi tion so as to eliminate the differenc between the nominal and measure values. Avco said this system does no require accurate information about th orbit and therefore tracking require ments are simplified.

According to Avco, the system capable of correcting the effect of ellip ticity, altitude error at the start of th controlled phase, errors in the know edge of the upper atmosphere an density variations of either the latitud or diurnal type.

The result of an error analysis fixe a density range from which the contr system can achieve a landing poin accuracy of plus or minus 150 miles in the orbital plane. This indicated by the "landing slot" show in Fig. 4. During the controlled phas the satellite flies within the "landin corridor," correcting the drag brak position in accordance with the contr system dictates, until it achieves th proper velocity vector at the re-entr point.

• **500°F temperature**—From th re-entry point to final touchdown r further functions are required, Avc said. The nose of the capsule will he up to a temperature of about 500° when the vehicle is only 1000 n. mil from the final landing point. Up to th point the linear relationship betwee distance and time will have been acc rate to 20 n. miles. At the low dra parameter, W/C_DA, of 1.5 peak hea ing occurs at a very high altitude ar consequently the heat transfer rat and the radiative equilibrium temper tures will be relatively low.

The maxium temperature encou tered by the structure at the capsu nose surface will be less than 1500° assuming an emissivity of 0.85. T drag brake surface, which can radia from both the front and rear surfac should not exceed an equilibrium te perature of 1200°F.

At peak heating, at 270,000 ft. al tude, the deceleration will be abo four g. After peak heating the decele tion will continue to increase a should reach 8.2 g at 233,000 ft. T time above eight g will be aproximate 20 seconds and should be well with

FIG. 5—Drag Brake Re-entry Conditions

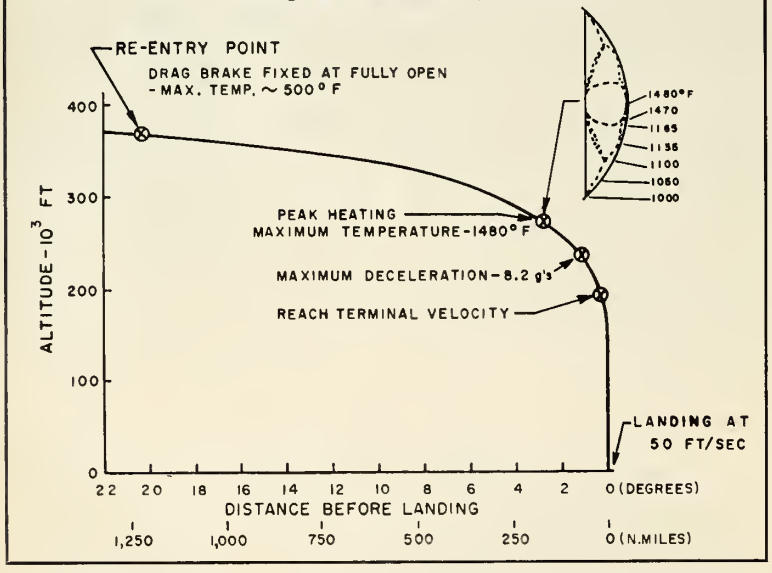
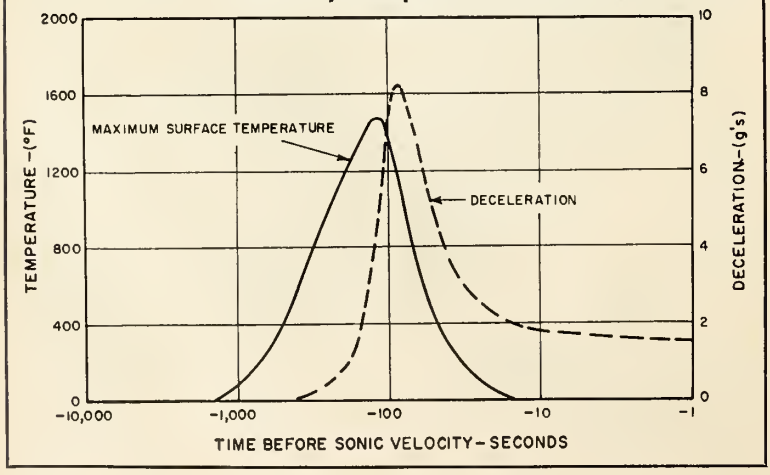


FIG. 6—Re-entry Temps & Accelerations



established limits of human endurance. At peak deceleration the maximum temperature will have decreased 1130°F (Figs. 5 and 6).

Avco said the relative time of occurrence of the peaks of heating and deceleration points out an interesting possibility for future drag brake vehicles. If at the instant of peak heating (i.e., 4 g) the acceleration is held constant by retracting the drag brake slightly, then the peak re-entry g can be reduced to four—without any increase in maximum temperature. The peak heating condition would merely be held for a somewhat longer time, which does not penalize a radiating re-entry vehicle structure.

The drag brake will continue to decelerate and will approach terminal velocity just under 200,000 ft. The terminal velocity will decrease with increasing air density until at sea level the vehicle will land at 50 ft./sec. During the terminal descent, which takes approximately 15 minutes, the large metallic surface should be an excellent radar target for tracking and locating the vehicle at the landing.

• **Mechanical details**—The mechanical problems of building a drag brake satellite system have been faced in considerable detail. The device consists of four basic components, i.e., the ribs, the covering material, the actuating mechanism and the capsule. Of these the ribs represent over 50% of the total weight of the drag brake.

The total weight of the ribs could be reduced by decreasing their number, Avco said. However, the consequent departure from a true spherical surface due to the scalloping effect of the covering between the ribs would increase the heat transfer on the ribs. The ribs are .020" stainless steel beams with reinforcing cap strips. Buckling due to compression of the cap strip is the most critical design condition.

The covering material should be as light as possible, Avco points out. Stainless steel cloth made of .001 wire woven into a close, 400 x 400, mesh is commercially available, and this material meets all the requirements except that it is somewhat porous. Even a small amount of porosity increases the heat transfer on the drag brake significantly due to the removal of the cool boundary layer air blanketing the surface.

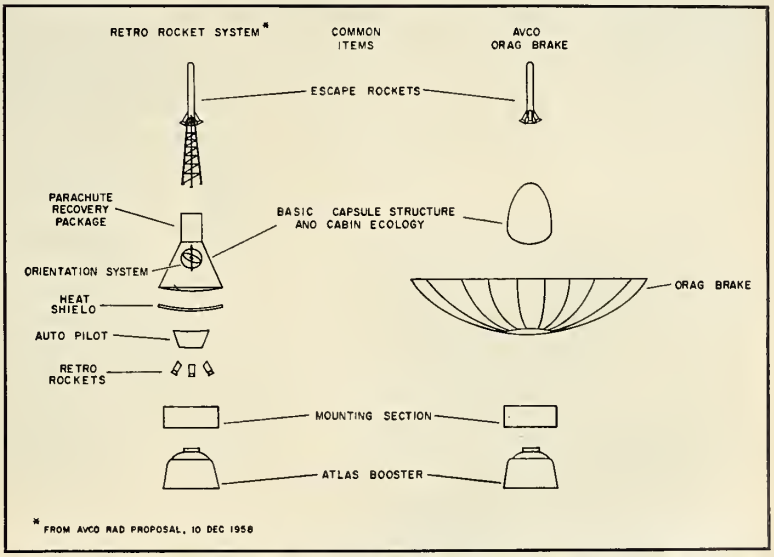
Several methods of reducing the objectionable porosity are under consideration. It is presently possible to build up a drag brake skin out of a layer of the above cloth, a layer of thin (.005 inch) solid sheet but cut into circumferentially aligned ribbons or shingles, and another layer of cloth of coarser mesh.

The shingles will eliminate the porosity, yet are flexible enough to satisfy the folding requirements. The two layers of cloth maintain the shingles in place and prevent tearing. The air loads can actually be transmitted to the ribs by any one of the three layers alone.

• **Actuation choices**—The actuating system and capsule do not represent serious design problems, Avco said. It is mostly a question of arriving at the lightest and simplest structure for each. Actuation can be either pneumatic, electric or mechanical. A two-way pneumatic system is proposed.

• **Would-be sphere**—The optimum pressure vessel, i.e., a sphere, is very nearly a compatible shape for the drag brake vehicle. Only a slight conical section need be interposed between the spherical top and bottom halves. The conical section is extended both up and down to form the hinge points for the drag brake. This capsule weighs only a few percent more than an equivalent spherical vessel.

Avco said that in this design the configuration was dictated by the orbital, re-entry and escape conditions, rather than by the sea level landing speed. The resultant landing velocity of 50 ft./sec. is somewhat higher than has been proposed in other satellite designs. However, Avco believes that the decelerations on the passenger can be kept at a level equivalent to a 30 ft./sec. landing by a shock-absorbing structure similar to aircraft arresting gear. This can be accomplished, Avco said, at the cost of far less weight than would be needed to reduce the landing velocity by geometrical changes or by adding recovery parachutes.



FUNCTIONAL comparison of the Avco drag brake and a typical retro-rocket system. Company says brake's "multiplicity of functions" gives it "several advantages."

Weight Comparison of Systems

Retro Rocket System		Avco Drag Brake	
1. ADDED STRUCTURE	133 lbs.	1. 0	
2. BERYLLIUM HEAT SHIELD	398	2. 0	
3. AUTOMATIC ORIENTATION SYSTEMS	137	3. LOW TORQUE SYSTEM	25.5
POWER	66		
4. RETRO ROCKET	207	4. 0	
5. RECOVERY SYSTEMS	165	5. 0	
6. 0		6. DRAG BRAKE	425
7. 0		7. SECOND STAGE ESCAPE	50
	1106 lbs.		500 lbs.
LAUNCH WT.	2902 lbs.		2297 lbs.
ORBITAL WT.	2207		1527
RE-ENTRY WT.	1914		1399

Common Items for Both Systems

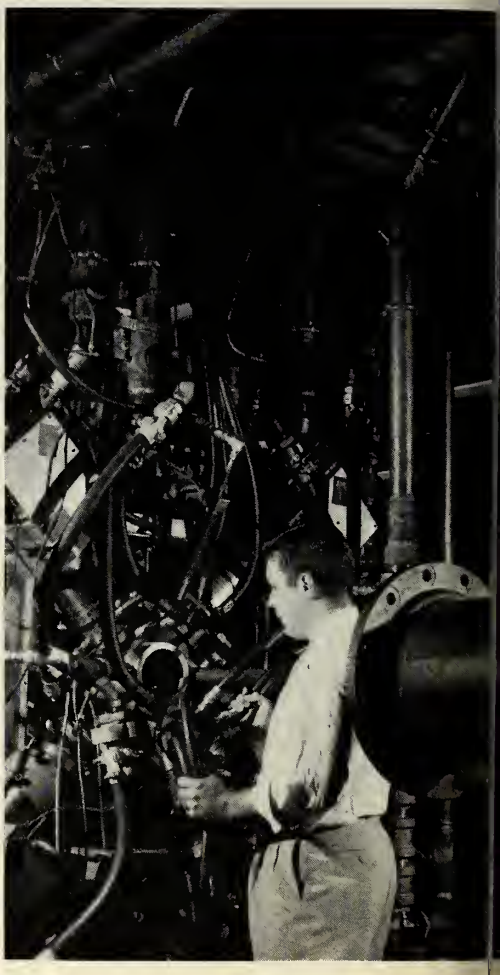
BASIC STRUCTURE	167 lbs.	PILOT SUPPORT	46	INSTRUMENTS	15.
INHABITABLE CAPSULE	133	COCKPIT	17.	RECORDING EQUIP.	24
ESCAPE SYSTEM	695	NAVIGATION AIDS	41.	POWER SUPPLY	157
ENVIRONMENTAL EQUIP.	70	COMMUNICATIONS EQUIP.	212.0	PROGRAMMER	9
				MAN AND SUIT	210
					1796 lbs.

Re-entry Stresses Simulated in Lab

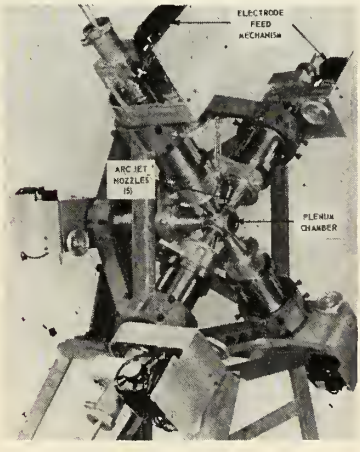
EVERETT, MASS.—A 10-megawatt high-pressure arc plasma generator which realistically duplicates the pressures and temperatures met by ICBM nose cones and satellites on re-entering the atmosphere has been developed by Avco's Everett Research Laboratory.

The unit uses five arcs instead of the usual one to generate this tremendous power. Each of the five nozzles is separately powered and water-cooled. The giant generator itself is powered by 2000 12-volt truck batteries.

The facility was developed by Avco as part of its research and development program on ICBM nose cones. Models are subjected to the high-velocity, 15,000-degree plasma jet to evaluate the performance of ablating materials and heat sinks under re-entry conditions.



AVCO technician prepares the arc wind tunnel for firing. Confusion of pipes, tubes and cables supplies the device with water, air and power.



JET NOZZLE assembly. Each of the five jets, powered by arcs from water-cooled graphite cathodes, discharges hot plasma into central copper plenum chamber.

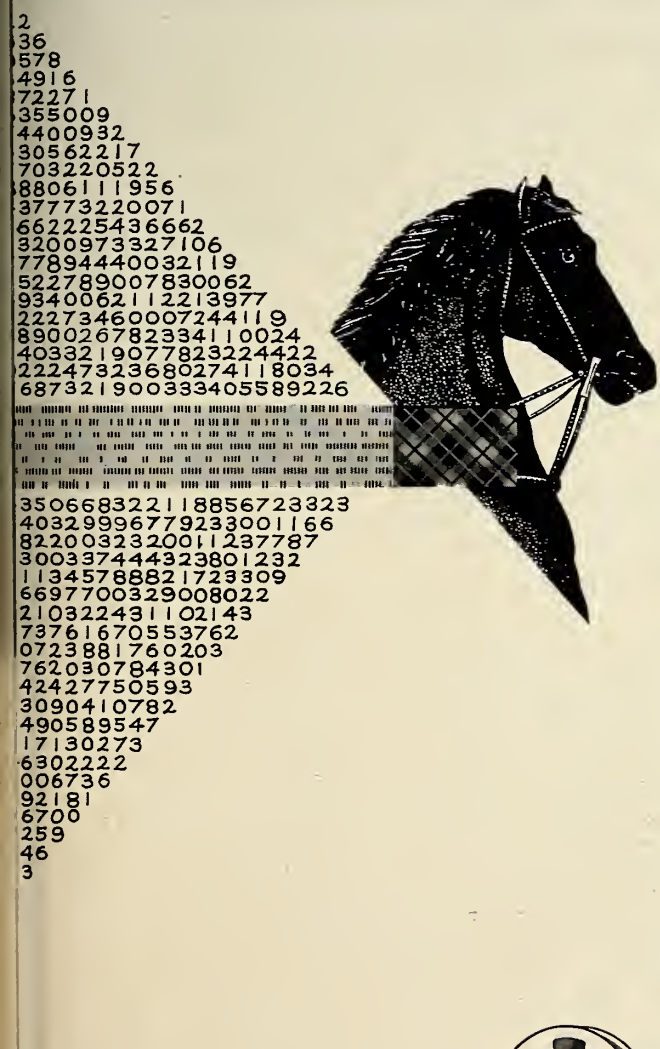


TEN MEGAWATT arc jet in operation. The jet, containing five to six million watts of energy, issues through supersonic nozzle.

NEED A TAPE WORKHORSE?

"SCOTCH" BRAND Sandwich Tapes

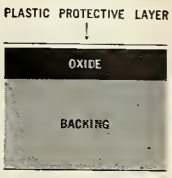
wear longer, cut head maintenance even in digital work



Tote that tape—change that reel—clean that head! If your project atmosphere sometimes seems that way, "SCOTCH" BRAND Sandwich Tape comes to the rescue. How about the possibility of getting over 50,000 passes out of a computer tape? And if that sounds attractive, consider the value in a tape that has no rub-off, won't give you any head buiid-up, drastically reduces maintenance and replacement on costly head assemblies.

One user found that the simple change to "SCOTCH" BRAND Sandwich dramatically reduced head replacements. And—where heads previously had to be cleaned after every run, "SCOTCH" BRAND Sandwich Tape cut cleaning to once a week.

The secret's in the Sandwich—the high potency oxide magnetic coating is sandwiched between the tough polyester base and a thin protective plastic layer. The coating never contacts the head—you get smooth, low-friction tape movement, plus an end to rub-off, head build-up, and a reduction in erosion of the critical slit in the recording head. Though the 50 micro-inch protective layer causes some slight reduction in high frequency response, the plain facts are that Sandwich Tape packs up to 600 pulses per inch in digital work—has broad usage in AM, FM, or PDM applications.



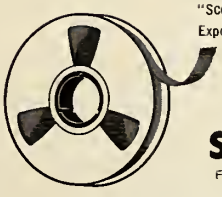
In "SCOTCH" BRAND Sandwich Tape you have a tape workhorse, pulling a big load over long distances. One user reported fewer drop-outs with each successive pass. As his recording heads were cleaned, the contaminates proved to be in the system, not the tape. Speaking of drop-outs, beware the villainous cigarette—often a culprit. One careless gesture and an ash can cause 40 to 60 drop-outs.

Whatever your application — data reduction, acquisition or control programming — count on 3M technology to create tape of higher uniformity and reliability for error-free performance.

"SCOTCH" BRAND High Output Tape No. 128 gives you top output at low frequencies, even under extremes of ambient temperatures. "SCOTCH" BRAND High Resolution Tape No. 159 lets you pack more bits per inch, offers extra playing time. Finally, for top performance at low cost per foot, "SCOTCH" BRAND Instrumentation Tapes Nos. 108 and 109 remain the standard for the industry.

Where there's no margin for error, there's no tape like "SCOTCH" BRAND. For more details, write Magnetic Products Div., 3M Company, St. Paul 6, Minn., or mail the reader inquiry card. © 1959 3M Co.

"SCOTCH" is a registered trademark of 3M Company, St. Paul 6, Minnesota. Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontario.



SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
... WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

NASA Space Lab Plans Outlined

ARS meeting also hears debate on the long-term value of Project Mercury 'holding facility' and reports on ramjet, ion engine and APU developments

by Frank G. McGuire

SAN DIEGO—Planned as a "sounding board" for practicable ideas rather than a mere exchange of technical information, the American Rocket Society's 1959 semiannual meeting, June 8-12, provided an extremely well-managed forum for all types of astronautical ideas and problems.

The meeting, marked by attendance of some 2000 members and presentation of 115 papers, covered such broad topics as the economic impact of space technology, politics in the Space Age and the influence of astronautics on contemporary thought. But it also fulfilled its original role as clearinghouse for treatment of more technical subjects.

Scattered throughout the activities were such names as Whipple, Stuhlinger, Medaris, Yates, Douglas (Donald, Jr.) Stapp, Kaplan, Dempsey, Ehricke, Urey, Silverstein—almost all of whom presented papers.

A keynote was the solid reality characteristic of most papers. There was little "wild, wild blue yonder" speculation on imaginary or insignificant academic problems. Instead, there was a down-to-earth approach keyed to actual operational requirements, logistics, and costs. One of the first sessions, that on Logistics and Operations, was aimed at making R&D personnel aware of logistical and operational problems involved in space vehicles and weapon systems.

• **Balance demanded**—Most papers presented at this session were highly critical of our pouring millions of dollars into missile performance, while spending only a fraction of that amount in appropriate instrumentation. "Supporting facilities, such as are provided by our range and its instrumentation, are too often taken for granted," according to Maj. Gen. Donald N. Yates, commander, AFMTC, Patrick AFB, who added: "We have been driven into a frantic race with missile performance in our job to provide instrumentation of commensurate performance."

Other speakers echoed the general's remarks and pressed for a more balanced program, rather than one stressing only the "bird" itself. "We are now at the bottom of the barrel . . . in instrumentation development," Yates said. He declared that instrumentation has become the bottleneck of a development program, as far as time is concerned.

• **Solid-state future**—The electronics segment of astronautical engineering was warned that it, too, is approaching the "point of diminishing returns" in one phase of its field—component microminiaturization. "Fortunately," said Donal B. Duncan of Autonetics, "there is an extensive research effort which . . . can replace, not existing components, but existing circuits," with solid-state circuits.

These units, packaged as one, replace present devices in which components are packaged individually, then connected by wiring or printed circuitry. Duncan predicted an accelerated development of these solid-state circuits, bringing a major technological breakthrough within a few years.

The time will come, he predicted, when a small digital computer, now requiring decision, memory, and other circuits, will consist of a single block of material incorporating all these elements.

"The material might consist of a single thin crystal of a semiconductor with dimensions on the order of inches, which is modified by depositing on the surface various elements to change the lattice structure of the semiconduct or to modify in other ways the surfa characteristics. It is possible that t deposit of these various thin fil can be made by some automatic pr cess and that the time to modify t crystal so that it is a complete di tal computer can become a matter minutes," Duncan said.

• **Space observatory**—The propos launching of a 2500-pound orbiti space observatory by NASA came for some attention. The platfor mounting six telescopes up to 36 inch would be placed in a 500-mile orbit a two-stage configuration of *Vega* not less than two years. The prelimi ary planning stages of the progra have been funded, and several int mediate steps are in the works, su as orbiting a solar observatory satell of several hundred pounds at abo 300 miles.

The unmanned platform will designed to aiming accuracies of o second of arc, relying on a flywh system instead of control jets. T high accuracy would drop if men we put aboard—even the heartbeat of crew member could conceivably distu it. "Actually," commented Dr. Fr Whipple, "we're not even aware what disturbing influences on the pl form might be introduced by the blo flow of a crew member."

Objectives of the orbiting obser tory are several: to make a compl map of the sky; locate "cold" st presently not visible; and locate p sible planets in "nearby" space (wit 10 light years).

Aiming of the platform would by radio control from earth. The f wheels would be set in motion in desired direction at the proper tim then stopped at the correct point. destruct system would quite likely

ilt into the platform, or at least its dio, to eliminate it from the communications spectrum and to prevent becoming a hazard to future navition.

The six telescopes would all point the same direction, but use different ters. This would eliminate the need r a mechanical filter-changing system which might cause reliability problms if just one telescope were used. ife of the platform was estimated, preming realization of plans, at over 0 years.

• **"Holding facility"**—A not-previsly-publicized facet of the Project *ercury* program was brought out at e meeting in several technical papers. his was the "holding facility" concept volving pre-launch and post-launch olation of astronauts for training, ealth and psychological preparation d debriefing.

The holding facility is defined as "training and medical maintenance nter" for the space crewman. To its job—completely preparing the tronaut for his mission—the facility eally would be located close to the unch site; provide quarters for all supt personnel; and be equipped to odify life support gear, simulate nearace conditions, and carry out final reening and selection.

The holding facilities would give omedical personnel maximum opportnity to control and observe the asonauts' environment and behavior bere and after a mission.

It was estimated that for four to weeks prior to launch the astronaut ould be isolated from his family and dergo an intensive training period in mulators, centrifuges, and other deces. The holding facility now being nned for the *Mercury* program at pe Canaveral will be able to simule every parameter of the mission cept weightlessness.

Biomedical experts at the meeting d varying opinions of the holding cility. Some felt that the four to 12ek period was absolutely mandatory. hers, including Toby Freedman of AA, felt that the holding facility with s isolation concept would be fine for one-shot mission, but that if the aim continuing space flight for long pends of time, it should be made as n-special" as possible, while still aintaining the requirements necessary r successful completion of the mison. The amount of special treatment r astronauts was the main point of ntention.

• **Lamps for wives?**—Freedman's per conceded that it is worth every ort to keep the astronaut free from ease. But he questioned the wisdom an absolute quarantine. ("In short, ould our space pilot sleep with his

THE GRAND CENTRAL REPORT

Tennessee Gas Transmission Company and Food Machinery and Chemical Corporation, the parent companies of Grand Central Rocket, have extensive investments in the energy field. In addition to their interest in Grand Central, TGT is in the oil, gas, and petrochemical fields, while FMC has three other divisions in dimazine, peroxygen chemical and boron propellants as well as other fuel and related products.

It is the long-range plan of both parent companies to build a strong position in the energy field. Grand Central Rocket Co., as a developer and producer of solid propellants and solid rocket motors, is a vital part of this plan.

It is our goal to make Grand Central Rocket, under new and aggressive management and with the addition of major facilities, one of the strongest and most capable solid propellant rocket organizations in the country.

J. J. King

JOE J. KING
Chairman of the Board
Grand Central Rocket Co.

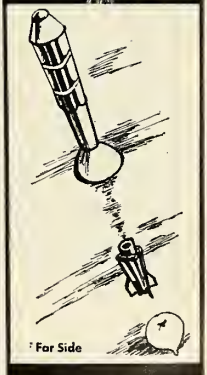
(If you have the qualifications that a fast-moving space propulsion team needs, contact our Director, Personnel. Openings now for chemists and engineers.)

Grand Central Rocket Co.
P. O. Box 111
REDLANDS, CALIFORNIA


Mercury


The Dart


Explorer III and IV


Far Side


Vanguard


Nike-Zeus


Test Sled

ultraviolet lamp on his wife?")

"On the other hand," maintained Lt. Bruce W. Pinc of AF Ballistic Missile Division, "We can't have this highly-trained man abort a mission simply because he has a middle-ear block from a cold which he picked up from his wife six days ago and didn't detect until the morning of launch."

• **Propulsion**—In the realm of propulsion, the meeting heard a profusion of highly-technical papers on all types of systems and problems.

Ramjet engines were viewed as an excellent answer to hypersonic flight, even though many obstacles must be overcome in their development. Better ramjet performance was predicted as Mach numbers go up.

The principal problem, that of temperature, was graphically stated when Richard J. Weber of NASA pointed out that the stagnation temperature at Mach 8 is 4500°F, or nearly half the surface temperature of the sun. Neither stainless steel nor such other currently available materials as molybdenum or ceramics can retain adequate strength at such temperatures.

Design techniques can, however, limit the structural temperatures to values that can be withstood by currently-available materials. Both regeneratively cooled ramjets and thermal-radiating ramjets have been considered for the dissipation of heat. The difficulty with the former is the larger amount of surface that must be regeneratively cooled, and the principal problem with the latter system is design of engine components, nacelles, etc.

The solid-propellant ducted rocket, basically a solid-propellant gas generator exhausting a fuel-rich gas into the combustion chamber of a ramjet, where it is further burned and exhausted, is also in search of heat-resistant materials. But it is considered profitably usable on a great many vehicles operating within the atmosphere.

The principal advantage would be the ability to achieve greater burning times than pure rockets, with low cost. In addition, high total impulse to gross weight makes the system attractive as a large ballistic missile booster. Also cited were its simplicity, reliability and high performance.

• **Ion outlook**—Tests of first-generation ion engines have shown that a number of engineering and scientific problems must be solved before these high-performance, low-thrust devices can be extensively used in space flight. According to Rocketdyne engineers, analysis has demonstrated that improvements in both the power-source-conversion and ion-source-accelerator systems must await development of scientific data not now available.

The accelerations produced by these first-generation ion engines will likely be less than 10^{-4} g, but they are advanced as useful engines for long missions, and some not-so-long missions. The coasting time of a chemical rocket to the nearest planet is about one year, and the low-thrust but lon duration ion rocket could make t trip in the same time.

However, a paper presented by e gineers at Electro-Optical Systems Inc cited problems—electrode destructio ionizing-surface poisoning, insulatic failure and loss of electrical power d to electron feedback—that must l solved before ion propulsion com into its own.

Some of the difficulties encountere in ion propulsion have been circun vented by extracting ions from the ic source at high voltage, then decelera ing them to the desired lower voltag according to ABMA scientists writi on the subject. This method wou avoid increasing weight, volume a complexity.

Materials problems were the prin item of interest at most propulsic discussions, mostly involving the ter perature and structure-strength cha acteristics of currently available a newer materials now under develo ment and study.

• **APU picture**—Auxiliary pow systems for space vehicles were most considered as eventually evolving in two types, solar and nuclear. Includ in a survey of feasible APU systen were: silicon photovoltic cells ("stan ard power system in 10 W-500 range"); solar thermo-electric ("pror ising"); solar thermionic-diode ("ve promising"); solar fuel cell ("promis high efficiency, much development r quired"), and solar turbo alternato ("very attractive about 3 KW. Need prove 6000-hour bearing life").

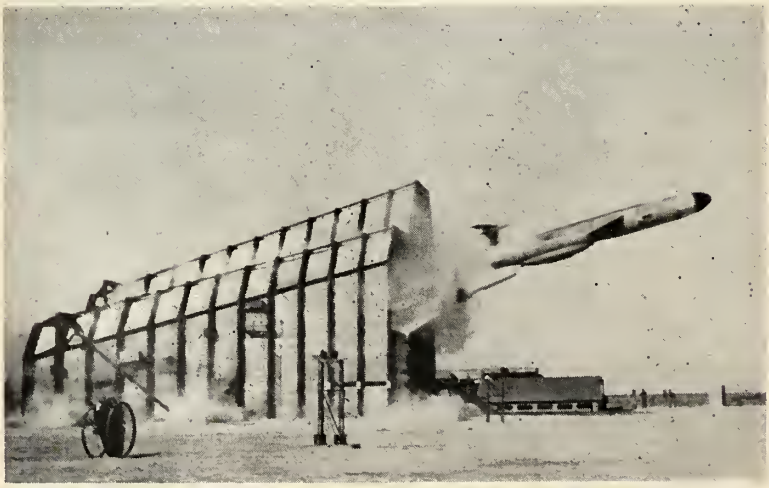
Nuclear power sources number four in the survey by JPL's Robe C. Hamilton: radioisotope therm electric or thermionic diode ("a tractive in 10 W-100 W range. Mo costly than solar power. Hazards." reactor thermo-electric ("promisi above 3 KW. Depends on materi research"); reactor thermionic-dio ("very promising. Cesium plasma r search promising. Multiple staging l ter"); reactor turbo-alternator ("ve attractive above 3 KW. Need to achie 6000-hour bearing life.")

Other sessions of great interest i cluded guidance systems, high-ener liquid rockets, high-performance pr pellants and vehicle program repor These, however, were classified.

Tours arranged for members a tending the meeting included visits the *Polaris* underwater jury rig firir Convair-Astronautics, and a trip on missile ship with firings at sea.

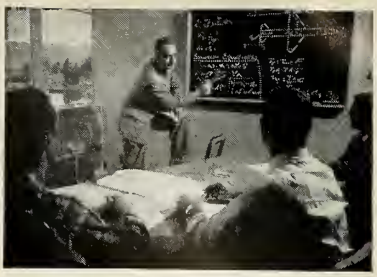
Almost 60 exhibitors set up boot at the meeting, and a glance at t list showed a sizable majority of We ern representation, but a relatively hi percentage of firms from the Ea Coast.

The Reliable *Mace*



USAF TM-76 Martin *Mace* is launched from "simulated shelter" in recent New Mexico test. The bird has been termed the "most reliable" and "least complex" in the U.S. inventory by Maj. Gen. Daniel W. Jenkins of the Air Force's Tactical Air Command.

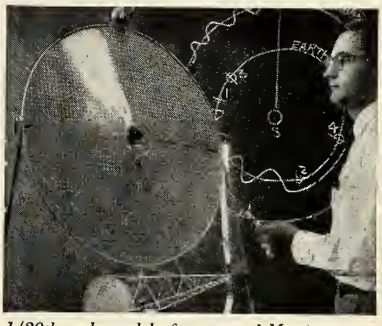




Boeing engineers work in small groups. Ability and initiative get plenty of visibility.



Test of ballistic missile propulsion system. Other tests cover space vehicle control units.



1/20th scale model of unmanned Martian reconnaissance vehicle, a Boeing study project.

Environment for Dynamic Career Growth
for Engineers and Scientists

Ability is important in getting ahead in engineering and science. But of almost equal importance is the environment in which you work. A dynamic environment that provides challenge and scope, unexcelled facilities, and plenty of room at the top, can accelerate your advance to higher levels of responsibility and income.

This is the kind of environment you'll find at Boeing... pictured and described in Boeing's new 24-page booklet, "Environment for Dynamic Career Growth."

The booklet, in addition, reports on engineering and science assignments in connection with current Boeing projects—from advanced military and commercial jet aircraft to space vehicles, guided missiles and intercontinental ballistic missiles. It also outlines Boeing research and development activities, and documents the dynamic Boeing environment that fosters career growth of engineers and scientists.

There are openings at Boeing, now, for engineers and scientists of all categories, all experience and educational levels. A Boeing assignment in Research, Design, Production or Service could be the answer to *your* future.



Mr. Stanley M. Little
Boeing Airplane Company
P. O. Box 3822-MIC
Seattle 24, Washington

Please send me a free copy of "Environment for Dynamic Career Growth."

Name .....

Address ..... City ..... State .....

Degree(s) .....

Field of Interest .....

NEW PROGRAM

Raytheon enters new weapons systems program and offers advancement opportunities for both Junior and Senior electronics engineers with experience in the following fields:

- Microwave engineers—component and antenna design
- Communications systems
- Guidance systems
- Computer systems
- Radar systems
- Inertial reference systems
- Feed-back control
- Auto-pilot
- Ground support
- Electronic packaging engineers
- Radar systems engineers (project management)
- Electromechanical engineer for missile control and auto-pilot design (project management)
- Mechanical engineer experienced in ground handling of large missile systems (project management)

You and your family will enjoy the many advantages of living in the metropolitan Boston area. Relocation assistance and modern benefits.

Please forward resume to:

Mr. W. F. O'Melia
Employment Manager
Raytheon Manufacturing Co.
Bedford, Mass.

or call collect:

Crestview 4-7100
Extension 473

RAYTHEON MISSILE SYSTEMS DIVISION

Excellence in Electronics

Prospects for Thermoelectricity

Heavy investment in research gives hope for long-lived power units for space application

by Hal Gettings

WASHINGTON—Widely hailed as the t evidence that practical power gen- tion could be achieved by thermo- ctricity, the SNAP III generator nonstrated before President Eisen- ver in January was indeed a signifi- t development. Developed under the C's SNAP (Systems for Nuclear xiliary Power) program, this first t offers hope that small electrical rces can operate in space for long iods with no maintenance or re- ling.

The need for such units is obvious. nsidered only in the light of mili- y application, thermoelectric genera- n fills many desirable requirements:

1) Units with greater efficiency n present powerplants for shipboard base production of electrical power.

2) Units free from the noise of ving engine parts.

3) Small power units with high iciency and small maintenance re- rements.

4) Small power units for satellites spacecraft capable of using nuclear rgy and solar radiation.

5) Power units adapted to use non- ventional sources of energy such nuclear energy, solar radiation, and te sources of all types.

•Operating principles—The basic nciple of the thermoelectric genera- is deceptively simple: if the junc- ns of two dissimilar metals in a ed circuit are at different tempera- es, a current will be generated in h circuit.

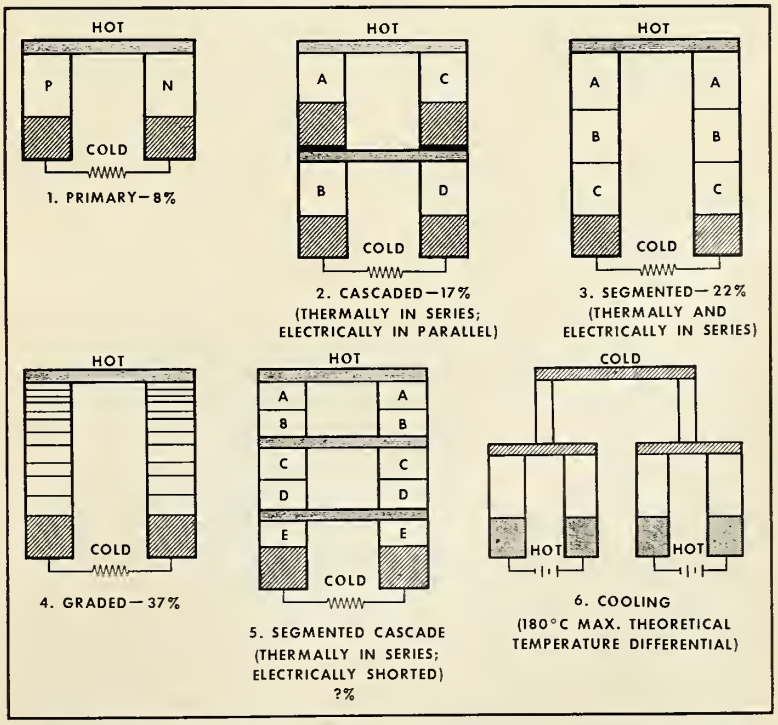
This principle was first stated by mas J. Seebeck, a German physi- , over 125 years ago. In 1834, Jean ier restated it in reverse: a current ough the junction of two dissimilar als causes heat to be absorbed or n off. This is the "Peltier effect" he basis of electronic refrigeration.

Neither Seebeck nor Peltier really erstood what he had found, how- r, and except for Lord Kelvin's f by the principles of thermo- amic theory, nothing much was e for almost 100 years.

The diagram shows a basic thermoelectric circuit. To understand the principle even more clearly, one could imagine a box partially and uniformly filled with electrons. If one end of the box is heated and the other kept cool, the electrons at the warm end move around more and push toward the cold end. So long as new electrons are added (from the other member of the junction) and an electrical load draws off the excess that tends to pile up at the cold end, the current continues to flow. Heat is "pushing" the electricity. (By considering that the electrons carry some of this heat, a picture of Peltier heating and cooling can also be developed.)

• Commercial application—The Russians have been given much credit for their early application of the Seebeck principle. They developed a kerosene-powered generator for home radios, which received much publicity, and have also successfully applied Peltier cooling.

The first commercial application of thermoelectric power generation in this country was in the early 1950's and resulted from the experiments of Dr. S. Karrer, then director of research of the Baltimore Gas and Electric Co. Dr.



BASIC CONFIGURATIONS of thermoelectric generators. First three types in working and experimental stages. Graded (Type 4) requires development of technique to produce semimetal with linearally varying amount of impurities (from .0001 to .01%, for example) throughout length of material. Relative maximum efficiency figures based on given temperature differential.

Karrer later organized a research department at Baso Inc. and this group developed a doped lead-telluride junction that was capable of generating 10 times more power than the bimetal thermocouples. This binary compound exhibited the high thermoelectric power, low electrical resistivity, and low thermal conductivity requisite for an efficient conversion.

This device was successfully incorporated in heat-powered control valves for gas heating systems. Power generated by the thermocouple in the gas pilot flame electrically held open the main gas valve and provided fail-safe operation. (If the pilot went out the main valve closed and would not answer thermostat control.) The Baso valve is used today in practically every gas furnace and hot water heater.

The Baso research team, under Dr. R. W. Fritts, later moved to Minnesota Mining and Manufacturing Co. Here they applied the same basic device to the SNAP III generator; except now they used the natural decay heat of radioisotopes as a heat source instead of a gas flame.

When Martin, the prime contractor, ordered the thermoelectric generator for SNAP III from 3M—on a purchase order; not a research and development contract—it was practically an off-the-shelf item based on the previous eight years of development. Every issued or pending patent pertaining to the design and construction of the thermopile is today in the name of 3M.

Many companies—at last count, 837—are presently involved in thermoelectric research. All work for the armed forces is coordinated by the Navy's Bureau of Ships, a strangely reticent group which apparently makes a concerted effort to keep its name out of the public press. Whether BuShips is merely modest or is intent on developing their own in-house capability is not known. They have, however, a large and responsible part in thermoelectric progress and certainly deserve considerable credit for their work. They oversee today some $3 million in research and development contracts. Budget for FY 1960 is reported to be around $6 million with increasing amounts in following years.

•**Nuclear power application**—The SNAP III unit—two of which have been built—uses 1700 curies (0.38 gram) of polonium-210 to deliver 3.3 watts of electricity. The four-pound unit has an efficiency figure of 5.5% and can deliver about 10 kilowatt-hours over a period of 280 days.

Although this efficiency figure was considered fantastically high a short time ago, efficiencies of 18% are now reported possible within the present state of the art. Unless available money



MODEL OF the SNAP III device, the heart of which is a thermoelectric generator designed and built for the Atomic Energy Commission by the Minnesota Mining & Manufacturing Company.

is wisely used in development, however, it may be several years before a working application with this efficiency is realized. According to Dr. Clarence Zener of Westinghouse, figures as high as 35% may be attained in the foreseeable future. Only two years ago no one had exceeded 1%.

•**Materials development**—Although the doped lead-telluride thermocouple was developed many years ago and has proved itself capable of efficient application, a large percentage of BuShips research and development money is going into materials research. The number of possible binary (and ternary) semi-metal combinations is practically unlimited, and a program to investigate every combination could assume fantastic proportions. Present methods require about a week per sample to merely screen each material. Thorough evaluation, which must come later, will require many weeks for each sample.

Presently, money is allocated roughly on the following basis:

Materials, 50%; devices, 40%; generators and radiators, 7%; servo controls, 2%; and services, 1%.

The attention given thermoelectric materials is, of course, demanded by their importance. Other aspects of the problems must also be considered, however, in designing a workable system.

Since the possible compounds that might be explored are almost limitless, there is a pressing need for criteria to predict the more promising materials.

In evaluating a thermoelectric material, three properties are of particular concern: Seebeck coefficient, electrical resistivity, and thermal conductivity. The relative importance of these properties varies with the application.

Of the various parameters involved in materials evaluation, thermal conductivity gets the most attention since it is least susceptible to modification. For this reason it serves as a valid basis for screening in a materials survey. A major problem here, however, i that measurements of thermal conduc tivity are extremely difficult to make

The basic properties have been ex pressed in a relationship to provide "figure of merit" (Z) for use as yardstick in preliminary evaluation:

$$Z = \frac{S^2p}{K}$$

S = Seebeck coefficient
p = specific electrical conductivity
K = specific thermal conductivity

The figure of merit thus provides basis for relative comparisons of th materials under study. To the presen a figure slightly in excess of 2.5×10 per degree Centigrade is the best th has been obtained for a single materi in commercial quantities.

Some of the best representative m terial combinations developed to dat and their figures of merit, are bismutl telluride (2.8×10^{-3}), lead tellunc (1.8×10^{-3}), and germanium-telluric (1.1×10^{-3}). Near-future goals a for figures of 4×10^{-3}. It is general felt that figures of above 4 will b necessary for commercial application

•**Government-sponsored research**— Westinghouse is the largest contract to the Navy under the current prograr It currently holds contracts totaling excess of $2,000,000, mostly for m terials development. They have h and are continuing a company-su ported research program larger th that for the Government. Much Westinghouse's materials developme started from the work of Dr. Zen (of Zener-diode frame). It was the fi to obtain efficiencies of more than 4

Government-supported work f the Air Force and Army on generat and radiator systems is being carri on by General Electric's Engineeri Lab. A company-underwritten progra is in progress at the Knolls Aton Power Lab. Total GE contracts amou to more than $200,000.

Servomechanisms Inc. is doing cl sified materials research work whi grew out of previous company proje dealing with high-temperature el tronic components. At present, S Navy contracts total about $100,0

Naval Research Laboratory p vides service for the entire defense p gram, including a measurements fa ity just nearing completion. NRL a is involved in what is described as "minor" materials effort.

A study of thermoelectricity been in progress at Battelle Memo Institute for several years and has cluded a number of semi-conduc materials. Institute contracts are excess of $100,000.

At least 12 other contractors implementing the Department of fense program. Several small contra

ve recently been let. These are rela-
ely small, mostly around $100,000,
d concern materials development
ly.

The entire SNAP program is under
e Atomic Energy Commission and
ly a part relates to the thermoelectric
velopment. The only other project
blicized to date is the development
a "plasma thermocouple" which uses
sium gas as one of the metallic
ermo elements. This unit produced
3 volts for almost 12 hours before it
as shut down. Heat was provided by
riched radium.

The AEC provides substantial sup-
rt on fundamental work on material
d devices. They recently began oper-
ons at a new $2.2 million fission
oducts plant at Oak Ridge to sepa-
te isotopes from reactor fuel wastes.
ne of the important uses of these
covered isotopes will be as heat
urces for thermoelectric generators.
ne of the isotopes, cerium-144, is of
rticular interest for the SNAP proj-
t. Even strontium-90 is being used.

•**Industry-sponsored programs**—
mpany-supported work in thermo-
ctricity is about equal to the present
vernment program. It includes sev-
al major efforts as well as numerous
all projects.

One of the major research efforts in
aterials is carried on by Merck and
., which has a pilot plant operation
th a capability of about 50 kg of
muth telluride per month. Merck
s under development processes for
ge-scale production of lead telluride,
d selenide, alloys of these two com-
unds and ternary alloys of bismuth
luride. Fundamental research is be-
g done on new compositions to
hieve substantial improvement in the
ure of merit. They reportedly are
rking on an unspecified material
ich it is hoped may reach a figure of
erit of 4 or better.

As mentioned earlier, Minnesota
ining and Mfg. Co. has been active
thermoelectric material development
ce 1950. 3M's work covers a wide
nge of research from theoretical treat-
ent of thermoelectric phenomena to
e design of working, commercially
plicable generators.

Both RCA and Whirlpool are work-
g on Peltier refrigeration materials.
CA was the first to produce a full-size
ermoelectric refrigerator.

Other companies active in the field
clude Nortronics, Texas Instruments,
urtiss-Wright, Franklin Institute, Gen-
al Atomic and National Carbon.

•**Future research**—The future pro-
am includes five main areas of re-
arch. The first of these is materials
d includes high-temperature materi-
, liquids, and films.

The second deals with the behavior of materials under severe environments —radiation, thermal and mechanical shock, and chemical atmospheres.

The third area has to do with design and fabrication principles of hardware: contact problems, cascading, structures optimimization, heat transfer, encapsulation and loading.

The fourth and fifth areas concern performance characteristics and physical-chemical phenomena.

Westinghouse has just completed a 100-watt generator for ARDC, called the TAP-100 (Terrestrial Auxiliary Power). This unit uses gas for fuel and is claimed to have an efficiency of about 8%. The thermoelectric material is a combination of semiconductors in cascade, also developed by Westinghouse. An advanced version being built will use a nuclear isotope source for heat.

Two contracts have recently been let for oil-fired 5 kw generators. The guaranteed efficiencies of these units, however, should be no more than 6.4%, a figure well below the present state of the art which would allow efficiencies up to about 18%. Requirements for 500kw generators are now in preparation.

The Atomic Energy Commission is continuing with work on both isotope and reactor-heated generators.

Considering these facts, it seems logical to say that the potentialities of thermoelectric power generation (and refrigeration) are just beginning to be explored. The first giant steps have already been taken with practical versions of small generators and cooling units. Larger units can be foreseen in the near future.

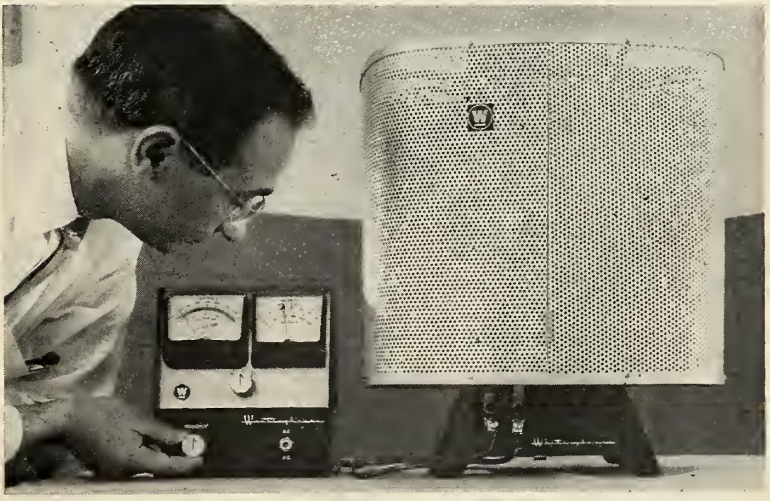
With purposeful direction and adequate financing, the next year or two could certainly yield significant advancements to make possible early practical nuclear-powered thermoelectric generators for space vehicles and more mundane applications. Conceivably, a generator sufficient to power the plasma propulsion engine for interplanetary travel (M/R June 8) could be built within the next few years.

Thermoelectrics face severe competition, however, from several other exotic power sources which have come to the fore very recently. Solar cells are being continually improved and show promise for many space applications. Solar energy may, of course, be directly converted to electrical power through solar cells or used to furnish heat to a thermoelectric generator.

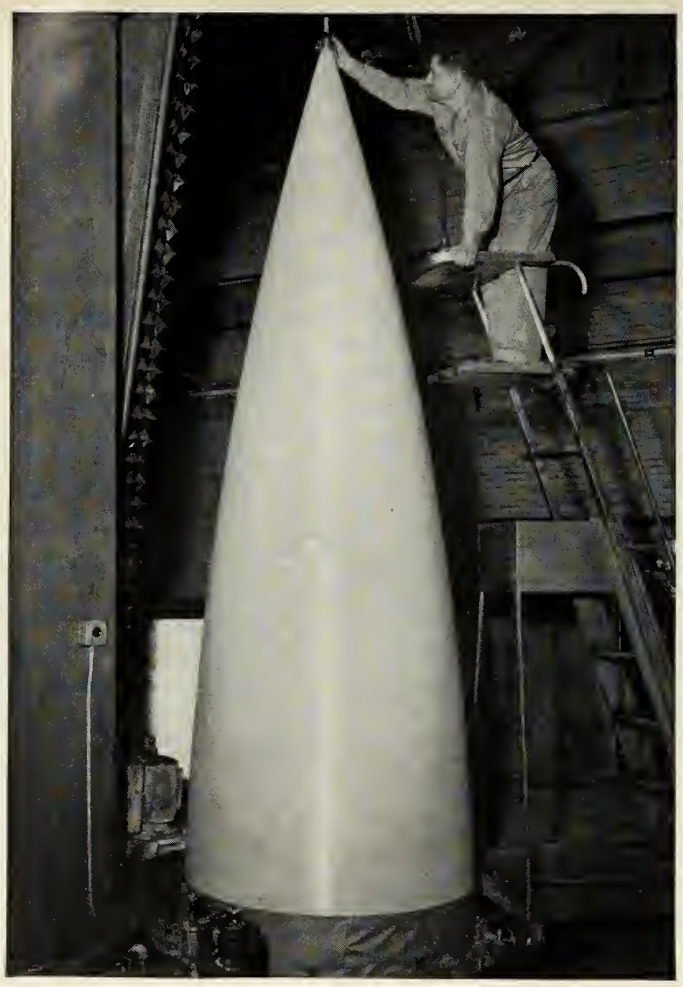
Electrostatic generation, although 300 years old, has been proposed as an efficient source for high-power applications in the vacuum and weightlessness of outer space.

Fuel cells which produce electricity directly from hydrogen and oxygen, such as the one recently announced by General Electric (M/R, June 8) are predicted to have a very bright future. Yale and Towne has announced plans for a cell within one or two years capable of powering a lift truck. A proposed sodium-mercury fuel cell would reportedly have fantastic potential.

It is impossible to say which of these possibilities, or even as-yet-unknown ones, will emerge as the most universal of tomorrow's power sources. It is fairly certain, though, that we may expect revolutionary progress in the near future. With the impetus of space program requirements and the broad interest of industry in the problem, the next few years may yield tremendous advancement.



TAP-100 built by Westinghouse is ten times larger than any similar thermoelectric device to date, and produces 100 watts.



NEW—the world's biggest filament-wound fiberglass radome!

Here it is — twelve feet high, four feet in diameter — the largest filament-wound fiberglass radome ever made. This huge form was produced by a special winding process—product of Kidde engineering knowledge and research — which results in an extremely high strength-to-weight ratio, plus a maximum in physical and electrical uniformity. Furthermore, this Kidde continuous-winding process, plastic reinforced by fiberglass, permits the construction of fiberglass shapes and forms which were either difficult or impossible to fabricate by previous methods.

Walter Kidde & Company has available complete facilities and personnel for the development, testing and production of fiberglass forms. If you have a problem in this area — write Kidde today. We've solved some pretty tough ones in the last thirty years!

Walter Kidde & Company, Inc., Aviation Division
620 Main Street, Belleville 9, N. J.

Kidde

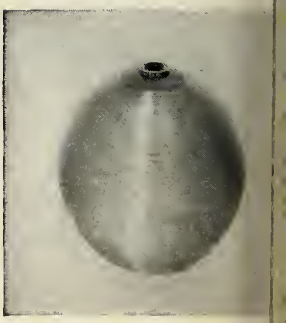
District Sales Engineering Offices· Dallas, Tex. Dayton, Ohio—St. Louis, Mo.—San Diego, Calif. Seattle, Wash.—Van Nuys, Calif.—Washington, D. C.

Walter Kidde-Pacific, Van Nuys, California
Walter Kidde & Company of Canada Ltd. Montreal—Toronto—Vancouver

FIBERGLASS FORMS ARE A KIDDE SPECIALTY!



Thanks to Kidde's continuou winding process, a new field fiberglass forms is now open aviation engineers. Structur tubing, pressure vessels can no be made stronger than steel wi half its weight!



For the engineer interested the field of pneumatics, filamer wound fiberglass spheres off the solution to many problem Available in capacities of fro 50 to 2500 cubic inches the spheres can withstand pre sures up to 5000 psi.



Missile rocket motor cases, t pedo bodies and missile radom are but a few of the forms wh Kidde can fabricate from hig strength, low-weight fibergla capable of withstanding te peratures as high as 1000°F. f short periods of time.

Successful AME Is Unveiled

Page Communications' gear tested in North Atlantic is expected to find more use on ionoscatter circuits and offers potential for increased channel capacity

by Charles D. LaFond

WASHINGTON—Three years in development, a new and highly successful anti-multipath equipment (AME) providing a significant increase in telecommunications reliability has been revealed here by Page Communications Engineers, Inc., a subsidiary of the Northrop Corporation.

The equipment essentially employs frequency translation technique at both the transmitting and receiving ends. Following long tests on northern operational ionospheric-scatter communication circuits of the U.S. Air Force, circuit outage resulting from ground-scatter multipath has been reduced from a recorded high of 27% to a maximum of 2½% of total operating time.

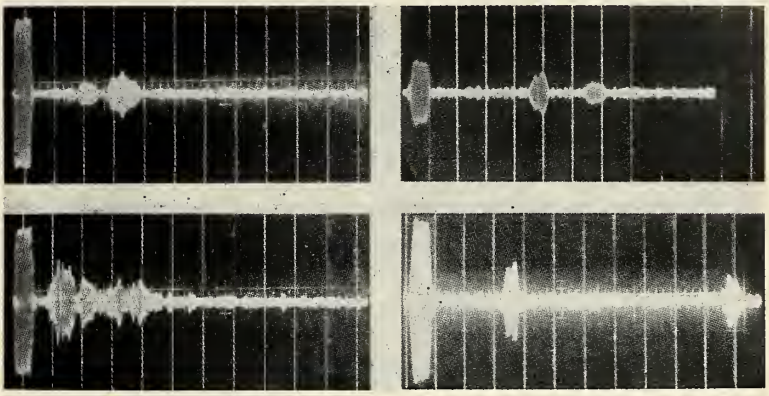
The North Atlantic Ionospheric-Scatter System in which AME has been employed is the first operational system built for the Air Force to use this propagational mode. A part of the global defense communication system, it stretches from Wachusett, Mass., to Goose Bay, Labrador; Sondrestrom and Thule, Greenland; Iceland, and England.

With a few changes in stations, the system has been in operation (including its initial test period) since 1954. Reliability has been very high and, based on this successful operation, many thousands of miles of additional dense scatter circuits have been or will be constructed. It is expected, that AME will be employed in the near future on other similar ionoscatter circuits.

• **History**—When the early VHF ionoscatter circuits were placed in operation, there existed a period of declining solar activity. Long-delay multipath as a result of ground scatter, propagated by the F-layer during daylight hours, was low. That multipath would increase with high solar activity was recognized, but its effect on reliability was underestimated. By November, 1955, solar activity had increased, the resulting sun-spot numbers had almost trebled, and multipath seriously affected operational performance.

It was at this time that the occurrence of long-delay multipath was observed on the North Atlantic ionoscatter circuits. Delays of the order of 50 milliseconds (msec) were encountered during daylight hours, severely impairing radio teleprinter operations and, at times, making operation impossible. To reduce this performance degradation, Page conceived a practical program for an experimental anti-multipath equipment and began its long development.

By the spring of 1957, prototype models built by Rixon Electronics, Inc., of Silver Spring, Md., were ready and installed in a few of the northern scatter stations. Tests were continued through the fall of 1957 and subsequently modified equipment (by then installed in five stations) provided substantial reduction in circuit outages due to ground-scatter multipath.



Frequently Observed — Rarely Observed

PHOTOGRAPHIC examples of ground-scatter multipath propagated by the F-Layer back-scatter multipath. To determine delays, a 6.6-millisecond pulse was transmitted with 10-millisecond timing markers.

A considerable amount of data was gathered during these preliminary tests. Delay data were obtained on these circuits while operating on a frequency of the order of 35 mc/s, with a transmitted pulse of approximately 6.7 msec. Ten msec markers were employed to determine the delays.

The ground-scatter multipath propagated by the F-layer was characterized by relatively long delays. Multiple echoes occurred in many instances—the majority arriving with delays in the range of from 10 to 50 msec. Occasional delays as long as 100 msec were observed. With the insertion of AME in the system, multipath interference was all but eliminated.

It was determined that an anti-multipath equipment providing protection for delays ranging from approximately 10 to 50 msec would be expected to give satisfactory performance.

• **Design criteria**—The character of multipath is such that to use frequency translation, the rate must be chosen so as to effect the first translation before

the arrival of shorter delay multipath. Also, the first translation frequency cannot be reused until the more serious multipath echoes have subsided.

This implies that for longer bit widths such as 5 to 10 msec, the translation had to occur once for every bit. For shorter bits the translation could be made to occur for any whole number of bits, as long as the sum of the widths does not exceed approximately 10 to 50 msec.

Multipath discrimination is a function of the magnitude of the frequency shift and skirt selectivity of the associated FSK (frequency shift) receiver. The receiver type in use on the systems under consideration, is a dual filter type and is known as the FSK-2. The skirt selectivity of the receiver is such that when using a frequency shift of 800 cps the discrimination against an echo arriving with a delay of 6.66 to 46.6 msec is from 12 to 60 db.

• **Description of AME**—AME as installed on the North Atlantic scatter system avoids receiving delayed multipath signals by means of a sequence of frequency translations. Immediately after the reception of each information bit, the transmitter and receiver are shifted synchronously from one frequency to the next. With the receiver lagging the transmitter by a time interval equal to the sum of the propagational and certain inherent equipment delays, the equipment operates in such a manner that the receiver and transmitter are not returned to any previously used frequency until approximately 46 msec have elapsed.

By this means, multipath signals arriving with delays longer than the time required for one frequency translation cycle, or arriving at a time less than the total time period required for one complete sequence of frequencies, will be off-frequency with respect to the receiver and will be attenuated in accordance with the receiver selectivity characteristics.

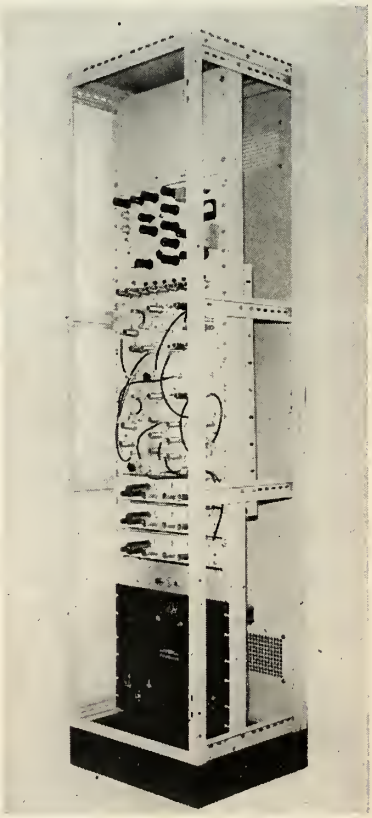
The equipment satisfactorily attenuates multipath components by shifting in 800-cps increments and employing seven different frequencies for mark and space. Beginning at the normal operating frequency, a shift of 800-cps is made, followed by successive shifts to 1600 and 2400 cps above the operating frequency. At this point a negative translation is made to 2400 cps below normal operating frequency, followed by successive shifts upward to 1600 and 800 cps below the normal operating frequency.

When used in a typical ionoscatter system, the transmitting AME is inserted between the output of the frequency multiplier and the input of the exciter combiner.

The signal input to the transmitting AME is the normal FSK-2 signal, while the output is translated over seven frequencies for mark and seven frequencies for space. Thus the output signal may appear on any of 14 frequencies, but only one frequency is transmitted at any one time.

The receiving AME is inserted between the output of the FSK-2 r-f amplifier and the input to the converter panel. The receiving translation is accomplished in a manner such that the signal applied to the converter now approximates the original FSK signal with the multipath echoes appearing off-frequency. The F-layer propagated multipath is attenuated by the selectivity of the mark-space filters of the FSK-2 receiver.

The rate at which the frequency translation occurs is determined by t timing of the multiplex equipme (When operating with the AN/FGC multiplex, the frequency translati occurs once for each transmitted and is coincident with the mark-spa transition.) Since the FSK-2 receiv normally is operated in dual space versity, it is necessary to provide AM with an additional set of mixers a an i-f amplifier.



PROTOTYPE model of Page's rack-mounted experimental Anti-Multipath Equipment Built by Rixon Electronics, Inc.

• **Cryptographic compatibility**—T experimental AME will operate w encrypting systems compatible with t multiplex equipment now in use on t scatter circuits. The equipment install in the North Atlantic area has be handling routine encrypted traffic w satisfactory performance. The equ ment also will handle synchronc cryptographic systems having a ma space output and a discrete modu tion rate not exceeding 600 bits/s and with a minimum mark-space tra ition rate of approximately 30 bits/s

• **Transmission security**—Page a has indicated that AME has a deg of inherent transmission security. Sir additional operations are performed modulation at the transmitting e these operations must be demodulat at the receiving end. For secure tra mission, the number of frequency st can be increased in the translation p gram in a random manner but w a known key.

Attempts to jam such a syst would require an increased bandwi with the resulting increase in power the jamming transmitter. An impro ment in transmission security wo thus be obtained, but additional f quency spectra would be required.

• **Performance**—During Janua 1958, traffic averages on the north circuits due to ground-scatter multip ranged from about 15% to as high 27% of the total operating time w almost all averages occurring duri the daylight hours. During Febru and March 1958 operation, followi the installation of the experimen AME, circuit averages ranged fr 0.1% to a max of 2.5% of the to time. This improved performance a includes time for multipath recogniti and time to place the equipment operation. An appreciable portion this outage time was due to interf ence. (Improved FSK-2 channel filt and additional personnel are expec to produce a further reduction in o age time.) Loss in signal detectabi when using AME was measured found to be approximately 1db.

• **Meteoric and auroral multipath** The instrumentation required for measurement of ground-scatter mu path delays also permitted observat of meteoric multipath. A 400-μ pulse was transmitted and a total

536 meteoric-multipath observations as made during April, 1958. The majority of meteoric multipath delays anged from 100 to 300 μsec with the elays occurring up to approximately 00 μsec.

During the above tests, a brief eriod of auroral disturbance was encountered, and limited data were obained. This type of multipath is characterized by an exponential decay over relatively long period. From the distribution of the observed auroral multipath, the predominent delays were less an approximately 1 msec, but continuous echoes ranging from possibly 0 msec to over 4 msec in length were served.

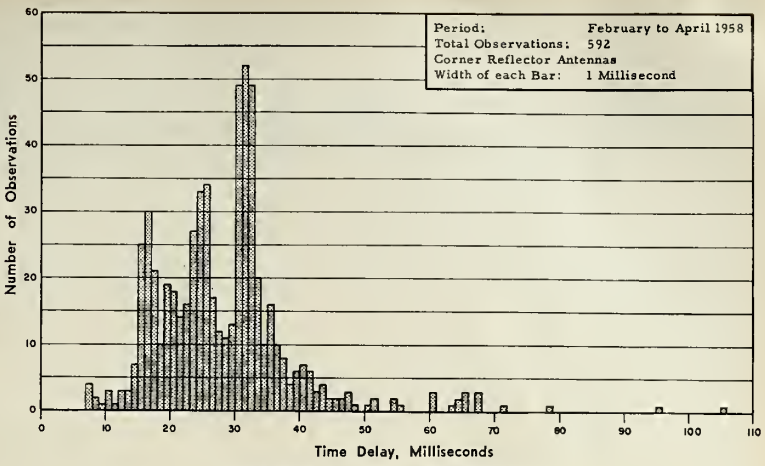
• **High-speed operation**—The constantly increasing volume of commercial and military traffic is requiring a ntinual increase in the number of affic channels. If additional teleprinter annels are to be provided by time-vision multiplex equipment, the bit gth becomes progressively smaller.

With newer 16-channel multiplex erating at 100 words per minute, the length is 1 msec. Such high-speed nsmission would be expected to result in a moderately high error liability ce to meteoric and auroral multipath. om the limited data obtained, it appars that satisfactory high-speed oeion of AME may be possible by pviding a minimum delay protection enal to the delay of a single bit and amaximum delay protection approxiting 5 msec.

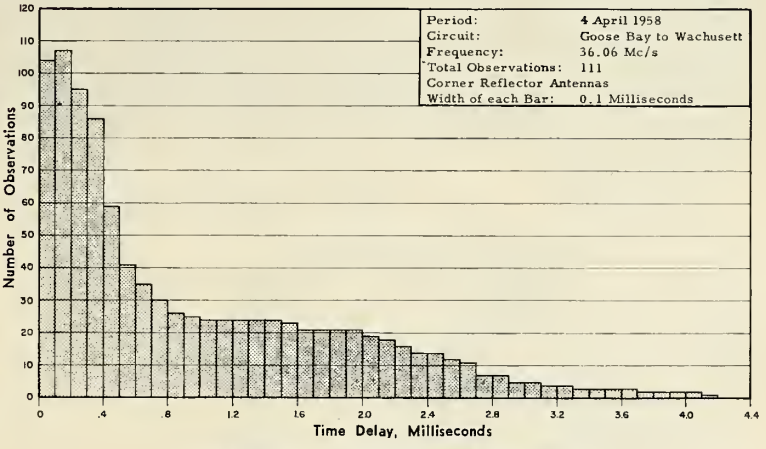
Synchronous transmission at high speeds with low error rates on ionoseric scatter has been limited in the pt by problems of decision ambiguits, filtering, diversity combination, mtipath and timing errors. Experiments recently conducted using improved diversity and decision techniqs together with the AME appeared toovide at least partial solutions for alexcept the timing problem.

The development of AME together wi advances in diversity and decision teniques offers the potential for incsing channel capacity of present sc er circuits.

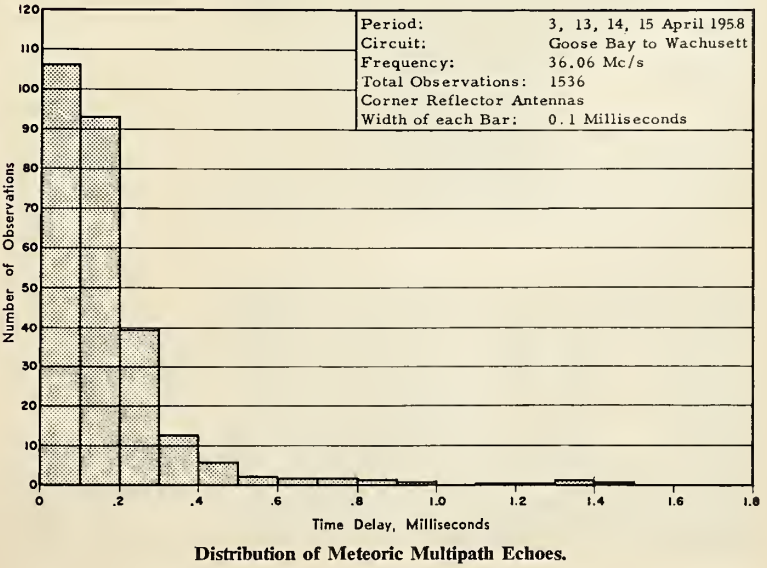
• **High frequency tests**—In June, 19, under contract with National Bau of Standards, Boulder, Colo., a tes program was initiated to deterine the effects of an experimental AE for reducing teleprinter errors fro multipath propagation on an exisi high-frequency radio circuit. AE was shown to provide an appreiae reduction in multipath errors. Tes results were similar to those obaind on ionoscatter circuits. A 2-10 ol reduction in errors were consisen observed, while the average reucon in error rate was approximately 1



Distribution of F_2 Multipath Delays.



Distribution of Auroral Multipath Echoes.



Distribution of Meteoric Multipath Echoes.

Temco | AIRCRAFT DALLAS



NAVAL AVIATION MAKES HISTORY



NAVCAD Earland R. Clark of Stroudsburg, Pa., receiving congratulations from Rear Admiral Joseph M. Carson, Chief of Naval Air Basic Training.

with ALL-JET TRAINING

On March 13 at the Naval Air Basic Training Center, Saufley Field, Pensacola, Florida, the first student pilot in Naval Aviation history soloed a primary jet aircraft—without previous propeller-driven aircraft experience. The flight was made in a TT-1 "Pinto" — designed specifically by Temco for all-jet training.

The first primary jet trainer ever purchased by any of the U. S. military services, the Pinto is designed for today's jet age. It is built closely along the lines of high-performance jet fighter aircraft and gives the student pilot the "feel" of jet training from the very beginning.

With its high safety standards, fine handling characteristics, optimum maintenance provisions and overall reliability, the Pinto is an ideal primary jet trainer. From initial cost to operation and maintenance, it is designed to provide better pilots at less cost, in less time. All in all, it gives the Navy a decided edge in the ever-advancing pace of military jet aviation.

TEMCO
ELECTRONICS • AIRCRAFT • MISSILES

SYSTEMS MANAGEMENT	DEVELOPMENT
DIRECTED RESEARCH	PRODUCTION

New 4000° Range for Pyrometers

WASHINGTON—Many of the questions arising in high-temperature standardization, calibration, use, and manufacture of optical pyrometers were discussed at the recent National Bureau of Standards symposium on high-temperature pyrometry. Principal subject at the meeting was the possible use of the temperature scale beyond 4000°K.

In the last few years, the interest in high-temperature measurements has created a demand for optical pyrometers capable of greater precision and accuracy. Recent studies, principally at the National Bureau of Standards and Argonne National Laboratory, the symposium sponsor, have shed new light on some of these problems.

Trends in the NBS work on optical pyrometry were outlined at the beginning of the conference by Dr. C. M. Herzfeld, chief of the bureau's Heat Division. He pointed out the necessity for improving methods of temperature measurement in the range 800°C to 3000°C under ideal conditions. Here, he said, accuracy, precision, and convenience of operation need further improvement.

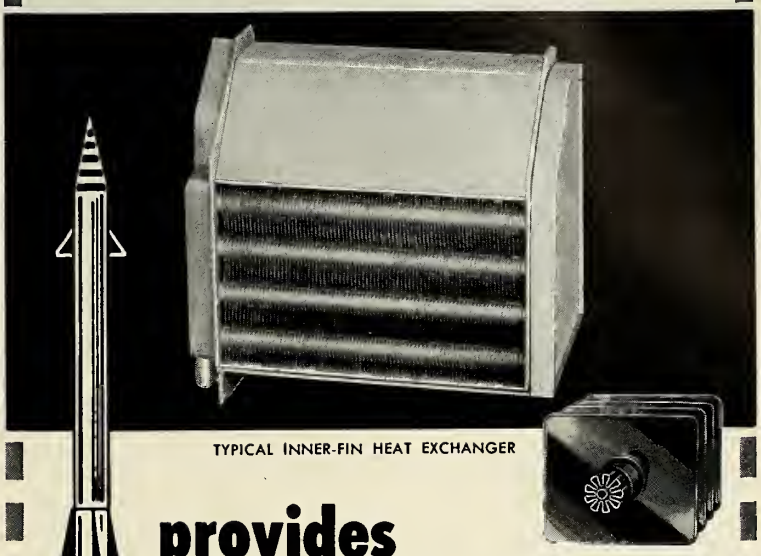
An extension of methods for measuring temperatures under ideal or approximately ideal conditions in the range 4000°C to 10,000°C is also required. And improvements in temperature measurement under non-ideal conditions, such as in flames and complicated systems, are needed along with more basic research for new and better ways of measuring temperature.

• **Setting scale**—The procedure used at Argonne to establish the temperature scale in the range of 1000°C to 2000°C was discussed by R. J. Thorn and G. H. Winslow. The starting point was the freezing point of copper, which has been determined as 1083°C on the 1948 International Temperature Scale. Above the freezing point of copper a black body constructed of tungsten, contained in a vacuum and heated inductively, was employed as a light source.

The National Bureau of Standards and Argonne National Laboratory optical pyrometer temperature scales agree within 1°C at the gold point, but differ by 4°C above 1600°C. It was suggested that the most likely source of the difference lies in the effective wave lengths.

• **Limits**—Basic limitations on accuracy of optical pyrometry were discussed by D. R. Lovejoy of the National Research Council of Canada. An

INNER-FIN HEAT EXCHANGER



TYPICAL INNER-FIN HEAT EXCHANGER

provides cooling for missiles

Dunham-Bush Inner-Fin heat exchangers in Electronic Tube Cooling Units have proven the answer to the ever-present space problem in aero-electronic heat transfer.

Inner-fin coils have effected a 60% savings in coil sizes in units. Maintaining the same air and liquid pressure drops through the coil, an Inner-fin coil equivalent in capacity to a standard finned tube coil occupied 60% less space.

Whether your problem is "unusual" or not . . . whether it's in air conditioning, refrigeration or heating . . . Dunham-Bush has the products and engineers to meet your needs.

WRITE FOR FREE INNER-FIN BROCHURE

DUNHAM-BUSH

AIR CONDITIONING • REFRIGERATION
HEATING • HEAT TRANSFER

Dunham-Bush, Inc.

WEST HARTFORD 10, • CONNECTICUT, • U. S. A.

SALES OFFICES LOCATED IN PRINCIPAL CITIES



A HIGH POLISH FOR HIGH FLYING

KENNAMETAL* meets many critical requirements

This unretouched photograph shows the high reflective finish of a Librascope† integrator disc, 1⅜" diameter, made from Kennametal. Little discs like this one are of big importance in the operation of guidance systems, automatic pilots, and gyrostabilizers. In addition to a high polish, the discs must have high YME, hardness, and compressive strength . . . all qualities of Kennametal. Need for these properties, or a combination of other exceptional characteristics, is often met by a specific grade in the Kennametal family of tungsten carbide alloys.

In highly specialized types of photographic equipment, for example, Kennametal optical flats substitute for fragile glass mirrors to overcome distortion due to centrifugal or other forces. Many other vital parts subject to abrasion or corrosion are now being made of Kennametal . . . such parts as high pressure compressor cylinder liners, seal rings for rotary pumps, valve parts, plungers, and bushings.

JUST HOW IS KENNAMETAL SUPERIOR?

- Kennametal has an extremely high YME . . . up to 94 million psi compared to steel's 30 million . . . ranges up to 94.7 Rockwell A.
- Some grades of Kennametal have a density as high as 15.5 gms/cc . . . twice that of heat treated steel . . . while other grades will stand up for days in boiling 5% HNO_3 and 5% H_2SO_4.
- Kentanium,* a series of hard titanium carbide alloys, retains sufficient strength for many applications at temperatures of 2200°F. and above.

Chances are some vital components for *your* equipment could be made of Kennametal to provide greater reliability, over a wide range of operating conditions, than that provided by conventional materials. A Kennametal Carbide Engineer will gladly discuss your problem with you. Or write us for one or both of these booklets: B-111A—"Characteristics of Kennametal," and B-444A—"Kentanium." KENNAMETAL INC., Dept. MR, Latrobe, Pennsylvania. 97216

*Trademark †Trademark of Librascope, Inc.

INDUSTRY AND **KENNAMETAL**

. . . Partners in Progress

estimate of the errors arising in p mary standard pyrometer calibratio and in secondary standard strip lan calibrations agreed with the results a recent intercomparison of seconda strip lamps. An evaluation of a carb arc, accepted as a useful seconda standard at 3514°C, showed that this region the effect of the unce tainty in eeffctive wave length excee all other sources of error combined.

Even though very precise wo was involved in determining the pla num point at 1769°C, metal freezi points seem to offer little advanta over the strip lamp as secondary stan ards. It was determined that go commercial pyrometers can be ca brated with a precision comparable that of primary standard pyrometers the lamp current is calibrated direc rather than through the internal p tentiometer and scale.

R. D. Lee of the Bureau discuss the procedures used in calibrating op cal pyrometers and tungsten ribb filament lamps submitted to the B reau. Temperature comparisons a made with the NBS standard pyron ter from 800°C to 3800°C. In ca brating optical pyrometers, a tungst ribbon filament lamp is used as a te perature source up to a brightness te perature of about 2400°C, and a z conium arc and carbon arc to te peratures of 2800°C and 3800°C, spectively. Since the brightness te perature of a non-black body is det mined in part by the red filter glass a pyrometer, corrections are made test pyrometers with different tra mission characteristics.

The estimated uncertainty of calibration below 2800°C is based experience with a number of inst ments rather than on the specific d of a given instrument. The stand deviation, with respect to the Inter tional Temperature Scale, of pyrome and strip lamp calibrations is ab ±1° from 800°C to 1500°C, ±2° fr 1500°C to 2000°C and increases about ±6° at 2800°C.

• **Photoelectric**—A summary NBS work on photoelectric pyro ters was given by C. P. Johnson D. Erminy. The first model of the N photoelectric pyrometer has a se tivity of 0.1°C at the gold point a spectral band width of only 100 These features together with its jective character make it an attrac instrument. However, the measurem of brightness temperatures to a p cision of 0.1°C introduces many d cult problems involving lens abe tion, scattered light diffraction, and stability of light sources. These n be investigated in great detail before photoelectric pyrometer can be c sidered a reliable accurate instrum

McElroy Hit for Failure To Halt Missile Rivalry

A bitingly critical statement by the U.S. Chamber of Commerce accuses Defense Secretary McElroy of ignoring his power to stop "unhealthy and intolerable" service rivalry over missiles. The Chamber told the Senate Defense Appropriations Subcommittee Congress should force full and prompt use of McElroy's power "to curtail multiple development . . . and to eliminate unnecessary overlapping and duplication in a dozen or more support-type activities."

Without referring to specific cases, the Chamber urged the subcommittee to go along with House cuts in President Eisenhower's budget. Added the business group: "Congress has barely scratched the surface insofar as savings opportunities are concerned."

President Eisenhower has signed a bill increasing the authorization for an AEC "weapons diagnostic" plant at Los Alamos from $2.2 million to $3.5 million.

Nike-Hercules missiles have been integrated into the air defense system of U.S. military installations in West Germany.

Snark alert test at Northrop Field, Calif., was well past the half-way mark in a 400-hour continuous 24-hour standby operation last week. Total run will require 17 days.

Scientists Protest Secrecy; Harming Basic Research

Consensus of opinion of 17 Nobel prize-winning scientists is that secrecy in basic research is senseless and harmful, and in many cases causes unnecessary duplication of effort. The views were expressed in letters sent to the Senate Constitutional Rights Subcommittee in repsonse to queries from Chairman Thomas C. Hennings, Jr. (D-Mo.). Other points raised by the scientists—physicists, chemists and medical doctors—included:

—the government's "need to know" contract restrictions hinders scientific progress because it is often impossible to prove NTK until it is known "what the other man is doing";

—blanket security classifications often cover areas of a project which in no way touch on the sensitive;

—because many good scientists steer clear of classified projects under the present set-up, secrecy could become a cloak for mediocrity—morale is lowered when a scientist is denied the recognition that comes with publication of a discovery.

Hourglass Rocket Chamber

For NASA Solar Aircraft has developed brazed stainless steel rocket thrust chamber, shaped like hourglass. Chamber is cooled regeneratively and is being used to test new propellant combinations at Lewis Research Center, Cleveland. Chamber is formed of 120 U-shaped AM-350 channels .008 inches thick, assembled around a stainless steel mandrel with about 100,000 spot welds and wrapped tightly with .008 inch stainless steel ribbon, which is brazed with copper.

A prototype device to measure amount and temperature of gas in the upper atmosphere has been developed by **Lockheed Aircraft.** The unit, mounted in a satellite, contains a small hole which allows a beam of gas molecules to enter. This beam is chopped by whirling blades and hits a microphone where it produces a tone directly proportional to the density of the gas. In addition, the beam fans out, or spreads, a measurable amount proportional to the temperature of the entering gas. The same technique could, according to Lockheed, be used to provide an input to stabilize the satellite.

Renegotiate Act Extension Approved by Senate Unit

The Senate Finance Committee approved a 30-month extension of the current Renegotiation Act.

The committee's move had the effect of rejecting a House-passed four-year extension of the law. Critics attacked the House bill as a boon to big missile and aircraft manufacturers.

The Democratic Advisory Committee called for spending an extra $30 billion over the next four years to expand U.S. defenses.

The committee charged U.S. defenses are in disastrous shape compared to Russian military might.

It said one of the first steps needed to improve U.S. defenses is "a crash effort to bridge the missile gap." It called for doubling the production of **Martin** *Titans* and **Convair** *Atlases*.

NASA established a committee to study the possibilities of establishing an equatorial launching site for satellites. Dr. John P. Hagen, NASA assistant director, is chairman. (M/R May 18)

French IRBM?

France is trying to develop its own IRBM. A special society called SEREB has been established to do the job in cooperation with French industry.

The Air Research & Development Command announced a twin-rail rocket sled reached a speed of 2,075 miles an hour last month in a test at Edwards AFB, Calif.

ARDC said it believed the speed was a record.

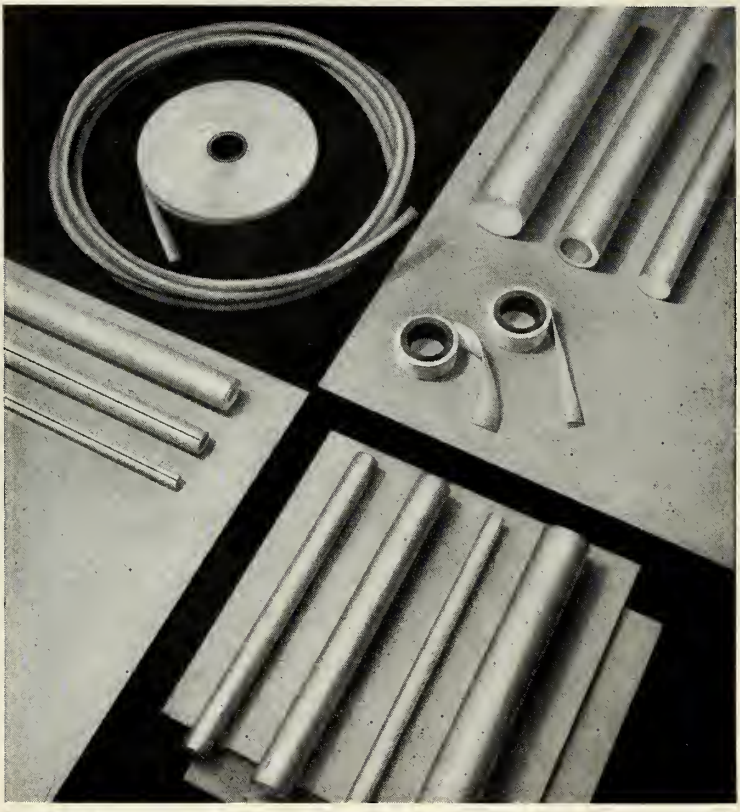
NASA awarded a contract to **Grumman Aircraft Engineering Corp.** to conduct studies for search and recovery operations for Project *Mercury*.

Consideration will be given to recovery by ships, helicopters, airplanes and airships.

March of Progress

Electronic Communications, Inc. has acquired Advanced Technology Corp. of Santa Barbara in exchange for 1,000 shares of ECI common stock. ATC which was formed by a group of research scientists formerly with Aerophysics Development Corp. and Avco will be operated as a wholly owned subsidiary of ECI . . . J. H. Pomeroy & Co., Inc., engineering and construction firm, has been cited for outstanding support of the Navy's ballistic missile program . . . Aerospace Industries Association (formerly Aircraft Industries Association) has raised the status of its Guided Missile Committee to Guided Missile Council—expanding its functions to include "all types of management interests relating to guided missile manufacture." . . . Aerojet-General Corp. has set up a Space Technology Division which will concentrate on research and development in electrical and other advanced propulsion and space systems. Facilities purchased by the company last month at Downey and Riverside, Calif., will be used to continue product development and to expand its powerplant and systems programs . . . Recent groundbreakings for new computer production facilities were begun by Philco in Montgomery County, Pa., and by Librascope, Inc., at Sonora, Calif. Philco's multi-million dollar plant, just west of Willow Grove, is scheduled for occupancy in November and will house production facilities for the Transac S-2000 electronic data processing system. Librascope, subsidiary of General Precision Equipment Corp. supplies weapon control systems and computers for anti-submarine warfare.

LOOK TO R/M TO MEET ALL YOUR TEFLON* NEEDS



R/M—headquarters for "Teflon" products. R/M can meet all your needs for sheets, rods, tubes, tape, thin-wall tubing (available with permanent color striping for identification purposes) and bondable "Teflon." R/M can also supply molded, machined and extruded "Teflon" made to your exact specifications.

"Teflon's" many remarkable properties have established it as an important material for use in aircraft, missiles and spacecraft. Yet when you select "Teflon" for a particular job, you solve only part of your problem. Equally important is the selection of a source of supply you can depend on for both competent engineering assistance and the production capability needed to meet your exact specifications and quantity requirements. This *complete* "Teflon" service is yours from R/M.

A pioneer in "Teflon" application and fabrication research, R/M offers design guidance that can help assure maximum part performance, and its ample production facilities can supply "Teflon" in the form best suited to your needs. Learn more about R/M's complete "Teflon" service—and how it can benefit you—by contacting your nearest R/M district office. Or write Plastic Products Division, Manheim, Pa.

*A Du Pont trademark

R/M

RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION FACTORIES: MANHEIM, PA.; PARAMOUNT, CALIF.

Contact your nearest R/M district office listed below for more information or write to Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

BIRMINGHAM 1 • CHICAGO 31 • CLEVELAND 16 • DALLAS 26 • DENVER 16 • DETROIT 2 • HOUSTON 1
LOS ANGELES 58 • MINNEAPOLIS 16 • NEW ORLEANS 17 • PASSAIC • PHILADELPHIA 3
PITTSBURGH 22 • SAN FRANCISCO 5 • SEATTLE 4 • PETERBOROUGH, ONTARIO, CANADA

RAYBESTOS-MANHATTAN, INC., Engineered Plastics • Asbestos Textiles • Mechanical Packings • Industrial Rubber
Sintered Metal Products • Rubber Covered Equipment • Abrasive and Diamond Wheels • Brake Linings
Brake Blocks • Clutch Facings • Laundry Pads and Covers • Industrial Adhesives • Bowling Balls

—moscow briefs—

by Dr. Albert Parry

The building of their first electron computers is reported by the scientis and engineers of Poland and Rumani Aid given by Soviet experts is praise The first Polish computer was made f that country's Hydro-Meteorological I stitute. The first Rumanian machin built under the leadership of the sta of the Timisoara (Temesvar) Polytec nic Institute, can make more tha 15,000 operations per second in add tion and subtraction.

Under the title "Materials of Sovi Rockets," a brief article in Prague monthly magazine *The SNTL Tec nical Digest* states that "the who world" is asking these questions: Wh are the most stressed parts of Sovi rockets made from? What materials a used in the fuel pump nozzles and con bustion chambers of the huge engin stressed by temperatures of many tho sand degrees and enormous force What materials are used for the k details of the 300,000 component par combined into one single interplaneta rocket? The Czechoslovak magazi then proceeds to give this answer:

"No material produced by metallu gical processes hitherto known prov to be satisfactory. In the USSR the pr duction of these materials has been d veloped on the basis of ultrasonics a plied during casting and solidificatio The crystallization of a freezing met begins with the formation of fir-tr shaped skeletons, the so-called dendrite

"The distribution of the solidifi metal around the dendrite axes dete mines the homogeneity of the structu and thus the quality of the final pro uct. In a melt exposed to vertical ultr sonic vibration and to a horizontal v bration with frequencies 10 tim higher, up to 200,000 c/s, the dendri axes are continuously breaking off, t solidified material acquires a super-fi ordered structure, and a material remarkable properties is obtained. T solution of the riddle is: while vibr tional casting is solved in the USSR the stage of shop operation, it is n yet solved in the USA."

• **Several movies** devoted to Sov advances in rocketry have recently be produced and issued by the Mosc Studio of Scientific Popular Film Among them is "Four-Legged Astr nauts" on the role of dogs in Russi rocket flights. A 20-minute docume tary, it includes material not alone the training of such canines as Lai of *Sputnik II* but also on Soviet expe ments with birds and rabbits which p ceded the work with dogs. This film

ased on a scenario by P. Isakov and rected by N. Tikohonov, with assistnce from A. Genin and A. Seriapin, o of Russia's space-medicine experts. nother latest Soviet film is "Automats Cosmos," dealing with automatic uipment installed on Russian rockets nt aloft for purposes of research.

This film is notable for a detailed monstration of the equipment sent in *Sputnik III*. Yet another recent oscow film is "Mankind's Great Vicry," dedicated to the launching of the nar rocket *Mechta* or, as it is called tside the USSR, *Lunik*.

olaris Data Gathered y Leach Cylinder

COMPTON, CALIF.—A rugged inument cylinder has been developed the Leach Corp. for use in gathering launching data on the *Polaris*.

Mounted in the nose of a dummy ssile test-launched from submarines ship simulators, the 176-lb. cylinder rries 15 pounds of encapsulated inuments in a ½" steel shell. It can thstand complete submersion for two ys or more and resists water pressure 75 psi.

Instrumentation, claimed to have thstood more than 1000 g's in the ckage, includes a 14-channel recorder, battery power pack, three accelerometers, two rate gyros, transistrized amplifiers, control and calibran circuits, a static inverter providing 0-cycle power to the gyros, and a modulator package.

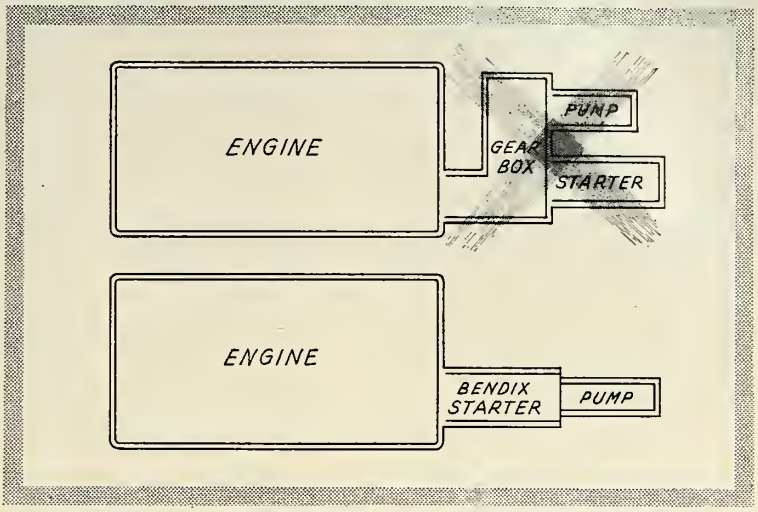
According to Leach engineers, en the *Polaris* dummy was test-fired to a bed of concrete the package rvived the shock with all instruents functioning perfectly, although missile itself was damaged.

ilors Study *Polaris* b's Auto-navigator

DOWNEY, CALIF.—Selected U.S. vy men have begun a 12-week ining course in installation, checkc, maintenance and operation of the rtial auto-navigator being produced North American Aviation's Autonics Division for *Polaris*-equipped marines.

Training specialists of the division's litary Logistics and Service Departnt are instructing the Navy students a specially-designed laboratory conaing the first auto-navigator productn model—including gyro-stabilized tform, separate navigation console d digital computer.

BENDIX EXCLUSIVE FOR JET STARTERS: AN EXTRA ENGINE PAD!



NO GEAR BOX *is needed with the Bendix Utica air turbine starter with accessory drive pad. Compare standard engine arrangement, above, with Bendix Utica maunting, belaw.*

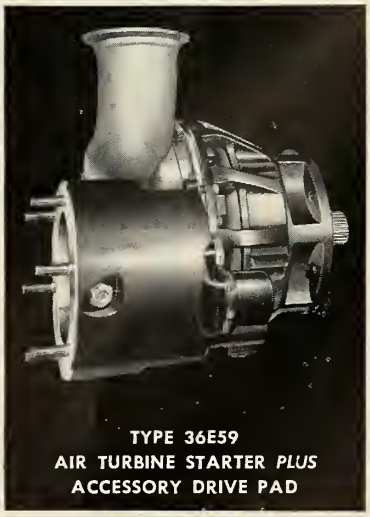
For the first time, Bendix Utica offers an air turbine starter and accessory drive unit, featuring an integral mounting pad for continuous drive of a pump, generator, compressor or similar accessory. Developed by Bendix engineers, the new unit minimizes accessory mounting problems, eliminates the need for a gear box and provides efficient operation with reduced weight and better economy. You get continuous accessory drive during engine operation—and the design can be readily modified to cover a wide range of engine requirements.

Engine starting with this unit is automatic and cockpit-actuated. The engine is carried through light-off by the starter to the established cut-out speed. Then air flow to the turbine is automatically cut off and the unit's starter section coasts to rest, while the engine continues to drive the mounted accessory through the drive shaft and accessory pad gearing.

The starter is adaptable to high-temperature cross-bleed starting for multi-engine installations. It conforms to military specifications and has a minimum service life of 600 starts and 500 operational hours between overhauls. Safe operation is assured by self-limiting runaway speed and reverse overload release mechanism. It's easy to install and mount and provides reliable operation at extreme ambient temperatures.

ADDRESS ALL INQUIRIES TO:
Bendix Utica, 211 Seward Ave., Utica, N. Y.

West Coast: 117 E. Providencia, Burbank, Calif.
Canada: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal, Que.
Expart Sales and Service
Bendix Internatianal, 205 E. 42nd St., New York 17, N. Y.



TYPE 36E59
AIR TURBINE STARTER *PLUS*
ACCESSORY DRIVE PAD

Bendix Utica Division
UTICA, NEW YORK

Bendix
AVIATION CORPORATION



The experts show you how to build a rocket safely

THE ROCKET HANDBOOK for AMATEURS

An Illustrated Guide to the Safe Construction, Testing, and Launching of Model Rockets

Edited by LT. COL. CHARLES M. PARKIN, Jr., Army Engineer Corps. *Foreword by WERNHER VON BRAUN.* Written by eleven contributors professionally engaged in rocket development, this book—the first of its kind—gives amateurs of all ages the basic knowledge essential for rocket-building. It includes chapters on organizing a rocket club, satellite orbit geometry, human factors in space flight, safety precautions, solid and liquid propellants, design, fuel pumps, cryogenics, test instruments and the building of a safe rocket. Thoroughly illustrated. The editor is President, National Capital Section, American Rocket Society. $5.95 at your bookstore or order from

THE JOHN DAY COMPANY
Sales Office: 210 Madison Av.
New York 16, New York

Now Available

NUCLEAR EXPLOSIONS IN SPACE

by Prof. S. Fred Singer

the story behind

Project ARGUS

Reprints of this exclusive M/R report are now available due to repeated requests.

A series of four illustrated articles combined, this important M/R special contains scientific explanations of:

* **project ARGUS**
* **creation of an artificial particle belt**
* **effect on manned space vehicles and nuclear warheads**
* **effects on radar and long-range communications**
* **scientific techniques for detecting such explosions**

50 cents per copy
(bulk rates on request from publisher)

missiles and rockets
1001 Vermont Ave., N.W.
Washington, D.C.

missile business . . .

By DONALD E. PERRY

What's best when you want to pick up . . .
more defense business? Acquire a new company—and take a lot of bad features along with the good capabilities you want, or go after competent personnel and build from within your existing organization? There's a lot of merit in the latter approach, and one company that is going all-out for it is the Crosley Division of Avco Corp., which is attempting to up its military business from a present $80 million annually to $125 million.

Avco-Crosley has a good position in the areas . . .
it went into earlier: some 75 to 80% of the business in command receivers, good prospects in fuzing and arming—*Titan* work now and a new NOL contract for *Polaris*—and a healthy outlook for honeycomb structures both in aircraft and missiles.

An old-timer in *Falcon* structures . . .
and complete radar systems (both looking good), Avco-Crosley under President F. C. Reith months ago started broadening. "We determined," Reith said, "to get competent technical and professional people in new areas which we had not been in before." Targets: sonar, electronic checkout equipment, human engineering, infrared (surveillance, ICBM detection, mapping).

But how to approach it . . .
was another thing. Reith decided almost entirely on going out and getting the personnel. "Not that we have anything against acquisition; we haven't. We're still looking in the infrared field but we are being selective," he says.

Crosley's personnel build-up is reflected . . .
by nearly a 30% increase in its professional staff, giving the company what Reith considers a strong capability for new business. In key spots are many newcomers brought in from other concerns usually for one reason: a broad background in particular areas where Crosley wants to expand its business scope.

To cite just a few . . .
Dr. E. A. Steinhoff (formerly with Aerophysics Development Corp.), and former member of von Braun's Peenemunde team, heads up a new missiles department. He is considered one of the world's foremost authorities on missile system guidance and control. Marine Electronics has Dr. H. W. Marsh (formerly with Westinghouse in missile ground-handling equipment), who has a broad background in the quantitative nature of environment and signal processing for sonar systems.

Still another former Westinghouse specialist in electronic and electromechanical systems R&D—Dr. F. E. Lowance—serves as Crosley's vice president of engineering. Dr. John W. Odle, director of Crosley's Advanced Development Department, came from the University of Michigan with a varied background in mathematics and systems and analytical studies.

Brought in from Control Instrument Co. where he was Controller and director of Purchasing was R. B. Marston, Crosley's engineering controller.

Dr. Frank B. Brown, Crosley's Reliability Director, came from Melpar, where he directed a study program for integration of SAGE into Air Traffic Control. Coming from Martin's *Titan* program was J. C. Elms, now Crosley Electronics Engineering vice-president, directing Crosley's weapon systems R&D.

So you can take your choice . . .
Buy up companies and perhaps get too much deadwood, or be selective and pick your own. Avco-Crosley thinks it has the best approach.

letters

Thiokol Plans Clarified

To the Editor:

We are afraid that the West Coast Industry column in the May 18 issue of Missiles and Rockets may create considerable misunderstanding among our customers regarding our intentions toward systems contracting.

Thiokol Chemical Corporation has no intention of becoming a prime systems contractor based upon the fact that our customers are such contractors and it is believed that they would not look favorably on purchasing engines from a competitor.

The history of engine development and production activities in this country has demonstrated the validity of separating such activities from airframe development and production. We believe that the validity of this principle applies equally to the aircraft and air-breathing engine field and the field of rocket engine development and production for missiles. The cost of the development and production of a rocket power plant is normally a small portion of the cost of a missile system. No single missile system should have to support the cost of a strong technological team engaged in engine development.

We believe that the current tendency to combine a wide range of technologies into a single organization can only serve to weaken the technological strength of many of the groups engaged in sub-system development. The current tendency to integrate rocket development technology with prime systems capability could have a very debilitating effect upon the whole industry.

It will remain the policy of Thiokol Chemical Corporation to serve as an engine development and production contractor. We hope to be able to serve many prime systems contractors in such a role. We have no intention whatsoever of scaring off our customers by going into competition with them.

H. W. Ritchey
Vice-President
Thiokol Chemical Corp.
Huntsville, Ala.

Trolley Breakdown?

To the Editor:

Regarding the "Moon Trolley" letter in the June 8 issue of M/R.

The two fellows from Picatinny Arsenal could have saved themselves a lot of embarrassment by a few simple calculations.

The strongest materials today would be torn by their own weigbt if made into a cylindrical cable only 20 miles in length. Even at an altitude of 4000 miles, the longest cable that could be hung would be 80 miles; at 12,000 miles: 320 miles long. A *tapered* cable could be made approximately 1000 miles long at the 12,000-mile altitude. However, the 1000-mile cable would be of little value toward spanning the 239,000 miles to tbe moon.

Sorry fellows, but the "moon trolley" must be given up as well as that strong brand of coffee you have been drinking.

R. S. Ronay
Aero. Engineer
Douglas Aircraft Co.
Cocoa Beach, Fla.

Our Pleasure

To the Editor:

The U.S. Army Ordnance Guided Missile School Library wishes to thank the Editors of Missiles and Rockets for tbeir most gracious gift of the bound sets of Missiles and Rockets, volumes 1-4, presented 7 May 1959.

These volumes are an invaluable reference addition to our new library. They form a nucleus for researcb in tbe field of guided missiles and are much appreciated and used by staff, faculty, and students of the school.

H. M. Thomas, Jr.
Major, Ord Corps.
US Army
Ordnance Guided Missile School
Redstone Arsenal, Ala.

BENDIX SR RACK AND PANEL CONNECTOR

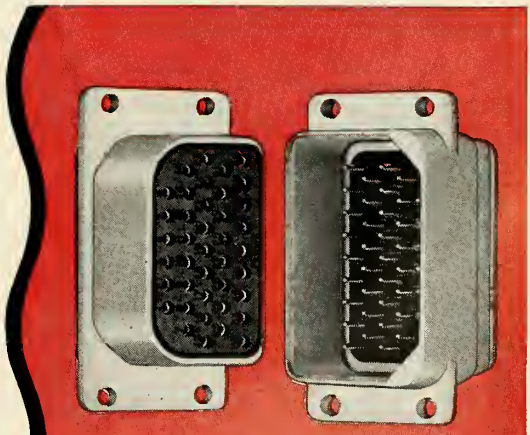
with outstanding resistance to vibration

The Bendix type SR rack and panel electrical connector provides exceptional resistance to vibration. The low engagement force gives it a decided advantage over existing connectors of this type.

Adding to the efficiency of this rack and panel connector is the performance-proven Bendix "clip-type" closed entry socket. Insert patterns are available to mate with existing equipment in the field.

Available in general duty, pressurized or potted types, each with temperature range of −67°F to +257°F.

Here, indeed, is another outstanding Bendix product that should be your first choice in rack and panel connectors.



FEATURES:

Resilient Insert • Solid Shell Construction • Low Engagement Forces • Closed Entry Sockets • Positive Contact Alignment Contacts—heavily gold plated Cadmium Plate—clear irridite finish • Easily Pressurized to latest MIL Specifications.

SCINTILLA DIVISION
SIDNEY, NEW YORK

Bendix
AVIATION CORPORATION

Expart Sales and Service: Bendix International Div., 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliates: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec
Factory Branch Offices: Burbank, Calif., Orlanda, Florida, Chicaga, Illinais, Teaneck, New Jersey, Dallas, Texas; Seattle, Washingtan, Washingtan, D. C.

STRENGTH OF CERAMICS AT HIGH TEMPERATURES, U.S. Department of Commerce, National Bureau of Standards, Summary Technical Report.

The strength of aluminum oxide single crystals has recently been studied at the National Bureau of Standards as a function of temperature. Modulus-of-rupture measurements were related to factors affecting crystal strength at temperatures up to 1000°C.

Certain crystal orientation significantly affects crystal strength by giving rise to plastic deformation at stress concentrations. As these stresses are relieved, crystal strength increases.

AN ANALYSIS OF ELECTRON BEAM INTERACTION WITH EMPHASIS ON THE CROSSED FIELD PROBLEM, J. W. Kluver, University of California for WADC, USAF, 86 pp., $2.25, available from OTS, U.S. Department of Commerce, Washington 25, D.C.

A general method of approach for the approximate solution of the small-signal perturbation of a bounded electron stream surrounded by a periodic structure was developed. With the requirement that energy be conserved, the electron stream is described on the basis of the Maxwell-Boltzmann equations.

The perturbation of dynamic equations is carried out and its effect on a defined boundary of the electron stream discussed. Beginning with the Lorentz reciprocity theorem in its complex form, the approximate boundary conditions for the rf electric field at an equivalent surface of the periodic structure are derived.

Characteristic waves are found by employing the discontinuity conditions at the beam boundary. A power theorem describing the conversion of rf kinetic energy into electromagnetic energy is also given.

GROWTH OF METAL SINGLE CRYSTALS, U.S. Department of Commerce, National Bureau of Standards, Summary Technical Report.

Equipment has been developed to grow preferentially oriented metal monocrystals in practically any cross-sectional shape. These crystals, having an ordered atomic arrangement, are particularly useful in studying the influence of crystal structure on corrosion.

A pre-selected crystallographic orientation is obtained with a technique known as "seeding," and the desired cross-sectional shape is produced by growing the crystals in a vertical furnace.

MECHANICAL DEGRADATION OF POLYMERS, U.S. Department of Commerce, National Bureau of Standards, Summary Technical Report.

To obtain basic information on mechanical degradation of polymers, the
tional Bureau of Standards has bee
vestigating the effect of mechanical sl
ing on various concentrated polyr
solutions. By studying mechanical deg
tion, the use of polymers which deg
excessively under severe conditions
be avoided and special polymers w
will remain intact under such condi
can be developed.

**SURVEY OF THE FIELD OF MECHAN
TRANSLATION OF LANGUAGES,** G
Reitwiesner and M. H. Weik, Ballistic
search Laboratories, U.S. Army, 65 pp.,
available from OTS, U.S. Department of
merce.

Developments and problems in
field of mechanical translation of
guages by means of high-speed elect
computers are analyzed in this Arm
port.

The information, gleaned from a
ature survey and from interviews
workers in the field, covers the mecha
translation activities of government,
mercial, and educational institution
the United States as well as contribu
made in Britain and Russia. Includ
a bibliography of 175 references.

The subject is described in tern
the two major aspects of machine t
lation, methodology and equipment.
methodology, the problems of
matical rules, syntactical analysis,
tionaries, flow charts, and program
are discussed. Information on equip
deals with character sensing equip
information storage devices, pri
methods, and arithmetic or proce
organs.

A number of general purpose
tronic computing systems are disc
along with the special purpose comp
of the University of Washington an
Air Force's Mechanical Translator
1. Predictions are made concerning f
developments and the time necessar
fore working programs in the ma
translation field can be expected.

**EXPERIMENTAL ALTITUDE PERFORMA
OF JP-4 FUEL AND LIQUID-OXY
ROCKET ENGINE WITH AN AREA R
OF 48,** Anthony Fortini, Charles D. He
and Vearl N. Huff, May, 1959, 27 pp. (
MEMORANDUM 5-14-59E).

The performance of a rocket e
having a nozzle area ratio of 48 wa
perimentally measured at four alti
and corrected to vacuum condition
comparison of experimental perfor
with that of a sea-level engine havir
area ratio of 5.5 was made.

The propellant combination JP-4
and liquid oxygen was used for boti
gines. The chamber pressure was cor
at 600 lb./sq. in. abs. Altitudes wer
tained by an ejector system utilizin
rocket exhaust gas as the pumping

Results indicate the large-area
engine gives a specific impulse of
lb.-sec./lb. at vacuum conditions. A
level, the large-area-ratio engine
countered flow separation within
nozzle and the specific impulse wa
lb.-sec./lb. The results also include
ured heat-transfer rates and heat loa
the engine.

This is not and is under no circumstances to be construed as an offer to sell, or as an offer to buy, or as a solicitation of an offer to buy, any of the securities herein mentioned. The offering is made only by the Prospectus.

New Issue June 9, 1959

1,800,000 Shares

Electronics Capital Corporation

Common Stock

Price $10 per share

Copies of the Prospectus may be obtained in any state only from such dealers participating in this issue, including the undersigned, as may legally offer these Securities under the securities laws of such State.

Hayden, Stone & Co.

Paine, Webber, Jackson & Curtis — Dempsey-Tegeler & Co.

Goodbody & Co. — J. A. Hogle & Co. — E. F. Hutton & Company

Piper, Jaffray & Hopwood — Daniel Reeves & Co. — Walston & Co., Inc.

propulsion engineering

Basic studies on plastics . . .
at Brooklyn Polytechnic Institute will give propulsion engineers more data on solid propellants. Brooklyn Poly will study cracking in rigid plastic materials under a $28,325 Wright Air Development Center contract. Far from being "library research" on a theoretical level, the project is primarily concerned with cracking under actual environmental stresses. Although the materials to be studied first are not fuels or binders, the information they yield will be applicable to polysulphide rubber and polyurethane. Brooklyn poly researchers will first look at nylon, polystyrene and irradiated polyethylene.

Propellant grains may change radically . . .
if the study yields new information about cracking, and many chemists and engineers expect it will come up with new findings, since very little has been done along this line. Grain sizes, configurations, storage requirements and applications are controlled by cracking characteristics of plastic material fuels and binders.

You can learn solid state chemistry . . .
or at least the rudiments of the solid state chemistry you have to have in your work, in a quick, easy way—thanks to a new Department of Commerce ten-year study of Navy activity in the field. Commerce's Office of Technical Services reviews 75 Office of Naval Research Reports in solid-state work in "Solid State Chemistry: Final Report on the Activity During the Period of This Contract 1948-1957," Technical Report No. 76, $1.00. W. A. Weyl and E. C. Marboe break down a discussion of the properties of matter into five easy-to-follow subheadings, and then cover six classical areas.

The ortho-para hydrogen conversion . . .
which has been discussed in this column several times as a factor moving liquid hydrogen closer to practical consideration as a missile fuel, is used as a brief example of quantum mechanics in the study. Weyl and Marboe discuss the K. Fajans concept of chemical binding forces at length: "Quantum mechanics deviates from the classical approaches to chemistry by not using atoms or ions as the ultimate building units, but by referring to the interaction of nuclei and electrons . . ."

For missilemen the major points . . .
outlined in the report are:

(1) Building unit properties change with their environment; concept of a "constant chemical bond" can be misleading.

(2) Any disturbance of a crystal lattice creates a "depth action" on the chemical binding forces.

(3) The first principle is establishment of electro-neutrality in the smallest volume possible; the second is the need of screening of positive cores, which accounts for most elements being solids at room temperatures.

(4) The rate of many chemical reactions is determined by penetration of a proton into a polarizable anion; anion polarizability varies with thermal vibrations of surrounding ions.

Properties of oxide surfaces . . .
is one study covered by the final report. Others in the list of 76 papers which contribute to the review include:

Catalytic activity of gases on decomposition of hydrogen peroxide; decomposition of hydrogen peroxide by lead fluoride; catalytic activity of semiconductors; effect of foreign atoms on electronic properties of crystals; change of a P-type semiconductor into a N-type semiconductor by vapor treatment; mechanism of recrystallization and sintering; differential thermal analysis of metal hydroxides; application of the polarization theory to ceramic problems; kinetics of reactions between oxides in the solid state; structure of the high-temperature modification of lithium sulphate.



Reach the heart of the missile market throughout the entire year.

missiles and rockets

3rd ANNUAL engineering progress issue

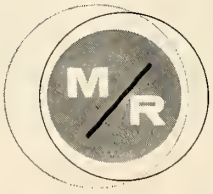
featuring the Guided Missile Encyclopedia

JULY 20, 1959

Your guarantee to high readership and constant reference . . . in the $7 billion missile market.

Here is the most exciting and popular issue of the year. Authoritative articles by recognized experts — from Astrometry to Ion Propulsion — PLUS the new and expanded Guided Missile Encyclopedia. Now you can reach the market in depth and quality as never before. Write, call or wire your *missile and rockets* representative today, and find out how you can put your sales message where it will reach the heart of the missile market throughout the entire year.

NEW YORK CITY: 17 East 48th Street PLaza 3-1100 • DETROIT: 201 Stephenson Bldg. TRinity 5-2555 • CHICAGO: 139 N. Clark Street CEntral 6-5804 • LOS ANGELES: 8929 Wilshire Blvd. OLeander 5-9161 • MIAMI: 208 Almeria Avenue HIghland 4-8326 • TORONTO: 12 Richmond Street E. EMpire 4-2001 • LONDON: 28 Bruton Street GRosvenor 8351 • PARIS: 11 Rue Condorcet Tru 15-39 • GENEVA: 10 Rue Grenus 34 66 73



missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.


RUBEL

John H. Rubel, 39, on leave from the Hughes Aircraft Co., where he was director of airborne systems laboratories, has been named assistant director for strategic weapons in the DOD office of research and engineering headed by Dr. Herbert F. York.

An electrical engineering graduate of California Institute Technology, Rubel has 16 years' experience in the electronics industry. In 46, he joined the Hughes company, ere he contributed to work on autotic celestial navigation, the *Falcon* ies of air-to-air guided missiles and airborne armament control systems d in Air Force all-weather jet intertors.

Dr. F. Kenneth Brasted, president of University of Dallas since 1955, has ed Texas Instruments Inc. as adistrative director of the Central Rerch Laboratory. Dr. Brasted holds a helor of arts degree from the Univerof Florida, an M.A. degree from umbia University, and a Ph.D. from w York University. Before coming to llas, he served seven years as a memof the coordinating committee and ector of the educational department, tional Association of Manufacturers.

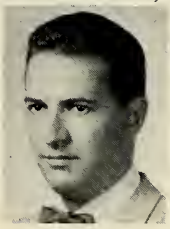
Space Technology Laboratories, Inc., appointed **Walter B. Brewer** manager its airborne systems and test depart-nt, *Atlas* Program Office. Brewer had n associate manager of the airborne ems and test department since joining in March of this year.

A new hypersonic tunnel department Cornell Aeronautical Laboratory, Buf-, will be headed by **King D. Bird,** nerly head of the transonic tunnel de-ment. **James F. Martin** has been ed assistant head of the new depart-t.

John P. Andes has been named head the transonic tunnel department and **W. Cotter,** assistant department head. es was formerly assistant department d of transonic tunnel.


PITTINGER

Rocket Power, Inc., a subsidiary of the Gabriel Co., has named **A. Lincoln Pittinger** vice president for planning and marketing. Pittinger, closely linked with the rocket and missile industry since 1943, was commander of the first Navy rocket plant at China Lake. As civilian of product and production engineerat NOTS through 1951, he helped place into production the Navy 2.75-inch *Mighty Mouse* aircraft rocket and many other advanced weapons. Called to Europe in 1952 by the NATO countries, he set up rocket facilities in Belgium and Greece to support the free world arsenal. Pittinger also has served as director of R&D for the Cooper Development Corp., and was responsible for major advances in upper-atmosphere sounding rockets. He resumed private practice in late 1957, and had been very active in the development of high-altitude meteorological sounding rockets prior to joining Rocket Power, Inc.


ELDER

Rocket Power, Inc., also has appointed **John K. Elder** vice president of its applied research and testing laboratories. Following graduation from the California Institute of Technology, Elder was employed by the Aerojet-General Corp. where he engaged in solid propellant research and development activities for four years. He joined Grand Central Rocket in 1955.

William H. Clark is the new general superintendent of Allen B. Du Mont Laboratories, Inc. Clark will be responsible for the company's plant and office facilities in Clifton, Passaic, and East Paterson, N.J. He succeeds **Walter H. Husselrath,** who died on May 25.


SHERWIN

At the Norden Division, United Aircraft Corp., **Samuel B. Sherwin** has been appointed manager of the Ketay department in Commack, L.I., and **Wladimir Reichel** engineering manager. A native New Yorker, Sherwin has been manager of the overhaul and repair department of UA's Hamilton Standard Division at Windsor Locks, Conn. Reichel is Norden's basic design chief and a pioneer in instrument miniaturization. Born in St. Petersburg, Russia, he has been in the United States since 1923 and holds numerous patents on servo components, gyro and navigational instruments. He directed important work on inertial navigational system development.

Dr. Robert W. Perry has been named head of Republic Aviation's re-entry simulation laboratory in the company's new $14 million Astronautical Center. **Dr. Samuel Korman** will head the Materials Development Laboratory to create new alloys and synthetics capable of withstanding the rigors of outer space. Associated with Dr. Korman are **Dr. Robert P. Bastian** and **Dr. Stanley Zirinsky,** who have been appointed chief chemist and chief metallurgist, respectively. Perry was formerly manager of the research branch, gas dynamics facility, at the Arnold Engineering Development Center, and is a member of NASA's Advisory Committee on Fluid Dynamics. Korman was formerly a consultant to the Atomic Energy Commission, the Air Force and several American industrial firms. Before joining Republic, Bastian was associated with Sylvania Electric Products, where he was an engineering specialist in analytical and inorganic chemistry, and Zirinsky was previously staff consultant to the Missiles and Space Vehicles Division of the General Electric Co.

Woodman Perine, president of Vitro Engineering Co., has been named vice president of Vitro Corp. of America. **James C. Tourek,** chief project manager, was named acting general manager of Vitro Engineering, replacing Perine. In his new position, Perine will direct the activities of Vitro's Technical Services and Products Group which includes Vitro Engineering; the Refinery Engineering Co., Tulsa, Okla.; Nems-Clarke Co., Silver Spring, Md.; Thieblot Aircraft Company, Martinsburg, W.Va., and Vitro Laboratories, Silver Spring, Md.

Dr. A. W. Wortham, manager of the Quality Assurance Department, Semiconductor-Components division of Texas Instruments Incorporated, has been elected executive director of the American Society for Quality Control. Dr. Wortham has jurisdiction over District 14 of the ASQC, including Texas, Oklahoma, New Mexico, Louisiana and Mexico.

Shareholders of Lear, Inc. recently elected six new directors and re-elected eight to the board. The new directors are: **James L. Anast,** who became president on April 9, 1959; **Roy J. Benecchi,** group vice president; **Barney M. Giles,** assistant to the president; **Philip E. Golde,** senior vice president, secretary and general counsel; **K. Robert Hahn,** executive vice president, and **Andrew F. Haiduck,** group vice president.

Re-elected were **William P. Lear,** chairman of the board, and **Richard M. Mock,** chairman of the executive committee; and the following non-employee directors: **Harold R. Boyer** of General Motors Corp., **A. G. Handschumacher** of Rheem Manufacturing Co., **Kenneth MacGrath** of High Standard Manufacturing Corp., **Richard W. Millar** of William R. Staats & Co., **Clarence J. Reese** of Continental Motors Corp. and **Russell A. Stevenson,** University of Michigan.

Jay W. Schnackel has been appointed vice president of Remington Rand Division of Sperry Rand Corp. in an overall staff position in the company's Univac-Tabulating Division. Schnackel has been vice president for manufacturing services of International Business Machines Corp. since 1956.

contract awards

ARPA

$600,000—**RCA**, for studying the feasibility of tracking and intercepting enemy space satellites.

MISCELLANEOUS

$193,000—**Avion Div. of ACF Industries, Inc.**, Paramus, N.J., for production of radar beacons used in test firings to extend the precision of tracking range of ground radar. (Contract awarded by the United Kingdom Treasury and Supply Delegation in the U.S.)

NASA

Grumman Aircraft Engineering Corp., has been awarded a contract to conduct studies concerning the search and recovery operations of Project *Mercury*. (Amount not disclosed.)

$100,000—**Applied Science Corp. of Princeton**, for airborne statistical telemetering equipment for Project *Mercury*. (Subcontract from **McDonnell Aircraft Corp.**).

NAVY

Stavid Engineering, Inc., Plainfield, N.J., for initiation of a new, advanced, lightweight shipboard radar, designated AN/SPS-40. (Amount not disclosed.)

$3,750,000—**Collins Radio Co.**, Cedar Rapids, Iowa, for production of electronic counter-measures receivers to be installed on both surface and undersea craft.

$140,050—**Cooper Development Corp.**, Monrovia, Calif., for development and fabrication of flight instrumentation assemblies.

$128,000—**Ralph T. Viola**, Oxnard, Calif., for site preparation for Cotar acquisition system at Point Mugu, Calif.

$100,000—**Magnetic Research Corp.**, Hawthorne, Calif., for production of 28 volt, 60 cps ground power supplies for use on the *Talos* missile.

$92,000—**Les Kelley**, Belmont, Calif., for instrumentation site, Point Pillar, Princeton, Calif., for naval missile center, Point Mugu, Calif.

$87,000—**NRC Equipment Corp.**, Newton Highlands, Mass., for design, development and production of ultra-high-vacuum gauges for satellite instrumentation.

$49,929—**Raymond Engineering Laboratory, Inc.**, Middletown, Conn., for design, manufacture and evaluation of rocketborne ionosphere antennas, housing units and antenna opening mechanisms.

$34,800—**General Dynamics Corp., Liquid Carbonic Div.**, Los Angeles, for liquid bulk oxygen.

$32,688—**Broderick & Bascom Rope Co.**, St. Louis, for wire rope, 6x19, preformed, high-strength, uncoated for aircraft launching and arresting.

$26,390—**Century Tool Co.**, Palmyra, N.Y., for organizational maintenance and assembly tool kit for the *Nike*.

AIR FORCE

Hermes Electronics Co., Cambridge, Mass., has been awarded a contract of more than $1,000,000 dollars for timing equipment for the IBM Bombing-Navigation Missile Guidance System to be used in the B-70 (subcontract from **International Business Machines Corp.**).

Westinghouse Electric Corp., Air Arm Div., Baltimore, has been awarded a "multi-million" dollar contract for development and building of a defensive system for the B-70 (subcontract from **North American Aviation**).

$47,000,000—**Sperry Gyroscope Co.**, Great Neck, N.Y., for development and production of high-powered air search radar systems.

$3,900,000—**Ryan Aeronautical Co.**, for *Firebee* jet targets to be used to simulate "enemy" attacks at Tyndall AFB, Fla.

$3,600,000—**Lear, Inc., Instrument Div.**, Grand Rapids, Mich., for coordinate converter systems for the early version of the Boeing *Bomarc IM-99*. (Total program now exceeds $20,000,000.)

$2,712,132—**Convair Div. of General Dynamics Corp.**, for B-58 mobile training units.

$2,300,000—**International Telephone & Telegraph Corp.**, San Fernando, for 36 multiple voltage supply systems for the B-58 (subcontract from **Convair Div. of General Dynamics**).

$1,843,944—**General Precision Laboratory, Inc.**, for navigation equipment components.

$1,706,469—**Convair Div. of General Dynamics Corp.**, San Diego, for installation of new Azusa Mark II missile tracking equipment at Cape Canaveral.

$1,500,000—**Electronic Associates, Inc.**, Long Branch, N.J., for range instrumentation equipment for the Eglin Gulf Test Range (subcontract from **IT&T**).

$951,374—**Convair Astronautics Div. of General Dynamics Corp.**, San Diego, for design, development and fabrication of a cosine rate system for the Azusa Mk II and other related items.

$819,400—**Diversified Builders**, Cocoa, Fla., for construction of a blockhouse for the *Saturn* missile at Cape Canaveral.

$194,692—**Conoga Div. of Underwood Corp.**, Ft. Walton Beach, Fla., for seven airborne timing systems to be used in telemetry aircraft of the AFMTC's 6550th Operations Squadron.

$182,500—**Raytheon Mfg. Co., Missile Systems Div.**, Waltham, Mass., for 13 Rayspan spectum analyzers.

$153,000—**Model Engineering & Mfg., Inc.**, Huntington, Ind., for signal generators to support various aircraft and missiles.

$100,000—**Ratigan Electronics, Inc.**, Glendale, Calif., for components to be used in the *Falcon* (subcontract from **Hughes Aircraft Co., Tucson Div.**).

$86,971—**Graflex, Inc.**, Rochester, N.Y. for 231 speed graphic camera sets.

$54,717—**Motorola, Inc.**, Phoenix, Ariz., for sub-miniature frequency modulated UHF radio receiver set used to receive and decode range safety command signals during missile flight operations.

$43,930—**Cooper Development Corp.**, Monrovia, Calif., for *Aspan* rocket vehicles, less *Nike* booster and *Nike* fins, engineering field service and firing circuit test set.

$37,955—**University of Illinois**, for laboratory investigation of SAGE operator performance factors contributing to operator fatigue.

$36,000—**Minneapolis-Honeywell Regulator Co., Aeronautical Div.**, Minneapolis, for liquid oxygen amplifiers for various aircraft.

$35,000—**Consolidated Avionics Corp.**, Westbury, N.Y., for a strain gage data reduction system (subcontract from **Hamilton Standard Div., United Aircraft Corp.**).

ARMY

BJ Electronics, Borg-Warner Corp., Santa Ana, Calif., for GMD-1 transportable ground tracking and data recording equipment (substantial addition to a $500,000 initial contract).

$3,172,929—**Douglas Aircraft Co. Inc.**, Santa Monica, for launching area items.

$2,798,219—**Blount Brothers Construction Co.**, Montgomery, Ala., for construction of *Bomarc* facilities.

$2,390,567—**Jet Propulsion Laboratory**, Calif. Institute of Technology, for continued research and development of the *Sergeant*.

$981,000—**Sperry Utah Engineering Laboratory**, Salt Lake City, for *Sergeant* missile repair parts.

$900,000—**The Firestone Tire & Rubber Co.**, Los Angeles, for the *Corporal* missile.

$390,000—**Rheem Manufacturing Co.**, Downey, Calif., for research and development.

$363,961—**Westwood Construction Co.**, Denver, for construction of liquid oxygen facility at F. E. Warren AFB, Cheyenne, Wyo.

$260,483—**Gilfillan Brothers, Inc.**, Los Angeles, for engineering services.

$150,879—**Douglas Aircraft Co., Inc.**, Santa Monica, for *Honest John* program.

$140,000—**The Rust Engineering Co.**, Pittsburgh, Pa., for architect-engineer services in connection with design of Third Increment Missilemaster facilities.

$122,599—**Murray Construction Co.**, Battle Creek, Mich., for building rehabilitation for SAGE support facility at Fort Custer AFB.

$100,000—**Paul Monroe Co.**, Bell Gard
Calif., for construction of specialized
draulic equipment for actuating the d
of "half-hard" *Atlas* sites at Fairc
AFB.

$85,000—**Pennsylvania State University,**
versity Park, Pa., for research and
velopment on the determination of
tron densities of the ionosphere.

$84,240—**Motordyne, Inc.**, Monrovia, C
for motor generators.

$75,000—**Ryan Aeronautical Co.**, San D
for miscellaneous support items.

$70,000—**California Institute of Technol**
Pasadena, for research and developm

$68,577—**Gilfillan Brothers, Inc.**, Los A
les, for *Corporal* missile repair parts.

$64,481—**The Andy Electric Company**
Andalusia, Ala., for the installatio
500 KW engine generators at Cape
Blas, Fla.

$60,000—**University of Florida, Gaines**
for basic research.

$57,527—**Aircraft Armaments Inc., Coc**
ville, Md., for design, fabrication and
livery of a rocket sled.

$56,279—**Telemetering Corp. of Ame**
Sepulveda, for technical services.

$54,161—**Nortronics Div., Northrop C**
Anaheim, Calif., for research and dev
ment.

$50,359—**Douglas Aircraft Co., Charl**
N.C. for *Nike* spare parts and compon

$49,850—**Spectralab Instruments, Monr**
Calif., for telemetry systems.

$39,800—**Servomechanisms, Inc., Hawth**
Calif., for computer systems.

$35,000—**North American Aviation, Ro**
dyne Div., for design and developme

$34,042—**Interstate Electronics Corp.,**
heim, Calif., for supplies.

$34,000—**Murice H. Connel & Associates,**
Miami, Fla., for architect-engine
services for design of *Saturn* missile
ice structure at Patrick AFB, Fla.

$31,911—**Motorola, Inc.**, Phoenix, for te
try sets.

$30,800—**Thiokol Chemical Corp., El**
Md., for motor, recruit and solid pr
lants.

$25,686—**Ryan Aeronautical Co.**, San I
for target missile flight service pro

$16,636—**Western Electric Co., Inc.,**
York, for *Nike* spare parts and co
nents.

BIDS

The following bids were made publ

Ogden Air Materiel Area, Hill AFB,
Att: Directorate of Procurement and
duction.—Removal and installation c
tenna supporting structures at
Site adjacent to McChord Air Force
Wash.—Job—IFB 42-600-59-336B—Bid
ing 22 June '59. If reply necessary
for OOPPCS-2.

U.S. Army Engineer District, Sacra
Corps of Engineers, Wright Bldg.,
mento, Calif.—Radar tower, FPS-7
pah AF Station, Tonopah, Nev.—
IFB Eng. 04 167 59 67B. Bid openi
June '59.

Procurement Office, Patrick Air Force
Fla.—Installation of fire protectio
emergency shower facilities for laur
pads 5, 6 and 26A & B, Cape Can
Missile Test Annex, Fla.—Job—IF
606-259B. Bid opening 29 June '59.

U.S. Army Engineer District, Los A
Corps of Engineers, 751 So. Figuer
Los Angeles 17, Calif. Construction
final increment of a technical bu
complete, including appurtenant u
and site improvements at Army Elec
Proving Ground, Ft. Huachuca, Ariz
IFB Eng 04-353-59-95. Bid openi
June '59.

Purchasing and Contracting Branch,
ing T-5333, Fort George G. Mead
Alterations and improvements to
and drainage at *Nike* site 25, 26, 30,
43.—Job—IFB 18-102-59-98. Bid o
24 June '59.

U.S. Naval Air Station, Oceana, V
Beach, Va., Air condition guided
support bldg. No. 920 at Naval A
tion, Oceana, Va.—Job—IFB NBY
Bid opening 25 June '59.



ENGINEERS • SCIENTISTS

General Electric's Heavy Military Electronics Dept.

AWARDED CONTRACT FOR

Systems Integration, Engineering, and Management of...

AIR WEAPONS CONTROL SYSTEM 212L

A universal electronic control system to meet the vast problem of Air Defense outside of the Continental United States

Systems-oriented engineers and scientists will appreciate the broadband technical challenge of the Air Weapons Control System 212L. There are important openings for men who are experienced in: Weapons Systems Analysis • Mathematical Analysis of Engineering Problems • Computer Programming • Military Communication Systems • Radar Systems • Weapons Control Systems • Electronic Circuitry • Industrial & Military Psychology.

● Working in close cooperation with the USAF, it is Heavy Military's responsibility to integrate all subsystems—data acquisition, communications, data processing and display—plus various defensive weapons into a well coordinated and efficient operating system.

VERSATILE AIR CONTROL APPLICATIONS The revolutionary 212L can be used to defend a single airfield, or, by linking control sites together, it could be used in a limited action to provide air control for an area the size of Alaska. Similarly, by linking the capabilities of countries together, a system could be provided for the air control of an entire continent. Designed for *both* fixed and mobile applications, the 212L will be used primarily outside the U. S. since the SAGE system is used for the defense of this country.

HMED IS ALSO DESIGNING THE "HEART" OF THE SYSTEM In addition to its prime mission of providing systems management, HMED will design, develop and produce the data processing and display subsystem which is the "heart" of the 212L. Capable of rapidly and automatically detecting and tracking air targets, the subsystem operates without human assistance, except under unusual circumstances.

OTHER FAR-RANGING PROGRAMS AT HEAVY MILITARY

At the present time additional far-ranging programs are being pursued in diverse and important areas at HMED:

- Fixed & Mobile Radar
- Shipborne Radar
- Underwater Detection Systems
- Missile Guidance
- Data Handling Systems
- Communications

Individuals with experience in systems analysis or specific equipment design in the areas listed above are invited to forward their resume in complete confidence to Mr. George Callender, Div. 73-WY.

HEAVY MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

Court Street Syracuse, N. Y.

—when and where—

JUNE

American Institute of Electrical Engineers, Air Transportation Conference, Olympic Hotel, Seattle, June 24-26.

Nuclear Industry Division, Instrument Society of America, Second National Symposium, Idaho Falls, Idaho, June 24-26.

Institute of Radio Engineers' Professional Group on Military Electronics, Third National Convention on Military Electronics, Sheraton Park Hotel, Washington, D.C., June 29-July 1.

Pennsylvania State University, Summer Seminar on Plastics—Its Mechanical Properties, Design and Applications, University Park, Pa., June 29-July 3.

JULY

Tenth Annual Basic Statistical Quality Institute, University of Connecticut, Storrs, July 12-24.

Radio Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Third Biennial Joint Meeting, Ambassador Hotel, Los Angeles, July 16-17.

Scond Annual Institute on Missile Technology, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 26-Aug. 7.

The Denver Research Institute of the University of Denver, 6th Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 30-31.

AUGUST

Institution of Investigation of Biological Sciences, sponsored by Air Force Office of Scientific Research—Aeromedical Div., World Health Organization and United Nations Educational Scientific and Cultural Organization, Montevideo, Uruguay, Aug. 2-7.

William Frederick Durand Centennial Conference, Problems of Hypersonic and Space Flight, Stanford University, Stanford, Calif., Aug. 5-7.

Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

Institute of Radio Engineers, Western Electronic Show & Convention, Cow Palace, San Francisco, Aug. 18-21.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

Air Force Association and Panorama; send reservations to AFA Housing Bureau, P. O. Box 1511, Miami Beach, Sept. 3-6.

Standards Engineering Society, Boston Section, Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, Conference and Exhibit, Chicago, Sept. 21-25.

Industrial Nuclear Technology Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology, Nucleonics Magazine and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

American Rocket Society, Solid Propellants Conference, Princeton University, Princeton, N.J., Sept. 24-25.

Institute of Radio Engineers, 1959 National Symposium on Telemetering, Civil Auditorium, San Francisco, Sept. 28-30.

OCTOBER

Electronics Industries Association Conference, University of Pennsylvania, University Park, Oct. 6-7.

Stanford Research Institute, First High Temperature Symposium, Asilomar Conference Grounds, Monterey Peninsula, Calif., Oct. 6-9.

National Electronics Conference, sponsored by American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University and University of Illinois, Hotel Sherman, Chicago, Oct. 12-14.

Armour Research Foundation, 15th Annual National Conference, Hotel Sherman, Chicago, Oct. 26-30.

Institute of Radio Engineers, Professional Group on Electron Devices, Shoreham Hotel, Washington, D.C., Oct. 29-30.

NOVEMBER

41st National Metal Exposition and Congress, International Amphitheatre, Chicago, Nov. 2-6.

Institute of Aeronautical Sciences, Annual Midwestern Meeting, Lassen Hotel, Wichita, Kan., Nov. 3-4.

Mid-American Electronics Conference, Kansas City, (Mo.) Municipal Auditorium and Hotel Muehlebach, Nov 3-5.

Fifth International Automation Congress and Exposition, New York Trade Show Bldg., New York City, Nov. 16-20.

The Institute of Radio Engineers, 1959 Northeast Electronics Research and Engineering Meeting, Boston Commonwealth Armory, Boston, Nov. 17-19.

Advertisers' Index

Aerojet-General Corp., Sub.-General Tire & Rubber Co.
Agency—D'Arcy Adv. Co.

Bendix Aviation Corp.
Scintilla Div. .....
Utica Div. .....
Agency—MacManus, John & Adams, Inc.

Boeing Airplane Co. .....
Agency—Fletcher Richards, Calkens & Holden, Inc.

Curtiss-Wright Corp. .....
Agency—St. Georges & Keyes, Inc.

Day John Co., The .....
Agency—Denhard & Stewart, Inc.

Dunham-Bush, Inc. .....
Agency—William Schaller Co., Inc.

Eastern Industries, Inc. .....
Agency—Remsen Adv. Agency, Inc.

Grand Central Rocket Co. 25,
Agency—Jakobsen Adv. Agency

Haydon, Stone & Co. .....
Agency—Doremus & Company

Kennametal, Inc. .....
Agency—Ketchum, MacLeod & Grove, Inc

Kelsey Hayes Corp. .....
Agency—Zimmer, Keller & Calvert, Inc.

Walter Kidde & Co. .....
Agency—Cunningham & Walsh, Inc.

Leach Corp., Relay Div. & Inet Div. .....
Agency—Hixson & Jorgensen, Inc.

Magnavox Co., The, Government & Industrial Division
Agency—Rothbardt & Haas Adv., Inc.

McCormick Selph Associates .
Agency—Aircraft & Missile Consultants

Minnesota Mining & Mfg. Co., Magnetic Products Div. .
Agency—MacManus, John & Adams, Inc.

North American Aviation, Inc. Missile Development Div.
Agency—Batten, Barton, Durstine & Osborn, Inc.

Raybestos-Manhattan, Inc. ...
Agency—Gray & Rogers

Raytheon Mfg. Co. .....
Agency—Donahue & Coe, Inc.

Ryan Aeronautical Co. .....
Agency—Batten, Barton, Durstine & Osborn, Inc.

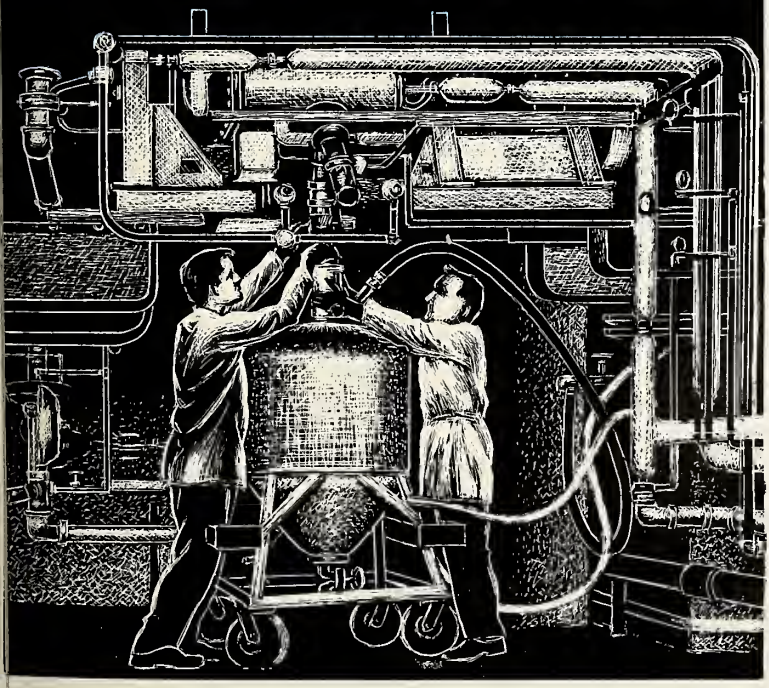
Temco Aircraft Corp. .....
Agency—Rogers & Smith Adv. Agents

EMPLOYMENT SECTION
General Electric Co. .....
Agency—Deutsch & Shea, Inc.

NO FINER CAPABILITIES



NO FINER CAPACITIES



To assure the missile industry of dependable high-energy solid propellants and solid rocket motors, Grand Central Rocket recently added $2,500,000 in improved engineering, research, manufacturing, and testing facilities. With these improvements and our competent technical staff we offer the finest capabilities.

Grand Central Rocket has in operation the largest solid propellant mixer in America. This mixer has a batch capacity of 350 gallons. In addition, a 50-gallon mixer and 25-gallon mixer are also operating. The maximum capacity of these three ultra modern, remote controlled mixers exceeds 500,000 pounds of solid propellant per month. Immediate plans call for replacing the 25-gallon mixer with a 200-gallon mixer.

These capabilities and capacities are *your* assurance of rapid and satisfactory service.

Write Dept. 2-A for Capabilities and Capacities Brochure.

Grand Central
Rocket Co.

An Affiliate of Tennessee Gas Transmission Company
And Food Machinery and Chemical Corporation

P. O. Box 111
REDLANDS, CALIFORNIA
Telephone: PYramid 3-2211

(If you have the qualifications that a fast-moving space propulsion team needs, contact our Director, Personnel.)



Sharp new eye for navigation

SHARPEST new "eye" for flight is the Ryan C-W Doppler navigator. Based on the advanced development of continuous-wave radar, this system of electronics "intelligence" has been pioneered by Ryan and the U.S. Navy for navigation at all speeds. It tells pilots how to fly to any spot on the globe, with speed and precision, and lets them know exactly where they are at all times.

With the Ryan navigator, military aircraft and jetliners can fly a new "electronic skyway" which provides precise separation between planes and conserves time and fuel. And, because RYANAV systems work right down to ground and sea levels, these advantages accrue at take-off, climb-out, descent and landings, as well as enroute.

The Navy has selected RYANAV for installation in six major types of naval aircraft. They are already in squadron use in the Navy's first all-weather anti-submarine helicopters and are being installed in Army aircraft and helicopters, for low-level "nap of the earth" operations.

Reasons for such wide and versatile use are found in the unique features of RYANAV systems: They are the lightest, simplest, most reliable, most compact of their type. They are setting new standards of accuracy, freedom from adjustment, and ease of maintenance... opening new areas of navigational, guidance, and orientation applications. Ryan electronics engineering assistance is available upon request, to those who wish to explore these areas.

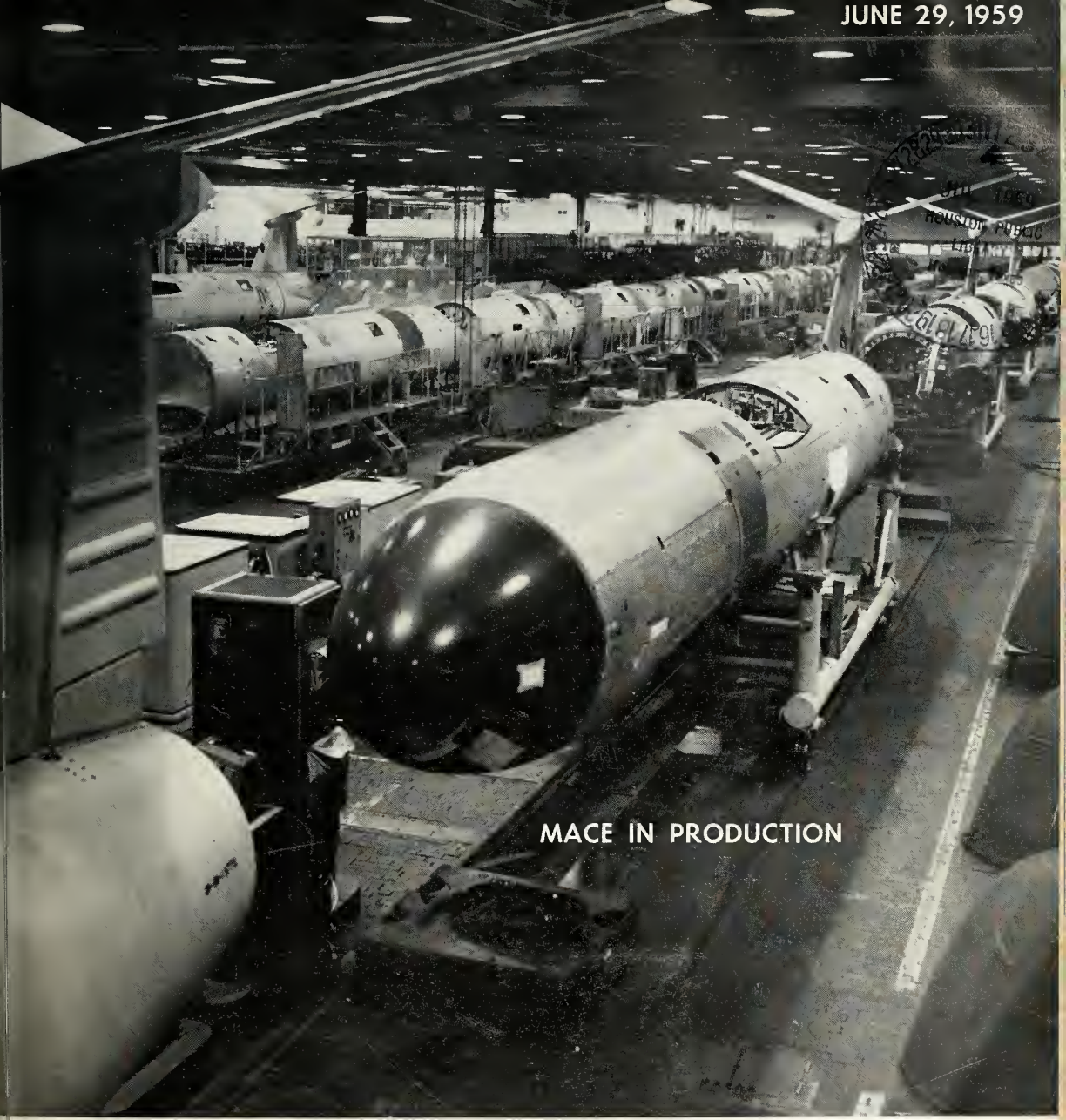
Ryan's rapid growth in electronics is creating new opportunities for engineers and technicians

RYAN BUILDS BETTER

ELECTRONICS DIVISION

Ryan Aeronautical Company, San Diego, Calif.

JUNE 29, 1959



MACE IN PRODUCTION

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

A Look at the Munitions Lobby .. 15
Handling 24-Megaton Thrust 16
Paris Show in Pictures 24

AN AMERICAN AVIATION PUBLICATION

ADVANCED FUEL MANAGEMENT ...FROM SMI



The requirements of accurately tanking missiles with propellants is but one of the areas of fuel management in which Servomechanisms, Inc. has demonstrated capability. *Propellant utilization* and *thrust control* are other areas in which SMI has developed highly accurate and precise measuring and control systems.

SMI's LOX Tanking Computer, which has been in production for the past year, accurately measures, controls and indicates the level of liquid oxygen in missile tanks. Loading is accomplished rapidly and accurately due to a unique two-mode control system. The first mode permits extremely high pumping rates until about 98% capacity is reached. The second mode then takes over and controls a precise proportioning valve which adds the necessary LOX to fill the tank within 0.1% accuracy. The second mode also provides continuous topping, thus compensating for LOX evaporation losses during standby.



SMI has currently in development, more advanced fuel management systems to meet the increasingly complex requirements of the next generation of missiles and spacecraft.

SMI would welcome the opportunity to discuss and propose solutions to your fuel management problems. Write for descriptive literature.



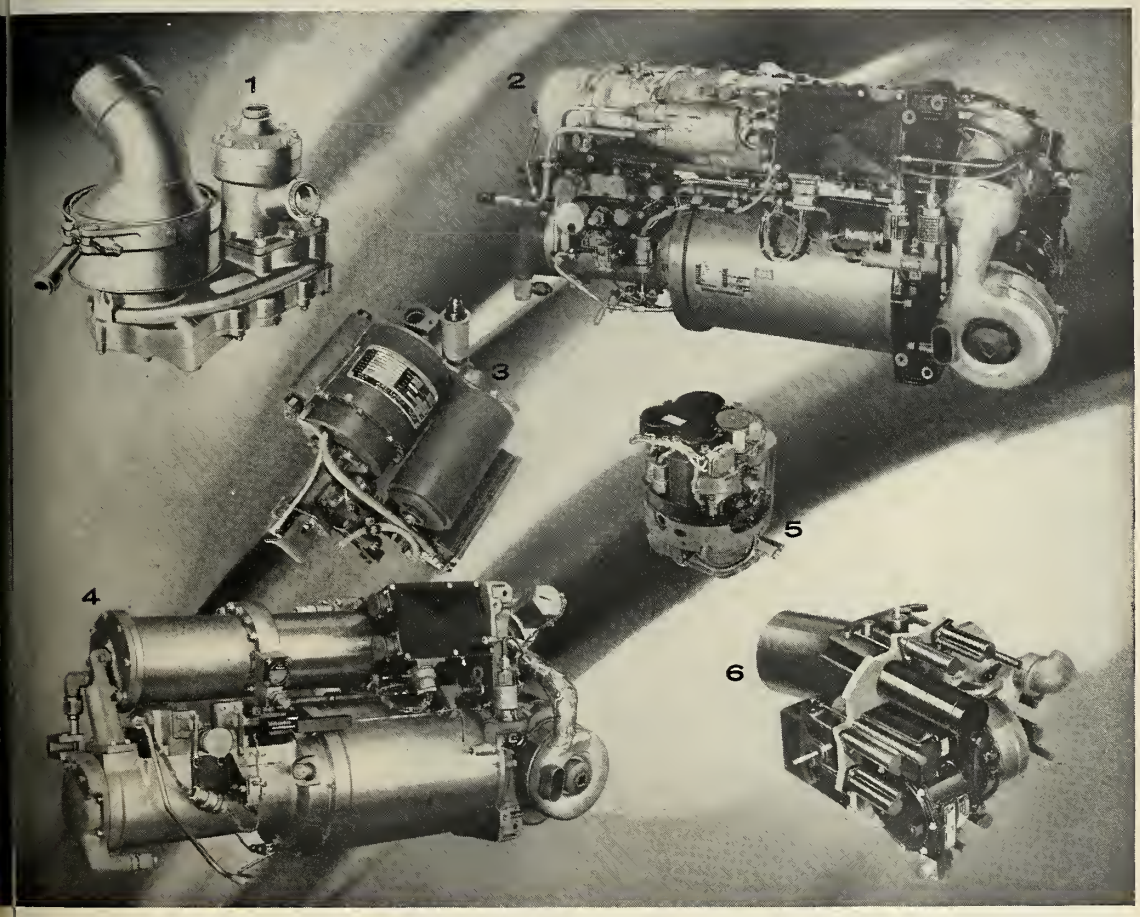
Positions are available for qualified engineers and scientists in the areas of:
Systems Synthesis and Analysis—Project Management —Qualification and Environmental Test Engineering—High Vacuum Deposition Techniques.

SERVOMECHANISMS SMI INC.

LOS ANGELES OPERATIONS: *12500 Aviation Blvd., Hawthorne,*
MECHATROL DIVISION: *Westbury, L. I., New York*
RESEARCH AND DEVELOPMENT CENTER: *Goleta, California*

The products of SMI are available in Canada and throughout the world through Servomechanisms (Canada) Limited, Toronto 15, On

DELIVERED—thousands of missile APUs



1. *Solid propellant—hydraulic output* 2. *Liquid propellant—hydraulic and electric output* 3. *Solid propellant—electric and mechanical drive output* 4. *Liquid propellant—hydraulic and electric output* 5. *Solid propellant—hydraulic and electric output* 6. *Solid propellant—hydraulic, electric and steering outputs*

AiResearch has designed, developed, manufactured and delivered thousands of missile accessory power units. Extremely reliable and lightweight, these various solid and liquid monopropellant APUs are completely self-sustaining within the missile system. Designed to minimum space and weight requirements, they are built to withstand high G loading and severe temperature extremes.

The several units pictured above provide hydraulic, electrical and/or steering surface control depending on the customer's requirement. Delivered horsepower ranges from 1.2 to 35 h.p. over hot gas operating durations from 30 seconds to 20 minutes. Electrical regulation is maintained as closely as ±½%. A significant advance in missile APUs is unit #6 pictured above. This package represents the first integrated hydraulic and electrical power unit providing a steering surface actuation system.

These tailored systems utilize the extensive hardware experience and complete laboratory, test and production facilities of AiResearch needed for quick and efficient quantity production of complex APU systems. AiResearch is the world's largest and most experienced manufacturer of lightweight turbomachinery—the key component of its APU systems. Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

missiles and rockets

the magazine read by the LEADERS in the missile and space vehicle field.



Need more missile personnel?

missiles and rockets is the magazine written expressly for missile experts. M/R can provide the best vehicle for you to reach this type of man. For further information, contact the **missiles and rockets** regional advertising manager nearest you.

M/R **missiles and rockets**

An American Aviation Publication
1001 Vermont Ave., N.W., Washington, D. C.

Executive Editor .....CLARKE NEW
Managing Editor .....DONALD E. PE

EDITORIAL STAFF
News Editor .....REED BI
Military & Defense .....BETTY OS
JAMES
Electronics/Support Equipment ..HAL GEIT
Electronics Engineering ....CHARLES D. LA
Missile Manufacturing .....WILLIAM E. HO
Missile Business .....ERICA M.
NASA .....PAUL M
Los Angeles .....FRED HU
RICHARD VAN O
FRANK MCG
London .....G. V. E. THOMI
Paris .....JEAN-MARIE R
Geneva .....ANTHONY VA
Art Director .....WILLIAM MA
Ass't Art Director .....BACIL GU

CONTRIBUTORS
Propulsion Engineering .....MICHAEL LOR
Industry .....JAMES J. HAGGERTY,
Soviet Affairs .....DR. ALBERT P.
Space Medicine .....DR. HUBERTUS STRUG
Astrophysics .....DR. I. M. L
Research .....HEYWARD CANNEY

ADVISORY BOARD
DR WERNHER VON BRAUN ROBERT P. HAV
DR. PETER CASTRUCCIO DR. ARTHUR KANTRO
KRAFFT EHRICKE DR. EUGEN SA
R. F. GOMPERTZ ALEXANDER S

BUSINESS STAFF
Assistant Publisher .....E. D. MUHI
Advertising Sales Manager .....W. E. BR
Circulation Director .....L. L. BRE
Promotion Manager .....J. E. MU
Advtg. Service Manager ..MRS. GLADYS BU
Production Manager .....J. F. W
Ass't Production Mgr. .....ELSIE
New York .....17 East 48 S
Eastern Advtg. Mgr. .....P. B. KI
P. N. ANDE
A. B. SCHE
Detroit .....201 Stephenson
K. J. W
Chicago .....139 N. Clar
G. E. Y
Los Angeles .....8929 Wilshire
J. W. C
C. R. MARTZ
Miami .....208 Almeria Av
R. D. B
Toronto .....12 Richmond S
ALLIN ASSOC
London .....28 Brutor
NORALL &
Paris .....11 Rue Cond
Geneva .....10 Rue Gr

Missiles and Rockets Volume 5 Number

Published each Monday by American Avia Publications, Inc., 1001 Vermont Ave., Washington 5, D.C.

WAYNE W. PARRISH .....*President & Publ*
LEONARD A. EISERER ...*Executive Vice Presi & General Man*
A. H. STACKPOLE .....*Vice Presi*
FRED HUNTER .....*Vice Presi*
ERIC BRAMLEY .....*Vice Presi*
ROBERT R. PARRISH .....*Vice Presi*

Printed at the Telegraph Press, Harrisburg Second class postage paid at Washington, and at additional mailing offices. Copy 1959, American Aviation Publications, Inc

Subscription rates: U.S., Canada and Pos Union Nations—1 year, $8.00; 2 years, $12. 3 years, $14.00. Foreign—1 year, $10.00; years, $18.00; 3 years, $26.00. Single c rate—$.75. Subscriptions are solicited o from persons with identifiable commerc or professional interests in missiles rockets. Subscription orders and changes address should be referred to Circulat Fulfillment Mgr., M/R, 1001 Vermont A Washington 5, D.C. Please allow 4 we for change to become effective and encl recent address label if possible.

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

JUNE 29 HEADLINES

Munitions Lobby Issue Comes to a Head
House Armed Services Subcommittee prepares to probe controversy fanned by recent developments 15

Priority Rating Revised for Missile Makers
New rules go into effect beginning Oct. 1 19

Paris Air Show in Pictures
U.S. and British manufacturers vie with French in Continent's top Space Age exhibition 24

British Astronautics
New success in testing the Royal Navy's *Seaslug* 28

Debate Over Authority of House Space Group
Chairman Brooks fights for sweeping power in battle which could lead toward a Science Department 32

The Continuing Problem of AF Weapon System Management
Program is reported working better, but basic difficulty is yet to be solved 35

MISSILE SUPPORT

How To Handle 24-Megation Thrust Vehicles?
An examination of some of the requirements of forthcoming boosters 16

ASTRONAUTICS ENGINEERING

Future of Range Instrumentation
A timely discussion of critical problems in a paper by Maj. Gen. Donald N. Yates, Commander, Patrick AFB 20

Adapting Man to Life in Space
Millions are being spent in seven research areas 22

MISSILE ELECTRONICS

Advent of Highly Reliable Automatic Checkout
Survey shows fully transistorized systems are arriving but conventional ones will still find uses 39

Space Observatories in Three Years?
NASA is spending $3.5 million to solve remaining obstacles to an astronomical revolution 42

THE MISSILE WEEK

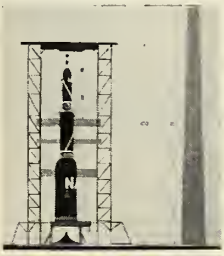
Washington Countdown 10
Industry Countdown 13
More About The Missile Week 38

DEPARTMENTS

Editorial 7
Reviews 31, 46
West Coast Industry 46
People 47
Propulsion Engineering ... 48
Contract Awards 49
When and Where 50



COVER: TM-76 *Mace* missiles on production line in The Martin Company's Baltimore Plant.



VEHICLE with thrust of 24 megatons might rival height of the Washington Monument (see p. 16).



COLLEGE students volunteers in experiment in Lockheed's simulated space cabin (see p. 22).



U.S. MISSILES dominated much of the scene at the big Paris Air show recently (see p. 24).



CHAIRMAN Overton Brooks claims his House Space Committee has broad jurisdiction (see p. 32).

on the countdown
split-second communication for split-second *action*









Launching today's highly complex missiles demands an unpre-dented degree of "team" cooperation. Hundreds of scientists, tech-cians and specialists must be kept constantly informed during all-important countdown. Instant action-getting voice communi-tions is the best answer.

An urgent call for a key man . . . an important change in fuel requirements . . . a broken control cable—all require *and get* inst-action over a DuKane "job-engineered" communications syst-DuKane systems are today providing these vital functions at Patr-Air Force Base, Fort Churchill, and White Sands.

DuKane's advanced engineering group, backed by more than years of specialized experience in the communications field, is av-able to help you plan your system. Their experience is your guar-tee of the best in communications.

For any missile base ground communications need, write or u-DuKane Corporation, Department MR-4, St. Charles, Illinois.

And, if you specify electronic equipment, ask for DuKane's Electronic Equipment Symbols wall chart . . . no obligation of course. DuKane products are installed and serviced by a nationwide organization of factory-trained experts.

DuKane
CORPORATION
St. Charles, Illinois

Job-engineered sound installations . . . Flexifone intercom systems . . . Private automatic telephone systems . . . Hosp-communications systems . . . Ionovac hi-fi tweeters and ultrasonic generators . . . Sound slidefilm projectors for educa-and industry . . . Electronic production facilities for industry and for defense.

The Matter of the Munitions Lobby

Last week we mentioned on this page that the President had used the allusion "munitions lobby" in a press conference reference which might be taken generally to encompass the aerospace industry.

We must assume that Mr. Eisenhower had considered his remarks and was conscious of the implications of such a phrase coming from him in the White House. For the record, here is the question and the reply:

Question: "Mr. President, following upon that same question, several Senators said that lately you have spoken out rather sharply to them about what you have termed the munitions lobby, which you feel has been bringing some pressure on some of the Congressmen to try to change your defense program and plan. Could you comment on that?"

President Eisenhower: "Well, I don't know who has a right to carry outside the White House any remarks I have been making, and to make those remarks public property. That is supposed to be a little bit of a private place over there, although maybe not always. (Laughter). I don't think I have used that word . . . in public. I do say this: I may have, but I am not saying I didn't, but I don't believe I have. I do say this: But there is obviously political and financial considerations gets into this argument, rather than merely military ones, and that is produced when people have to advertise very strongly about a particular thing companies do—obviously, something besides the strict military needs of this country are becoming influenced decisions."

Writing in the New York Herald Tribune on the subject, Columnist Roscoe Drummond, himself a former Marshall plan official, commented:

"In talking about the pernicious influence of the 'munitions lobby,' President Eisenhower is raising a cry which will not soon be silenced.

"It will not be silenced until the facts are spread on the record—and the sooner the better. This is a serious complaint—that big defense contractors are bringing improper pressures to bear upon Congress and upon the Pentagon in deciding what weapons ought to be manufactured.

"This is the kind of issue which can become very political, very emotional and very distracting unless it is responsibly investigated. There will be a tendency to consider everybody guilty until proved innocent.

"I am not suggesting that the President's complaint is not a valid one. What I am suggesting is that Congress ought to investigate this matter promptly, calmly and with all deliberate speed—not drag it out."

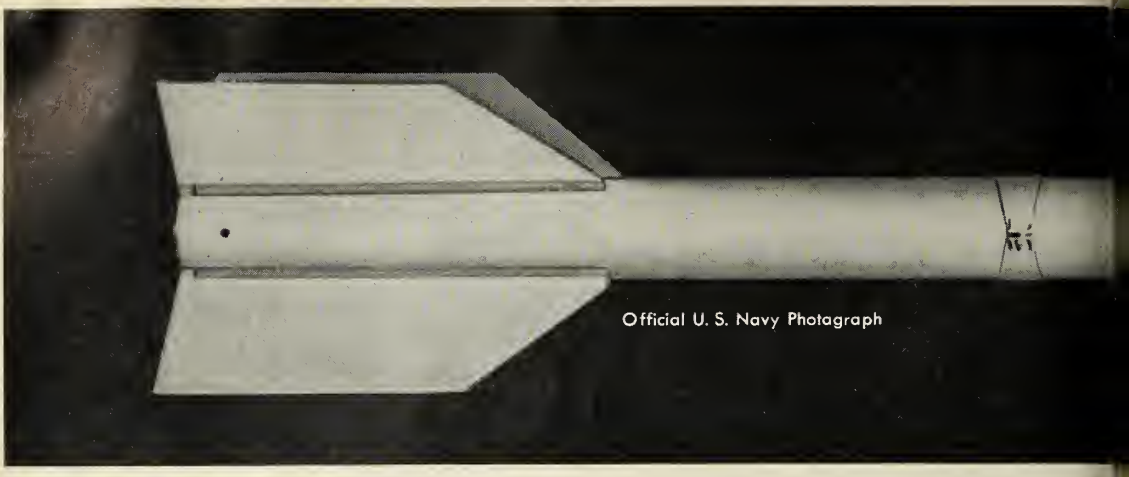
If the aircraft/missile/space industry is not seriously alarmed at this appellation—which carries with it all the connotations of warmongering, war profiteering, the German Krupp cartel—it should be. This is a term the enemies of our country would love to, and probably will, pick up and capitalize on to the fullest in propaganda aimed both at our friends and at the uncommitted nations of the world.

Actually, if there is a munitions lobby per se operating in Washingon it has been pretty ineffective. Congress has been walloping the whole aerospace industry right and left lately on every measure it has supported on Capitol Hill. But this is not the real point. The lobby label will hurt just about as much true or untrue.

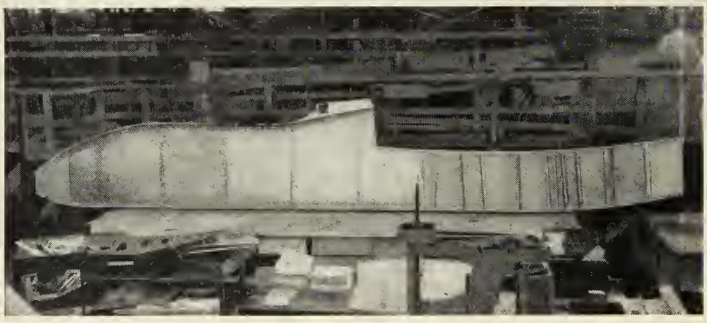
So let's indeed bring the matter out into the open. Congressman Hébert, chairman of the House Armed Services Investigating Subcommittee, opens hearings about July 6. The purpose of these hearings is to delve into the matter of the defense industry hiring retired military officers and why (see p. 15, this issue). This will bring a few headlines, but it is relatively unimportant to the greater question posed by the President's remarks: Does industry try to pressure Congress into approving purchase of weapons which may be obsolete, not needed, not the best, or unnecessarily expensive? Or, perhaps, in over-large quantities? Does this pressure extend to the military?

We would like to suggest that Congressman Hébert broaden his scope to bring the matter of the "munitions lobby" into the open where it can be examined. If it exists—beyond the scope of normal salesmanship—it would be far better to expose the sin and correct it. And if the term was misapplied that had better be understood, too, and quickly.

Clarke Newlon



Official U. S. Navy Photograph



REPUBLIC TITANIUM is used in doze[n] of structural components and details i[n] the Martin P6M SeaMaster, including e[n]tire nacelle center beams such as the [one] illustrated. Commercially pure titanium [and] titanium alloys supplied by Republi[c] increase strength and heat resistance, re[duce] weight. Republic Titanium Alloys are a[mong] the strongest produced, offer exceptio[nally] high strength values at elevated [tem]peratures.



REPUBLIC'S NEW, TYPE HS6460 METAL POWDER is ideal for sinterings of highly stressed components in aircraft and missiles. Provides minimum tensile strength of 60,000 psi at 6.4 density as sintered . . . 100,000 psi after heat treatment. Less than .004% shrinkage from die size at 6.4 density. Available in quantities up to and including 12 tons or multiples. Can be used with existing operating equipment. Mail coupon for technical data sheet.

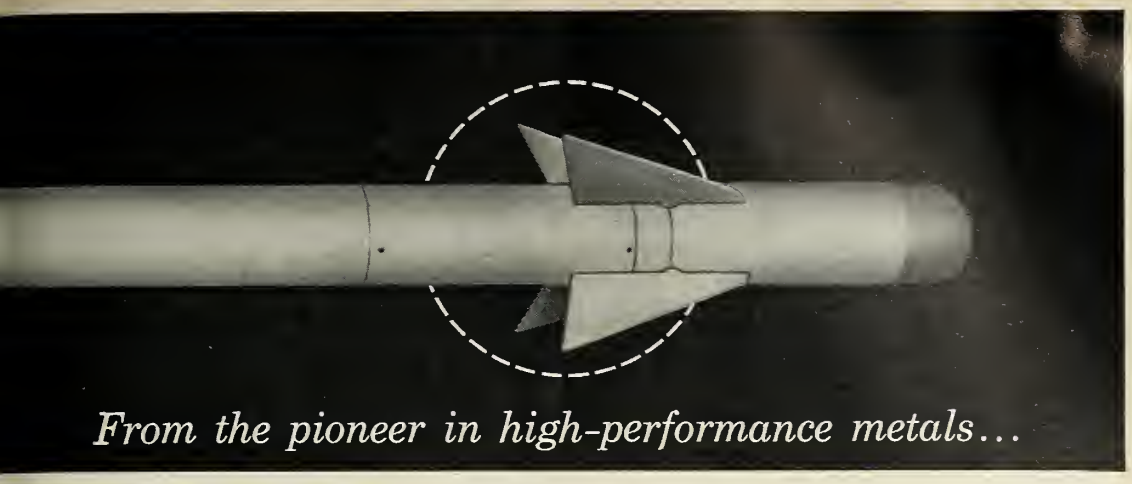


REPUBLIC ENDURO® STAINLESS STEELS—types 301 and 302—[are] currently being used by Solar Aircraft Company in the fabric[ation] of complete engine nacelles for Navy P2V patrol bombers. Sta[in]less construction offers greater strength, permits use of lighter ga[uges] increases corrosion and high temperature resistance. All types [are] readily formed into desired shapes by the usual commercial meth[ods]. Send coupon for complete information.

REPUBLIC

REPUBLIC STEEL

World's Largest Producer of Missile Metals—Titaniu[m]



From the pioneer in high-performance metals...

TYPE 4130 ALLOY STEEL FINS FOR THE SIDEWINDER

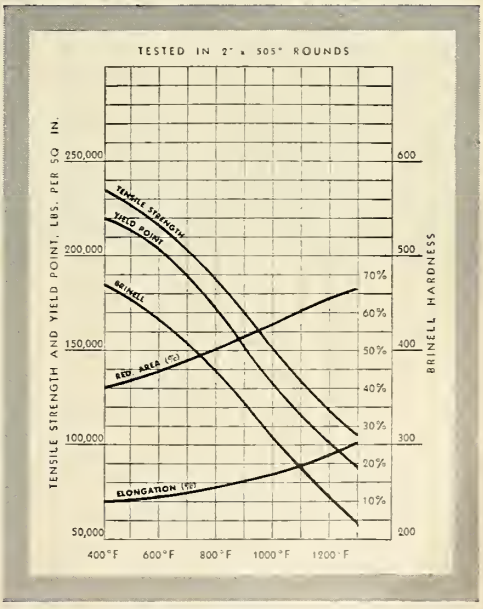
lose-tolerance, delicately contoured fins for the Sidewinder air--air missile are currently being produced from Republic Type 130 Alloy Steel by the Storms Drop Forging Company, Springld, Massachusetts. Choice of this high-strength alloy, according Storms, was dictated by extreme performance requirements.

Republic 4130 offers exceptionally high strength-to-weight tios with the highest strength values. As seen at right, tensile rength in the heat-treated condition is over 230,000 psi after mpering at 400°F., with a Brinell Hardness of 460. Uniform sponse to heat treatment assures complete deep-hardening enetration.

The Storms Drop Forging Company reports no production fficulties involved in the use of Republic 4130. Fins are produced om hot-rolled 1½" diameter 4130 bars in successive forging, ot trimming, grinding, wet tumbling, and coining operations.

Republic has pioneered in the development and production of w metals to resist heat, reduce weight, or increase strength. ith constantly expanding research as well as production facili-s and capabilities, Republic stands as the nation's largest oducer of *high-performance* metals—titanium, stainless, and loy steels.

Let us help you find the most advantageous use of these metals in *ur* project. Return the coupon for complete information without bligation. Please indicate if you would like a Republic Metalrgical Specialist to call.



TYPE 4130

REPUBLIC STEEL CORPORATION
DEPT. MS-7817
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Have a metallurgist call:	Send more information on:
☐ Alloy Steel	☐ Alloy Steel
☐ HS6460 Metal Powder	☐ HS6460 Metal Powder
☐ Stainless Steel	☐ Stainless Steel
☐ Titanium	☐ Titanium

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

STEEL

tainless Steel, and Alloy Steel

the missile week

washington countdown

IN THE PENTAGON

The Navy and Army . . .

are planning to turn the Western Pacific into a missile skeet-shooting range. Training shots from *Polaris* submarines are expected to be used as targets by the **Western Electric** *Nike-Zeus* test base being built on Kwajalein Atoll in the Marshall Islands.

• • •

The Air Force . . .

faces a possible drag-out fight over the continued development of the Mach 3 B-70 bomber and F-108 interceptor—offensive and defensive companions in future use of the ALBM. Reason: The two programs may cost as much as $20 billion.

• • •

ARPA is Working . . .

on two secret satellite programs. One is called *Samos*. The other is called *Somnium*. R&D on both is scheduled at the Pacific Missile Range.

• • •

Another new name . . .

to watch for is Project *Notus*. This is the ARPA code name for a whole series of communications satellite programs including *Courier* and a 24-hour satellite.

• • •

Some nuclear-power experts . . .

are saying that Project *Rover*—the program aimed at developing a nuclear-powered rocket—is headed in the wrong direction. They contend more money should be spent on developing propulsion from controlled nuclear explosions. *Rover*, based on heating a propellant with a nuclear reactor, claimed a successful first test firing June 20.

• • •

ICBM's fired by training crews . . .

at Vandenberg AFB, Calif., will be aimed at bulls-eyes located between the islands of Wake and Eniwetok and Wake and Midway. The bulls-eyes have a radius of 10 miles and are equipped with hydrophones for measuring the accuracy of firings. Range equipment has been in operation since last month.

• • •

New basic research program . . .

being started by ARPA in search of new and exotic materials for missiles, spacecraft and other defense needs is expected to cost $15 to $20 million in FY '60—possibly double that in FY '61. Details are still to be worked out.

ON CAPITOL HILL

Blistering new report . . .

can be expected soon from the House Inf mation Subcommittee. It will give details some 50 refusals by the Administration release unclassified information—mostly connection with defense matters. Operati of the Atlantic and Pacific Missile Ranges expected to be singled out.

• • •

Greater pressure for . . .

a tough freedom-of-information law may sult from the report. Many congressmen ready are considering a proposed fede public records bill. It would force officials defend keeping something secret rather th the current reverse practice.

• • •

No matter what . . .

the final congressional decision on the s called "master plan" for air defense, ba issues involved remain unsettled. Some of t questions still to be answered: What servi is in charge of air defense? What defer does the United States have against a Sov Mach 3 bomber or a nuclear-powered bomb armed with ALBMs? Is the U.S. AICBM pr gram moving fast enough?

AT NASA

John W. Crowley . . .

head of NASA's office of Aeronautical a Space Research, will retire at the end of t month. Taking his place will be Ira H. Abb Assistant Director of Research. Milton Ames, Chief of the Research Division, w take Abbot's position.

AROUND TOWN

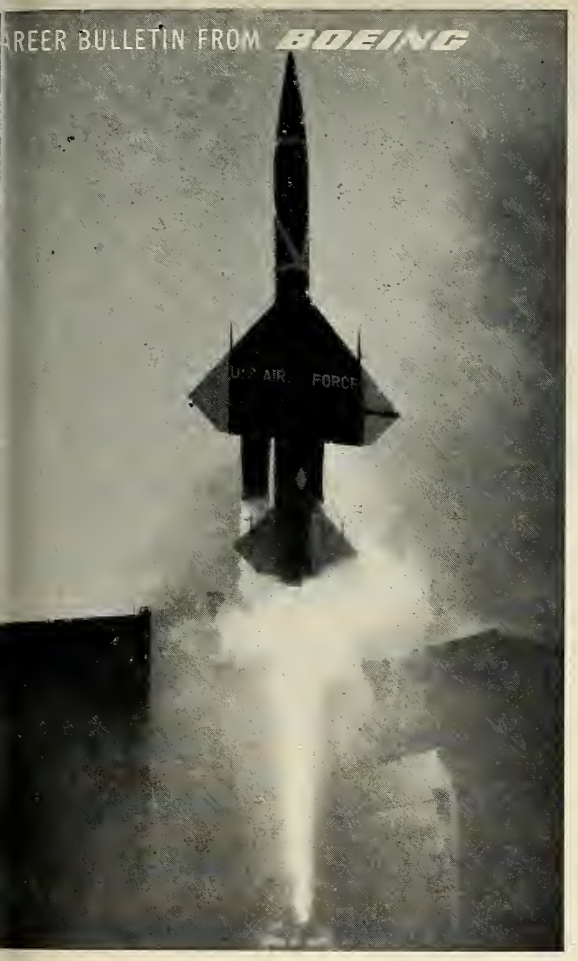
Some of the reports . . .

that are being passed as the "latest" in t nation's capitol:

. . . The advent of the **Boeing** *Minutem* and the era of ICBM-plenty will result in new blooming of U.S. isolationism.

. . . Continuing Navy pressure for a gre er role in space will lead to a new int service fight over military missions.

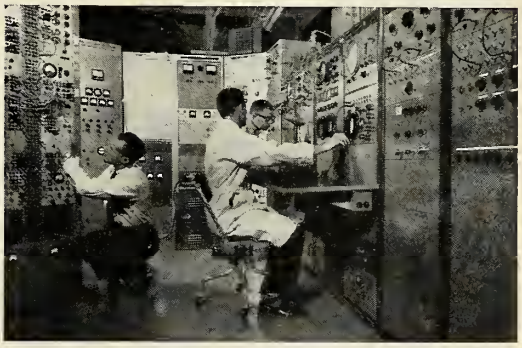
. . . Efforts to reach advance East-W agreement on such issues as internationaliz tion of the moon are considered dead a any early resurrection is considered unlikel



BLAST-OFF of supersonic Boeing BOMARC, the nation's longest-range defense missile. Now in volume production for Air Force bases under construction. Other Boeing missile projects that offer engineers and scientists outstanding career opportunities include Minuteman, an advanced solid-propellant intercontinental ballistic missile system.



SPACE-AGE projects are expanding at Boeing. Above is human factors laboratory in which problems of providing environments and controls for space vehicle crews are investigated. Celestial mechanics, lunar orbital systems and interplanetary systems are other areas that offer long-range space-age career opportunities to qualified engineers and scientists.



BOEING-DEVELOPED electronic counter-measures simulator, part of huge electronics installation. Boeing research and development facilities are the most extensive in industry. They could help *you* get ahead faster. Look into Boeing opportunities available now, in Research, Design, Production and Service.



SAILBOATS on Lake Washington in Seattle, boating capital of the U.S. Boeing headquarters are located in evergreen Puget Sound area, world famous for fresh and salt water boating, fishing, hunting, camping, scenic forests, dramatic snow-capped mountains, mild year-round climate. Wonderful Western living for the whole family!



Write today, *for your free copy of 24-page booklet, "Environment for Dynamic Career Growth." It pictures the career areas and advantages that could assure* you *a brighter future.*

Mr. Stanley M. Little,
Boeing Airplane Company,
P. O. Box 3822-MID, Seattle 24, Washington

Send me the Boeing career booklet by return mail.

Name .....

Address ..... City ..... State .....

Degree(s) ..... Field of interest .....

Experience .....

BOEING



AIRBORNE...NEW USAF T-38 TALON!

The T-38 Talon fills a vital requirement of the Air Training Command. It is a lightweight, low-cost aircraft in which our new generation of space age airmen can safely master the art of supersonic flight.

Pioneering a new Northrop family of economical manned aircraft for the space age, the Talon is a direct result of teamwork between Norair and suppliers. This T-38 Team that made the trainer a reality is now producing it under USAF contract at Hawthorne, California. Soon to follow is the N-156F multi-purpose fighter, American-designed for our free-world allies.

The T-38 Talon stands as the latest airborne evidence of Norair capability and production know-how. Norair's creative management further adds to the accomplishment by trimming production costs with methods that include PACE — the unique Performance And Cost Evaluation program; new and superior quality controls; and Norair-conceived, years-ahead production techniques.



NORAIR Hawthorne, California
A Division of **NORTHROP CORPORATION**

industry countdown

STRUCTURES

Dyna-Soar Goes to Boeing

This is the latest word which M/R has garnered from sources in AMC, ARDZ, and USAF headquarters.

Here are the believed facts.

Team headed by Boeing is the victor. Sources say—and this is confirmed by M/R—that announcement of awards is closely guarded secret.

DOD confirmed that a "blanket" press release has been made—listing both Martin and Boeing.

Look for General Motors . . .
to move much deeper into missiles in the next two or three years. GM's defense business has shrunk from 20% of its volume in 1953 to about 4.5% today. Recently upped from chief of the Cleveland tank division to director of GM's **Military Products Division,** Harold R. Boyer has been handed job of whipping GM's far-flung manufacturing interests into a "team" to bid on entire missile systems—though GM presently lacks a rocket propulsion division. New organization may be centered around **A.C. Sparkplug Division** which has *Titan* inertial guidance. Says Boyer, "Our approach is for the long haul." Is GM eyeing any particular system now to bid as a prime? "No," says Boyer, "we are preparing for the future." But he indicates GM is already gearing to expand its subcontract defense operations.

• • •

Proposed service-wide TIF . . .
(missile/aircraft support equipment technical information file) reaches a critical point at July 9-10 meeting in Penatgon. Ad hoc Army-Navy-Air Force study group will attempt to iron out a system for collecting data, printing and distributing the catalogue which would be patterned after the new AF TIF (M/R June 15, page 21). Agreement will be necessary before DOD will proceed to next step—evaluation and funding.

• • •

Small businesses . . .
looking for government R&D contracts must file a Form 449 with SBA by July 17 to be included in the agency's new directory. The directory is used by government purchasing agents and prime contractors and is also made available to private industry.

Ablating beryllium shields . . .
six feet in diameter and one inch thick are being fabricated by Alcoa for two of NASA's *Mercury* space capsules on 50,000-ton press. Material is being supplied by **Brush Beryllium.**

• • •

McDonnell's *Mercury* contract . . .
calls for fabricating 12 space capsules. If NASA puts a man in space on the first try, what happens to the remaining 11? Says Wilson H. Hunter of NASA's Lewis Laboratories, "we may use extra capsules to train a corps of spacemen."

PROPULSION

***Atlas* launching system . . .**
employs a brace of pneumatic release cylinders produced by **Western Design Division, U.S. Industries Inc.,** which exert holding force of 836,000 pounds when engines are fired. Force is reduced to 416,960 pounds within .35 seconds. As missile lifts, during next .4 seconds, holding pressure drops in each release cylinder to 7600 pounds and pistons move 4 inches. Pistons then ride free 42 inches before cylinders break away from missile by means of surface cam-actuated segment lock.

• • •

Officials of Thiokol's . . .
Longhorn Division at Marshall, Texas, report passage recently of the two millionth accident-free man hour by division's 1400 employes.

ELECTRONICS

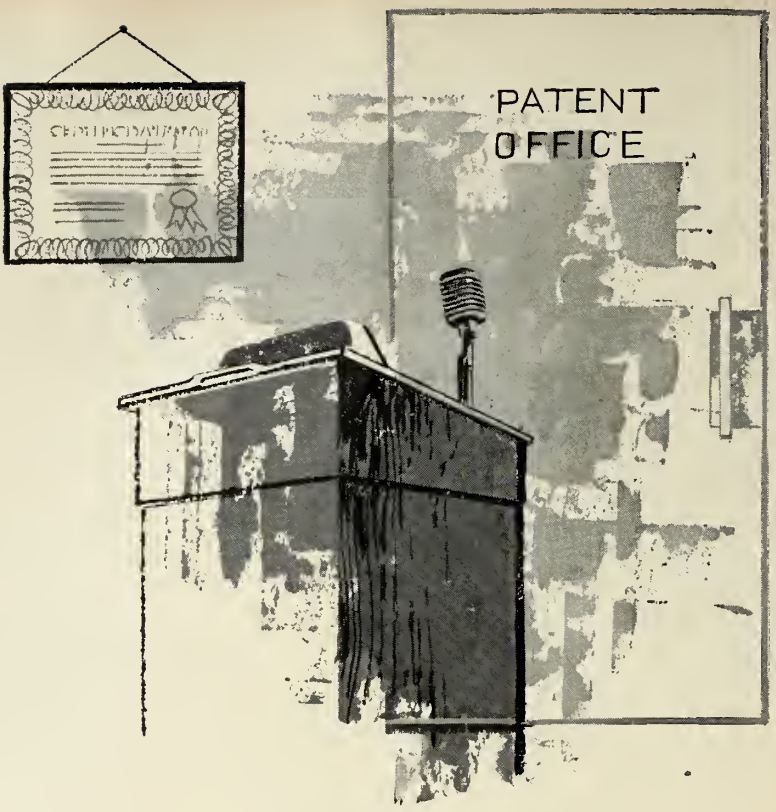
Under development . . .
by **Bell Laboratories,** an "improved" *Nike-Hercules* guidance system utilizing 68% parts common to *Hercules* and 32% new parts.

• • •

If and when *Nike-Zeus* . . .
is committed to production, guidance will be tested on **Chrysler** *Redstone* and *Jupiter* targets. Detroit missile makers believe a follow-on order for *Jupiters* is in the works and may be announced shortly.

ASTROPHYSICS

Huge Navy radio telescope . . .
being built at Green Bank, W.Va., theoretically will be able to peer 38 billion light years into space. Steel and aluminum dish weighing 20,000 tons will be more than 600 feet across; will have a 100-foot antenna in its center. Project (called Operation Big Dish) will cost $79 million.



How far can an engineer go at AC?

Inertial Guidonce Systems
•
Afterburner Fuel Controls
•
Bombing Novigational Computers
•
Gun-Bomb-Rocket Sights
•
Gyro-Accelerometers
•
Gyroscopes
•
Speed Sensitive Switches
•
Speed Sensors
•
Torquemeters
•
Vibocoll
•
Skyphone



If you are a graduate engineer in the electronics, electrical or mechanical fields, you a recognized as a *professional* when you work in AC's instrumentation business.

AC encourages you to write and present papers at professional society meetings. Wha more, if your original research and experimentation leads to new inventions, AC w assist you in obtaining patents.



You can also enhance your status through advanced training. AC offers three speci "in house" programs—for recent graduate engineers, for experienced engineers and f engineering supervisors. These practical courses constitute AC educational "extras" an are second to none in the country. They're offered in addition to the AC and Gener Motors educational assistance programs for men who wish to take additional studies nearby universities.

These are just a few of the advantages you'll enjoy while you work on AC's famo AChiever inertial guidance system or a wide variety of other electro-mechanical, optic and infra-red devices . . . for today and the "space age."

Step into the "space age" with the greatest name in industry . . . General Motors. Ju write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oa Creek Plant, Box 746, South Milwaukee, Wisconsin.

AC SPARK PLUG ✻ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Can Congress Define 'Influence?'

by James Baar

WASHINGTON—Some 2500 years ago mart Greek named Plato and some his chums stood around Athens and d to answer the question: What is uence?

The House Armed Services Investi- ions Subcommittee will take another ck at the problem next month with red high-ranking military officers, ense contractors and the Pentagon he heart of the discussion.

The subcommittee—headed by Rep. Edward Hébert (D-La.)—began paring for the investigation more n a year ago in conjunction with rk on its current investigation into weapon system management con- t.

But the full-scale public hearings eduled to open about July 6 received ir present headline status from a nber of most recent developments:

• The bitter, drawn-out fight over *narc* and *Nike-Hercules*.

• President Eisenhower's "attack" "the munitions lobby."

• The House defeat by only one of a proposal by Rep. Alfred E. tangelo (D-N.Y.) aimed at barring ense contractors from employing ior military officers for five years r their retirement.

At this point, Chairman Carl Vin- (D-Ga.) of the House Armed vices Committee directed the Hébert committee to proceed promptly h its investigation. He said it should lude retired federal civilian officials well as ex-military officers.

Vinson, who has shown growing dis- asure with defense contractors, urged ctment of any remedial legislation t might be needed.

• **Flood of questionnaires**—The bert Subcommittee responded by ding thousands of questionnaires to nation's 100 top prime defense con- ctors who have 75% of the gov- ment's defense business. It then sent ilar thousands to some 600 prime tractors who have the other 25% to some 30 defense industry as- iations.

All were asked to have all retired itary officers on their payrolls above Army-Air Force rank of captain the Navy rank of lieutenant fill out forms. They also were asked to e all former Federal employes who n more than $10,000 a year and o have retired within the last five rs fill out special civilian forms.

In essence, the questionnaires ask: Just what do you do? And what are you getting for doing it?

They put it this way:

"State whether you have solicited or participated in any discussions, oral or written, concerning sale, use, adaptation, modification, improvement, suitability, development or research of any article, plan, process or program with any officer or employe of the Department of Defense at any time since your retirement, and at any place, on behalf of any company, organization or yourself."

"If your answer to the foregoing question . . . is 'yes', state the subject of such discussions, conversations or writings, identify the persons with whom the exchanges took place or the circumstances under which they occurred."

"What compensation or remuneration, direct or indirect, in money or anything of value, are you receiving or have you received for the service performed?"

• **What's taboo?**—Behind these questions are the already-enacted laws restricting both retired military and civilian officials in their dealings with the Federal government.

All military and civilian officials are banned for two years from selling to the Department of Defense. Moreover, retired military officers are prohibited forever to sell anything to their former service. And retired Navy and Marine officers must forfeit retirement pay at any time that they are engaged in defense selling. Penalties for violations range to a maximum of a year in jail and a $10,000 fine.

But the crux of the problem is: What is selling? And this comes back to the question: What is influence?

Santangelo, in arguing for his proposal, told the House: "prominent military figures in retirement can have a great influence over their former subordinates."

"Persons within the department who may be looking forward to possible employment within a certain organization after retirement can display partiality and favoritism without ever realizing it," he said.

"Contact at social and professional gatherings between active and retired officers can provide a perfectly natural setting for influence and favoritism."

Maybe so. But Defense Secretary Neil H. McElroy told a news conference the Defense Department is not aware of improper influence by retired military officers.

Also, he said "retired officers of our military services have done very good work in behalf of defense production." And he warned against loss of retired officers' "minds and their experience."

Rep. Samuel Stratton (D-N.Y.) warned the House during debate on the Santangelo proposal that by passing it "we would be throwing out the baby with the bath."

• **What will happen?**—The Hébert Subcommittee will analyze its questionnaires and add the results to considerable information already in its possession. Then it will call in the witnesses—almost certain to be mostly a parade of retired generals and admirals.

The investigators will try to determine not only whether retired military officers have attempted to influence military purchasing, but also:

• Were such attempts—if made—successful?

• Does a "munitions lobby" really exist? If so, who are its members? (Only about three dozen names connected with the defense industry appear on the list of hundreds of registered lobbyists.)

• If changes are needed, how can they be made without causing more harm than good?

Hébert has repeatedly promised a high-level investigation conducted in all fairness. But the pressures to turn it into a headline-making circus will be great.

Several Congressmen—none members of the Hébert Subcommittee—have already released long grab-bag lists of retired military officers employed by defense contractors. One list included a retired officer who heads his firm's plant hospital.

Also, take this sample of possible testimony for example:

Q: "Admiral (or General), did you have lunch April 1 with Admiral (or General) Jones, a key figure in the XYZ contract decision?"

A. "Yes, but we only talked about golf and baseball."

What might be made of this exchange in the glare of TV lights and headlines? But even worse, what fair judgment can be passed in such matters? Was influence exerted?

This is the problem the Hébert Subcommittee and the defense industry face.

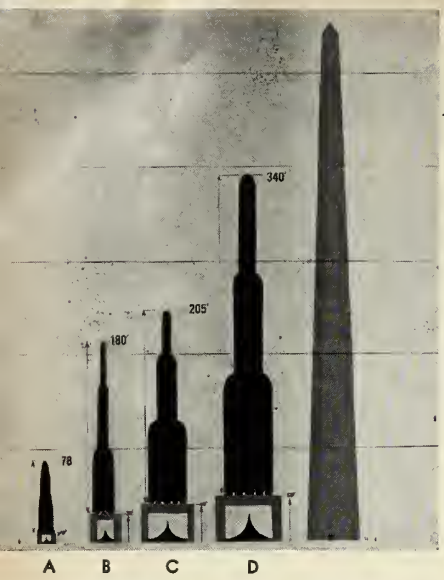


FIG. 1—Imaginary family of vehicles starting with *Atlas* compared with the 555-foot Washington Monument.

How to Handle 24-Megaton Thrust?

Special logistics will be needed for 1.5 million pounds-plus boosters

by Chauncey J. Hamlin Jr.*

LOS ANGELES—What are the support problems entailed in handling and launching a 24-million-pound-thrust rocket of the future?

The whole new generation of boosters of over 1.5 million pounds will involve special logistic requirements for transporting the rocket from the factory to launch site, erecting and completely preparing it for flight.

In setting forth some of these problems here, it is proposed to stimulate thinking on logistics in this large vehicle area and call to the attention of preliminary designers some of the problems associated with size. This discussion, moreover, will be confined to chemically fueled multi-meg rockets.

Since these systems will be very costly, every effort should be made to simplify ground handling problems. For instance, the cost of developing the prototype ground support equipment for the *Dyna-Soar* has been estimated at $60 million. As the size of the vehicles continues to increase, handling cost will go up proportionately.

One of the best ways to keep costs down is to consider handling and other logistic requirements as part of preliminary design. If planning in this area is started early in the game, simplified concepts of handling can be built into the system with appreciable dollar savings.

A 1.5-million-pound-thrust chemically fueled rocket powerplant is under development and will be available in the very near future. The development of engines with up to 20 million pounds of thrust is predicted in the early 1970's. Dan Kimball, president of Aerojet-General, makes a similar forecast in referring to rocket engines having "10 or 15 million pounds thrust."

• **Growing family**—To appreciate what these thrusts mean in terms of overall rocket size, consider Fig. which depicts a family of rocket-po ered vehicles, starting with the famil *Atlas* and increasing in size by m tiples of 4. This imaginary family, rived for the sake of size comparis is based on the following assumptio present state-of-the-art chemical fu with an impulse in the 250-260 s range at sea level, a mass ratio of 0 an initial acceleration of 0.3 g, and overall propellant specific gravity of



FIG. 2—Gantry with elevator would permit lifting upper stages and slid lower stages under them, structure rising as successive stages are install

*Corporate Development Planning Staff, North American Aviation, Inc.

en the thrust reaches 24,000,000 nds, the vehicle envelope approaches of the Washington Monument, a ewhat unbelievable structure.

What then are the principle new s of logistics facing the operator of a vehicle? First, there is the prob- of how to get a large booster from factory to the launch site. There severe limitations on current con- ional means of transportation by oad, highway or air transport. Size rictions of tunnels and highway passes make it obvious that any or structure with a diameter ter than 10.7 feet will require spe- handling.

A diameter somewhat in excess of feet can be transported over the on a trailer, but special permits special routing are required. Here here a look at handling problems y in the design phase will pay off. ecomes apparent that for conven- al transportation the design will re- e breaking the frame down into nents for shipment.

• **Where to build it?**—One alterna- of course, is fabrication at the ch site. Evaluation of the pros and of building block construction and of shipment versus construction he launch site should be made be- vehicle designs are finalized. ght penalties associated with mul- tank construction should be eval- d against the complexities of ch site fabrication. Fabrication at otely located launch sites such as e of those proposed for equatorial chings may prove far more costly he over-all program than the loss in performance associated with a booster built up of easily-transportable components.

For instance, an equatorial launch site where average temperatures are 80° and the relative humidity is between 80 and 90%, would require large air conditioned shops, would be far from normal industrial supplies and would require all of the necessary housing, etc., for the working force, which in itself would be difficult to recruit for such a location.

• **By water**—Another alternative exists where the frame manufacturing plant is located on a waterway and the bulky parts can be transported completely assembled by barge or ship, to a launching site that is also adjacent to port facilities. As a matter of fact, if taken into account during the initial planning phases, water transport of large boosters may easily determine the location of launch sites and manufacturing plants in a manner which could materially reduce the overall cost of a program.

Add to the ease of handling by marine methods the desirability of launching over water for safety considerations and launch sites adjacent to marine facilities appear highly desirable. In some recent studies of equatorial launch sites, the proposal has been made to utilize the highest ground available, often 2-3000 ft. above sea level for launch pads. I believe that a look into the future would relocate these to sea level at a great saving in cost.

• **400-ft. gantries?**—Having arrived at the launch site, the operator next faces the problem of erecting and servicing the rocket. To erect and service a 340-foot 24-million pound thrust vehicle standing on a 50-foot launching and flame deflector platform will require a gantry in excess of 400 feet high. The question immediately arises —is it practical to consider a structure this size? And if so, is it practical to move it away from the rocket for launching or will the ship have to be fired from within the structure?

In launchings from within the structure, exhaust flames can do extensive damage if vector control requires deflection of the jet onto the gantry. Wind drift during initial flight at low acceleration can endanger the rocket due to collision with the gantry. The complexity and cost of this system forces us to look for an easier way out.

• **Alternatives**—What avenues are there? One is to use a gantry with an elevator and, instead of stacking the upper stages upon the lower as is presently done, lifting them up and sliding the lower stages in beneath, so that the structure rises above the gantry as successive stages are installed (see Fig. 2). In this instance, the upper position of the elevator platform would only have to be high enough to permit the largest continuous section to be rolled into position beneath it.

Approaching the problem from a different angle, let us consider assembling the vehicle in a hole as shown in Fig. 3. The size and complexity of the gantry can be greatly reduced. By the time this rocket reaches the flight test stage, we shall have had a great deal of experience in launching missiles



3—Assembling vehicle in hole d cut gantry size complexity.

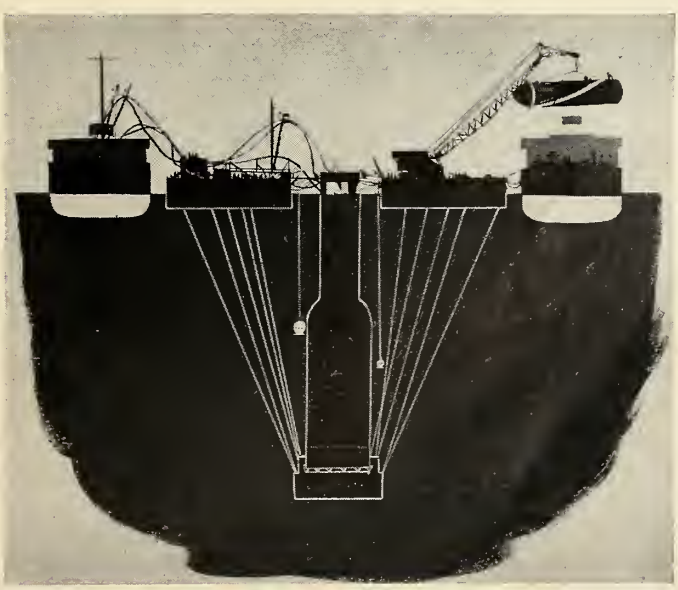


FIG. 4—Submerging missile in ocean is another possibility. As with the hole, the vehicle here could be raised to tbe surface for launching.

from holes in the ground, i.e. *Minuteman* and *Titan*. Of course, the complexity of constructing the hole and launching from it will have to be weighed against surface launching. After the rocket ship has been assembled in the hole, the possibility exists of raising it to the surface for launching if subsurface launching proves impractical.

Another scheme might be to submerge the missile in the ocean as shown in Fig. 4. Experience gained in underwater launching of the *Polaris* will provide many of the answers to submerged launching problems. Again, as in the case of the hole, the vehicle could be raised to the surface for launching.

It would appear at a first glance that the equipment associated with submerged or waterborne launching would be far less complex and costly than other types. Shipyard handling techniques already well-developed are available and the entire facility could be afloat. An added advantage of such a launching arrangement would be the ability to use it at many different locations, depending upon the mission of the flight, since it could be towed from one site to the next.

Another means of reducing the handling problem is to minimize the overall vehicle height by designing the stages to telescope into one another. Such a rocket would be rather squat with poor aerodynamic qualities, but these drawbacks might easily offset the cost and complexity of stacking one stage upon the other.

• **Two million gallons**—With the missile erected on the launching platform, cleaned, checked and ready for propellant loading, we are still faced with quite a problem in logistics insofar as our 24-million-pound-thrust giant is concerned. Approximately two million gallons of propellant must be pumped into the tanks. Servicing by conventional highway transport tank trucks would require the capacity of 666 such vehicles or 200 standard railroad tank cars. The problem of moving this equipment in and out of the launching area is immediately evident.

Again, a dock-side launch site appears superior, as propellants could be pumped directly from ocean-going tankers standing offshore. So far, only liquid propellant engines have been considered. If solids are to be used in these large vehicles, it would appear that they will probably have to be loaded at the launch site in much the same method as liquids, in order to simplify handling problems. High-capacity continuous mix processes will have to be developed for this purpose.

• **Boarding**—The problem of servicing the upper stages and putting the crews aboard in the case of rocket ships which are erected without the use of full-length gantries, or after the gantries have been removed, must be solved in an economical manner. The crew in particular should be boarded at the last possible moment, so that they are not subjected to extended periods of waiting.

One of the best ways to accomplish this for ships that are not too tall would be the use of cranes with lightweight aluminum booms. If height becomes excessive, helicopters with personnel platforms suspended by cable could be employed. It might even be possible to suspend a lightweight elevator sustained by means of captive balloons. (see Fig. 5).

In considering logistics for large rockets of the future, reliability of all phases of the equipment should claim first place—with overall system cost, a close rival. In general, the speed of launching preparations will not be an objective for nonmilitary missions—equipment can be kept unsophisticated and to a large degree, manually operated. Cost can always be kept to a minimum by using standard equipment when available. Design can always be simplified if a piece of equipment is not required to perform too many functions.



FIG. 5—Helicopters or balloons might be used for boarding crew members.

Medaris Gives His Basic Procurement Philosophy

DETROIT—An Army general r cently explained to the missile-spa industry the procurement philosop which governs the intelligent expen ture of some two billion dollars a nually in support of the Army's miss programs.

Maj. Gen. J. B. Medaris, comman ing general of the Army Ordnan Missile Command, addressed the se ond annual Industry Missile and Spa Conference here.

General Medaris' Command is r sponsible for 14 major missile systen including their ancillary equipme from the inception of the progra through production, fielding, supp and maintenance of the systems so lo as they remain operational.

• **Basic points**—The general su marized a one-hour presentation w "a few basic points of basic philosop that I consider far more essential th any matters of procedure:

1. "The procurement activity m support directly all of the work of parent organization, whether that wo be directed to development, to produ tion or to follow-on support of miss systems.

2. "All of our activities in procu ing goods and services must be bas on a firm, positive, and knowledgeal control of the work to be performed.

3. "In dealing with all segments industry and research activities, it our objective to be fair, but not to generous.

4. "The contractor selection, in th difficult area where only a minority our total needs can be so defined as permit standard sealed-competitive bi our selections must be founded on cold-blooded and objective apprai of the requirements to be met, of t realities of time and money requi ments, and of the capability and abo all the reputation for effective resu as applied to each contractor co sidered.

5. "By single and tightly coord ated management control, we must sure the maximum effective telesco ing of all of the finished activities volved in fielding a weapon syste keeping in mind that the effectiven of the system is strictly related to time of availability, and requires th the longer a program continues t higher the total cost."

Gen. Medaris added that "no w pon system development is worth c time or the taxpayers' money unless an end product we will have a syst that is effective when it hits the fi and for a reasonable period thereaft that is usable by the troops, and th is economical . . ."

Priority Rules Are Revised

by Betty Oswald

WASHINGTON—Manufacturers of ellites and intermediate and long-ge ballistic missiles will continue to a priority rating to get the equip-nt and materials they need to pro-ce in accordance with military sched-s.

The bottleneck-breaking priority X) is part of Defense Materials tem as it will be revised by the siness and Defense Services Ad-nistration shortly after July 1. The v rules will be effective in the third endar quarter which starts Oct. 1.

They will continue to provide ma-nery for distribution of steel, cop-and aluminum to defense contrac-s on a simplified basis. Nickel alloys d aluminum molten metal, foil and wder have been made controlled ma-ials.

Non-nickel bearing stainless steels ve also been made controlled ma-ials, but all steel castings, includ-stainless steel castings and nickel oy castings, have been deleted from list.

The decision to maintain and revise system followed conferences be-een Business and Defense Services lministration of the Commerce De-rtment, which administers the pro-m, and some seven industry groups cluding aircraft and electronics in-stry advisory committees. It was edicated on the belief that the ma-nery is needed to determine the use tterns of materials by defense con-ctors which help to set stockpile re-irements and the controls which uld be needed in the event of a ure mobilization program.

The system is also called necessary identify defense orders so that when ivery problems arise as a result of rtages, strikes or bottlenecks involv-materials or components, action n be taken to expedite deliveries. In 55, when defense contractors were ting more metal because of higher duction rates, some 8000 cases were ndled by the BDSA in efforts to get contractors what they needed. The rrent load amounts to about 4000 es annually—without counting the ormal expediting actions taken by my, Navy and Air Force under the hority provided by the Defense Ma-ials System.

• **Background**—DMS had its gen-s in the Controlled Materials Plan World War II and its revival, in dified form, in the Korean War. Basically, it's a method of distributing steel, copper and aluminum in mill forms and shapes to defense contractors and manufacturers of essential civilian goods. In a sense, it can be described as a rationing system.

However, experience has taught that it takes about a year to make the system work efficiently if statistical information is not available to show both the pattern of production of controlled materials and their consumption. After the Korean War, it was decided both by Government and industry that the system ought to be maintained on a modified and relaxed basis so that there would be no long time-lag in the event of another war or mobilization.

About six years have gone since the establishment of DMS, during which the Congress has continued the Defense Production Act on which the system is based. Relatively few changes have been made in DMS up to this point, although many have been suggested both by Government and industry.

• **Simplify and clarify**—Current changes are aimed at simplifying the rules without losing the priorities and statistical features of the system as well as the basic control machinery which could be made effective in the event of need. Second objective is to clarify certain gray areas and spell out the rules in black and white.

Among the major changes planned are a simplification of the definitions. Perhaps the most important of these changes makes construction and research projects a part of the Class A products, for which direct allotments of materials can be made. Industrial service operations are made Class B products, which are handled on the basis of automatic allotments.

Contractors will no longer be troubled with the problem of authorized production or construction schedules on which allotments were based. Under the new rules, the right of defense contractors to rate their orders and to an allotment of controlled materials flows from a rated order or contract or from a specific authorization.

Allotments of materials will be made under the new rules by the alloting agencies (Defense Department, Atomic Energy Commission, etc.). Prime consumers will no longer be permitted to make allotments to their subcontractors. Use of allotments, ratings or self-authorization by producers of Class A or Class B products having rated orders is mandatory except for purchase orders of $100 or less.

Purchasers of controlled materials are required to furnish suppliers with a prescribed statement that DMS rules must be followed in all cases where orders are placed for Class A or Class B products or authorized controlled materials orders.

Producers of Class A and Class B products extend their ratings to their suppliers.

• **Use of symbol**—As far as the bottleneck-breaking DX symbol is concerned, contractors are now required to use it and controlled materials producers are required to schedule the authorized controlled materials orders so identified without regard to lead-times or to set-asides set up under various production orders.

There will be a new schedule listing the authorized program identifications and alloting agencies. In addition, there will be a schedule containing a form for submitting a statement of controlled materials requirements when requested. However, unless there is a drastic change in current thinking, this request is not likely to be made very often.

BDSA is also trying to make the system more palatable for the controlled materials producers. Maintenance of the system is being described as a kind of insurance policy. The premium is represented by the cost of bookkeeping and related procedures involved.

William C. Truppner, Director of the Office of Industrial Mobilization, in summing up the decision to continue DMS, said that it was the intention of the Government to assure a top priority for ballistic missiles and satellites on the books of the controlled materials producers who are required to schedule orders for these programs, regardless of set-asides or leadtimes. However, an escape clause is provided which says: "Unless it is impracticable for him to make delivery within the required delivery month in which event he must accept such an order for the earliest practicable delivery date."

Generally speaking, the producers of materials prefer DMS as modified to a priority system. However, most of them believe that BDSA must do a better job of educating the contractors and distributors, so that the system works with a minimum of waste motion.

A Crisis in Range Instrumentation

AFMTC commander says more funds and effort must be expended to cure the rapidly widening time bottleneck

by Maj. Gen. Donald N. Yates
Commanding General, Patrick AFB

Mr. Chairman and members of the American Rocket Society—I wish to commend you on the organization of a Committee on Logistics and Operations. I think it is quite significant that the American Rocket Society now extends their concern over a broader area than just the research and development aspects of rocketry. One of the support areas of concern to the Committee on Logistics and Operations has a direct bearing on the success of the research and development program. This area needs attention and emphasis by the American Rocket Society and by the missiles and space vehicle community at large. The subject is the range instrumentation of the future.

The Air Force Missile Test Center has pointed with considerable pride to the fact that it has been able to grow and expand in pace with missile developments of the last ten years, particularly since the emphasis was placed on ballistic missiles during the last five years. The growth at the Atlantic Missile Range has been phenomenal, and we are proud that the vast majority of test data requirements have been met, on time, with instrumentation of the required precision and reliability.

With the spotlight logically enough resting on the missile programs themselves, it is only natural that supporting facilities, such as are provided by our range and its instrumentation, are too often taken for granted. It is a fact that for the past five years we have been driven into a frantic race with missile performance in our job to provide instrumentation of commensurate performance. We must match each masterful achievement in vehicle performance with an equivalent achievement in instrumentation performance.

• **Gaps to come**—Whereas our best instrumentation may suffice today, it falls far short of the requirements for the future. I see a gap forming which becomes wider upon close comparison of our future measurement requirements versus the state-of-the-art in data acquisition. For example, in electronic tracking we are being asked to improve our accuracy, not by a factor of two or three, but by one order of magnitude, to accommodate a second generation missile soon to be tested.

Explorations in space will bring about their own family of requirements which, a few years hence, will probably relegate today's space-tracking equipment to the class of primitive first attempts. There can be no question about the need for increased emphasis on instrumentation development. Our ability to advance in both ballistic missile and space work may, in fact, be determined by our achievements in the field of instrumentation development.

• **Past build-up**—When we began the build-up of the Atlantic missile range in 1950, we were able to draw upon the developments that had been achieved during World War II. With some improvements, the instrumentation equipment then available was adequate to meet the requirements imposed for the long-range cruise missiles and short-range ballistic missiles of that time period. Modified SCR-584 fire control radars, telemetry equipment constructed in accordance with RDB standards of 1947 and command co trol equipment used for drone conti during the late 40's, provided the ran with instrumentation that served well for a number of years.

The rapid build-up of our ICB programs beginning in late 1954 i posed significantly more stringent r quirements on instrumentation. The programs required far more accura position and velocity measuremen than had previously been necessa and at substantially greater slant ran distances. The telemetry requiremen increased in quantity, but fortunatel not very much in complexity. As wi the cruise missiles, it is still necessa to measure the actual impact locatic with great accuracy at distances of u to 4400 n.m. from the launching poin The limitations of our instrumentatic system to measure the actual impa location made it necessary to establis impact points adjacent to inhabite land masses. This, in turn, impose severe range safety problems and r quired the establishment of mo sophisticated range safety instrumenta tion.

In order to meet the requirement imposed by the ballistic missile pr grams, we exhausted the backlog th had been accumulated from our wa time developments. We were har pressed to meet many of the require ments of the ICBM programs. We wer oftentimes forced to use an assortmer of instrumentation systems obtaine from various sources to meet a singl requirement. In some cases, compro mises in missile test requirements wer made due to the exorbitant costs in curred by the use of these assorted an extensive systems.

• **Scraping the barrel**—We are no at the bottom of the barrel, so t speak, in instrumentation development We would like to initiate a majo development effort on a new trackin system during this fiscal year; however funding limitations have dictated tha

Editor's note—Due to the critical importance of adequate range instrumentation in the progress of our missile program, M/R feels this paper presented at the recent American Rocket Society meeting is of extreme interest to all in the missile business. General Yates points out the gaps in present instrumentation technique and equipment, the results of our inattention to the problem, and what must be done immediately to narrow the ever-widening gap.

must be deferred.

We must get this equipment developed and installed on the range if we are to meet presently known requirements. It is not difficult to foresee aeronautic systems of the future with more demanding requirements than can be met even with this new equipment.

• **Call for funds**—Based on the level of funding for instrumentation development during the past several years, we cannot hope to get the job done without a complete about-face. The funds expended on the Atlantic Missile Range for development of all instrumentation are a very small fraction of approximately the cost of the production missiles themselves. It is not unusual for the Range to be asked to evaluate a new guidance system that may have cost one hundred million dollars or more with an instrumentation system that has cost a few percent of what the guidance system cost. In most instances, the only solution has been to obtain funding assistance from the weapons systems people to buy, modify, and install "off the shelf" equipment on a crash basis to obtain marginal results.

The developer of instrumentation, in order to be effective, strives for two paramount goals in his product—maximum accuracy and one hundred per cent reliability. To properly evaluate vehicle performance, range instrumentation should be one order of magnitude better in accuracy than the performance parameters of the system under test. Certainly, we all agree that malfunction or impaired accuracy of instrumentation will invalidate a portion of the vehicle test objectives. To obtain the high degree of accuracy and reliability in instrumentation systems, sufficient funds are required: 1) to improve existing systems; and, 2) to develop systems based on new concepts.

The development of instrumentation to meet the exacting demands imposed on the test ranges is a slow and tedious process. Generally, we have found that it takes as long (and sometimes longer) to develop an instrumentation prototype as it does to develop new vehicle prototypes. When the missile contractor has his prototype complete, he is ready to test it. On the other hand, the range usually will require some production units of the developed instrumentation system to meet the test requirements of the new vehicle in addition to the prototype.

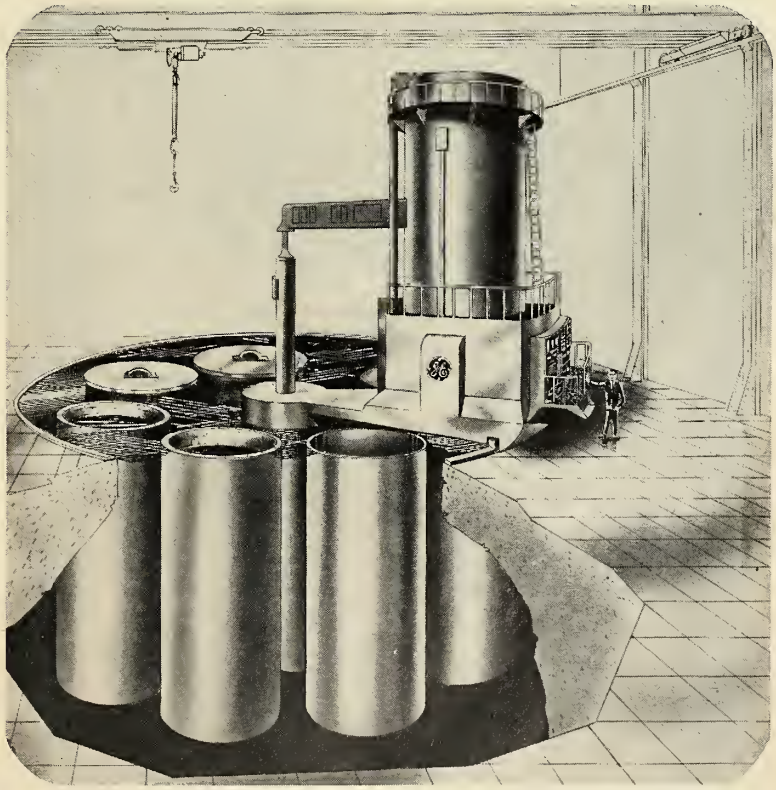
• **The bottleneck**—Thus, the "bottleneck," from a time aspect, is instrumentation. For example, several major instrumentation systems used to support the ballistic missile operations on the Atlantic Missile Range required an average of about four years for development. If you add to this the amount of time required for the budget cycle, plus the time required to check out and "de-bug" the system after it is installed, the average time from inception of the need to an operational use of a complex instrumentation system can be as great as five to six years.

A partial answer to the lead-time problem is to place the instrumentation developer where he can have continual cognizance of what the missile people are developing in the way of new vehicles. I recognize that such an approach is difficult to implement for a variety of reasons.

Systems contractors do not have a clear outline of test needs until the actual test stage is near. Consequently, they are reluctant to release the advance information we need to proceed with our development plans. A better solution from a Range viewpoint is to permit the development of new instrumentation to proceed, not on the basis of known missile requirements, but solely to advance the state-of-the-art against the trend of technical requirements as forecasted by our top missile and astronautic people. ARDC has an applied research program oriented toward such goals; however, these projects must compete with more glamorous end-item developments for their funds.

I doubt that there is any complete answer to the instrumentation development problems that the test ranges face today. Certainly, some breakthroughs are necessary in the state-of-the-art if we are to satisfy the data acquisition needs for future vehicles. The test ranges earnestly solicit the constructive suggestions and ideas of this Committee in the establishment of performance criteria for the next generation of instrumentation which will provide the desired test data for the next decade . . .

Heat Treatment for Solid Cases



PART OF A multi-million dollar expansion program at GE Evandale is this heat treating facility for solid rocket cases. Scheduled to be in operation in March, it will handle cases 10′ in diameter and 30′ long. It can be expanded to process cases 40′ in length. Evandale also will put into operation next year a hydro spinning machine believed to be the world's largest.



COLLEGE student volunteers in Lockheed's simulated space cabin.

Adapting Man to His Life in Space

by James Baar

WRIGHT-PATTERSON AFB, OHIO—The most complex part of any space craft will be man.

Today hundreds of scientists are working on projects costing millions of dollars in an attempt to better understand how this key part works—and how to make better use of it.

The complexity of the problems involved is tremendous. But the results are expected to pay off not only in helping man in the conquest of space but in widespread application to life on earth.

Much of this work is under the direction of the Aero-Medical Laboratory's Engineering Psychology Branch at Wright Air Development Center. Here are seven areas under study:

• Efficient work and rest periods—A million-dollar program being conducted by the Lockheed Aircraft Corp. at Marietta, Ga., aimed first at determining the most efficient way to break up the day for men aboard a space craft.

Volunteers perform assigned tasks in a specially constructed space cabin while extensive data on their reactions is collected by observers. The work-rest cycle will be varied from two hours on duty and two hours off to eight hours on and eight hours off.

• Ionized air—An investigation to determine the effects on astronauts of ionization of space cabin air caused by operation of electronic equipment.

Preliminary results show that positive ionization of the air causes crew members to suffer headaches, hay fever and asthmatic disorders. Some reports say positive ionization also causes feelings of depression. On the other hand, negative ionization appears to result in a feeling of well-being bordering on euphoria.

• Information handling—The collection of ever-greater amounts of data by electronic means has led to the problem of finding new ways to process and act upon it rapidly. This problem is expected to become particularly acute in manned satellites and space craft.

Researchers are attempting to come up with solutions based on simplified design of equipment.

• Magnetic fields—An investigation into the effect on astronauts of passage through magnetic fields of various intensities as well as proximity to magnetic fields possibly used to contain nuclear energy.

• Control Panels—Researchers are attempting to determine whether the time spent by a pilot looking at indicators on his instrument panel display area can be resolved into a patte

The goal would be replacement all indicators with one screen wh would flash readings in a similar p tern. This would save considera weight through miniaturization. P sibly time could be saved, too.

• Man as a "Black box'—An tempt to describe man in mathemati terms and hereby fit him into complex system of a space craft.

Researchers are operating on concept that of all the electronic "bl boxes" that make up a missile or sp craft, man is by far the most comp "black box" of all. The astronaut the Space Age is seen more and m as a manager and less and less as stick puller.

• Available light—In order to c serve precious electric power, or cause of inability to carry large pov sources, astronauts may face operati in very dimly lit space craft.

Researchers are attempting to termine whether lighting can be i proved by providing a series of 20 30 brighter flashes of light a seco rather than a continuous dim bea This would be the same as reduci the flicker of a normal fluorescent t about 70 to 80%.

• **Space work and ease**—The sp cabin at Marietta is 218 inches lo and 76 inches wide. Its height ran from 58 to 78 inches.

The front work area is divided i five compartments, each equipped w a chair and a control panel. The r rest area is equipped with bunks, ba room, small kitchen, a table and chai

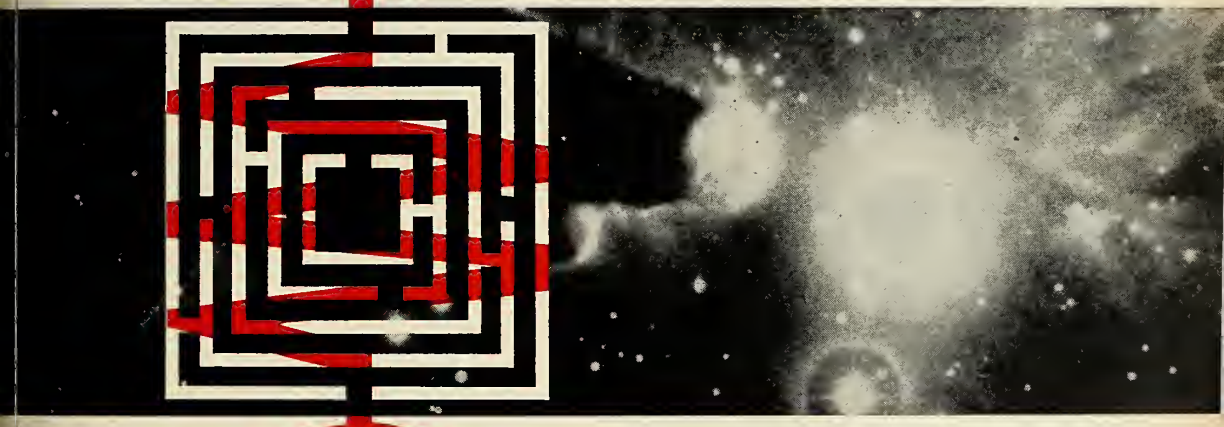
Occupants can be observed throu one-way mirrors and screens as well by closed-circuit TV cameras. El tronic equipment collects data on t occupants' heartbeat rates, breathi muscle tension and skin temperatur

The central panels provide sev tasks for crew members to accompl during work periods.

They must monitor three types scales and dials, solving mathemati problems, watching light patterns sir lar to radar and listening for a chan in an audio signal. Also, a series red lights must be turned off if th go on, and a series of green lights m be turned on if they go off.

Early experiments are expected concentrate on study of the work-r cycles. Crew members will not sleep the cabin but will bed down near Later experiments are expected to clude continuous confinement.

"This work-rest cycle will be a k thing in space," one scientist said. "T Navy's been working men four ho on and four off for generations. probably just superstition. But w knows? Maybe they're right."



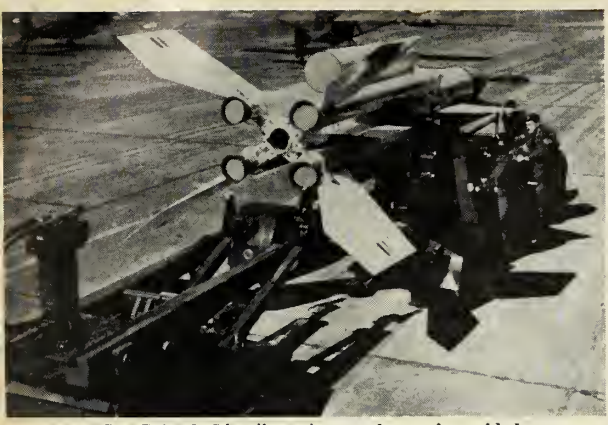
COMPUTATION FOR THE SPACE AGE

PEDITIONS INTO SPACE FOLLOW TRAILS BLAZED BY COMPUTATION SPECIALISTS. IN THIS HIGHLY PHISTICATED TECHNOLOGY, BURROUGHS CORPORATION'S DEMONSTRATED COMPETENCE RANGES FROM SI RESEARCH THROUGH PRODUCTION TO FIELD SERVICE AS PROVED BY PROJECTS SUCH AS THE AIR RCE ATLAS. BURROUGHS CORPORATION IS EQUIPPED BY ABILITY AND ATTITUDE TO FUNCTION AS AN MEMBER—A CLEARCUT RECOGNITION THAT EVEN IN THE REACHES OF OUTER SPACE, THE SHORTEST TNCE BETWEEN TWO POINTS IS SINGLENESS OF PURPOSE APPLIED TO MUTUAL OBJECTIVES.

Burroughs

Burroughs Corporation

"NEW DIMENSIONS / in computation for military systems"



BRITISH Bristol *Bloodhound* was shown in guided weapons enclosure. The trolley is used for transport and loading.



FRENCH Nord *SS-11* air-to-ground anti-tank bird atta to Sud Aviation helicopter. Photo by Réné Saint-Paul.

On Display at Paris Air Show

Pictures taken at the scene of the Continent's biggest Space Age exhibition

PARIS—British and American manufacturers vied with the French aircraft/missile industries at the 23rd Paris International Air Show—Europe's top international Space Age display.

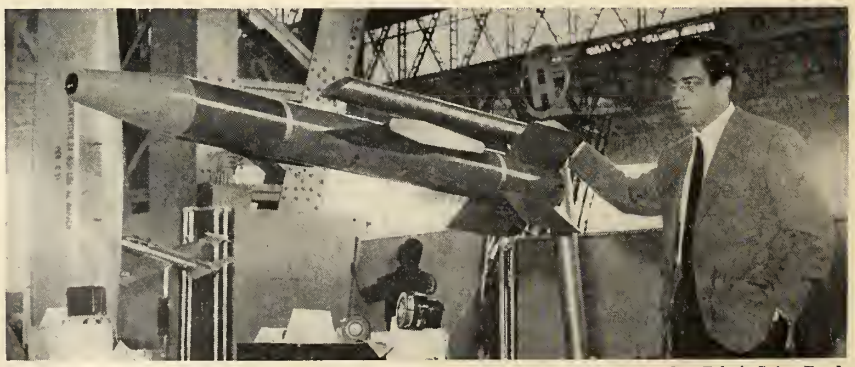
The French, who led in sheer numbers of exhibits, are emphasizing production rather than prototype missiles, such as the Nord *SS-10/11* SSM's.

Although they appear to be prospering, French manufacturers are troubled by labor unrest and a shortage of orders. Some observers feel that the French aircraft/missile industry must cooperate closely with its counterparts elsewhere in Europe. The French market alone is not enough.

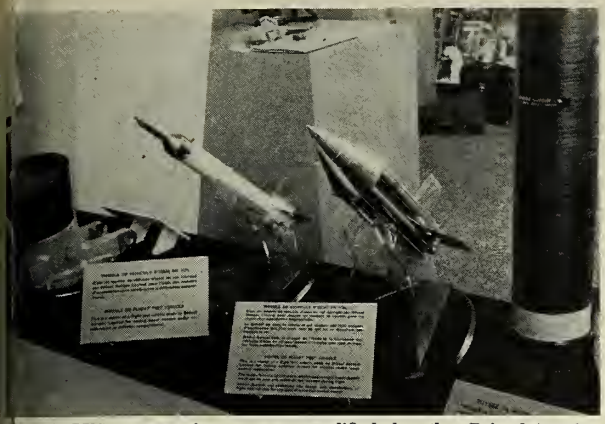
There has been considerable cooperation with the German and Italian industries, but cooperation with the British is regarded as the main key to broadening the scope of French manufacturers.

The British until recently showed little interest in wo ing with Continental aircraft/missile companies, except selling them license rights. But in recent months their tude has changed somewhat and they are now openly cussing how they can work with their continental ne bors to mutual advantage.

U.S. manufacturers, meantime, are increasingly in ested in the European market. The participation of Un Aircraft Corp., through its Pratt & Whitney subsidiary SNECMA activities is undoubtedly a sign of the times may well presage similar arrangements between other U and French companies.



ITALIAN S.I.S.P.R.E. official looks at the company's *C-7* AAM. Photo by Réné Saint-Paul.



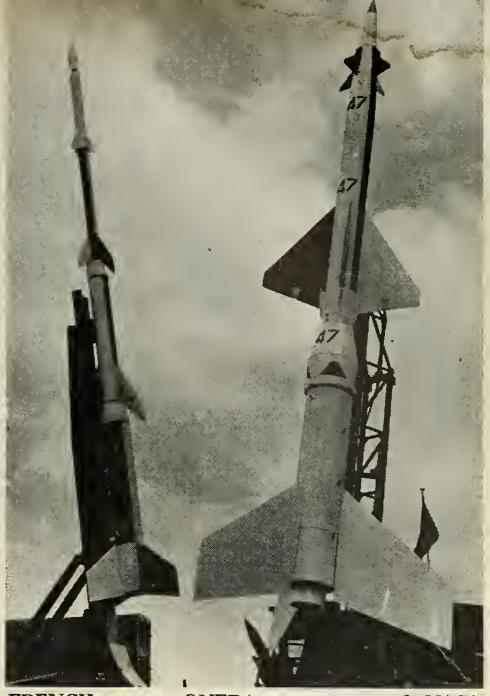
U.-BRITISH cooperation was exemplified by the Bristol-Aerojet stand with models of research vehicles. Photo by Réné Saint-Paul.



HUGHES Aircraft Co. exhibit featured *Falcon,* shown with Hughes official D. W. Harr. Photo by Réné Saint-Paul.



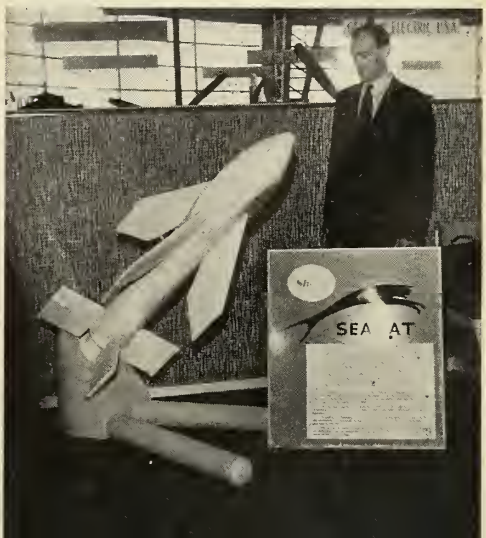
J. PRODUCTS dominated the missile park. They included *Redstone, Bomarc, Thor-Able, Nike-Ajax, Mace* and *Honest John.*



FRENCH agency ONERA, counterpart of NASA, developed these two test vehicles, one of them a four-stage Mach 7 exploration bird. Photo by Réné Saint-Paul.

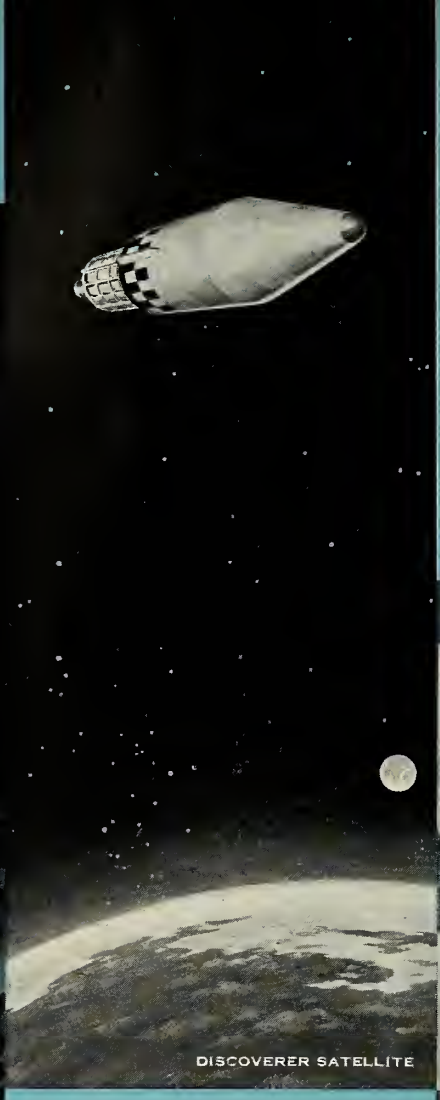


FIRST published firing picture of Short Brothers & Harland *Seacat* guided missile which will replace Royal Navy's 40 mm anti-aircraft guns. Bottom photo (by Réné Saint-Paul) shows *Seacat* unveiled at Paris.

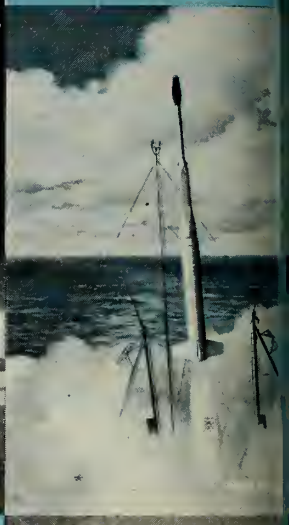


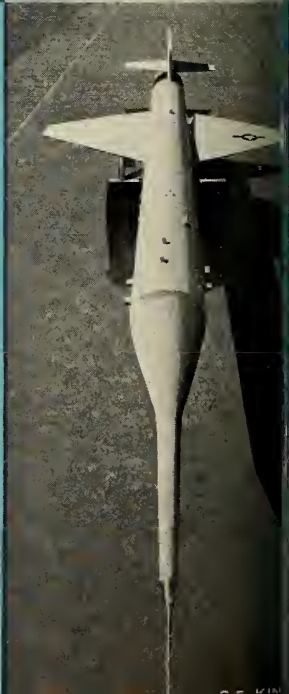


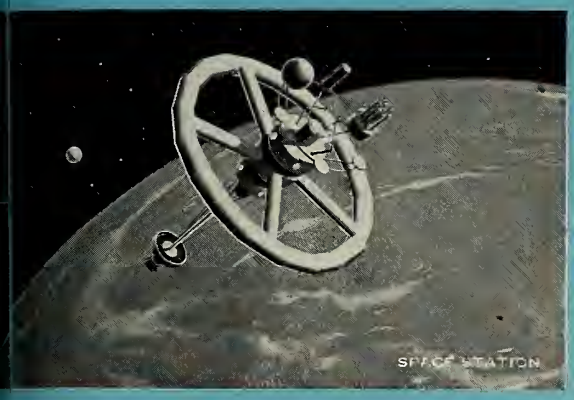
POLARIS FBM



DISCOVERER SATELLITE







EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

■

ADVANCED PROJECTS AT LOCKHEED

DISCOVERER SATELLITE—Designed and built by Lockheed Missiles and Space Division, the first of a series of DISCOVERER satellite launchings was successfully placed in orbit on February 28. Later satellites in the series will carry live animals and their recovery attempted. Valuable data will be obtained on space environment and recovery techniques of major importance to the nation's space program. The DISCOVERER is an Advanced Research Projects Agency program under the direction of the Air Force Ballistic Missile Division, with Lockheed as systems manager.

POLARIS FBM—Lockheed is missile systems manager for the Navy POLARIS Fleet Ballistic Missile, under the cognizance of the Special Projects Office of the Bureau of Ordnance. Submarine-launched, the POLARIS will travel through three mediums in a single flight: water, air and outer space. With three-quarters of the earth's surface being water, practically no target in the world is outside its range. The solid-propellant POLARIS was *designed with the future in mind*—an approach that the Navy states has cut nearly two years from the original timetable.

Q-5, KINGFISHER—Developed for the Air Force, and currently being manufactured for the Army, the Kingfisher is designed to simulate enemy attacks to test the efficiency of our various defensive weapon systems. It is equipped with extensive instrumentation to register "kills" without itself being destroyed and can be recovered by parachute and landing spike to be used again, with marked savings in cost.

X-7—Lockheed's X-7 recoverable ramjet-engine test vehicle, developed for the Air Force, has established speed and altitude records for air-breathing vehicles and is also recoverable for re-use following flight.

X-17—The nation's first successful reentry tests were conducted by the Air Force with the three-stage, Lockheed X-17 solid-propellant ballistic missile. The X-17 has pioneered many new techniques and the valuable experience gained from this program has facilitated development of other, inter-service projects, including the Navy POLARIS FBM. The Navy's history-making, 300-mile-high, Project Argus radiation explosions featured the X-17 as the vehicle.

SPACE STATION—An orbiting research facility, to serve as an advance base for space exploration, has been proposed in practical detail by Lockheed's research and development staff. The station would carry a 10-man crew. Prefabricated compartments for the rim of the wheel, the spokes, and the three hubs would be launched separately by means of ballistic missiles and guided into a cluster on the same orbit.

The successful completion of projects such as these requires a bold and imaginative approach to entirely new environments. Lockheed's programs reach far into the future. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, F-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed / **MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA · CAPE CANAVERAL, FLORIDA · ALAMOGORDO, NEW MEXICO · HAWAII

BRITISH ASTRONAUTICS

- *More successful Seaslug trials*
- *Rolls-Royce building Rocketdyne motors*
- *Thunderbird comes into service with Army*

by G. V. E. Thompson

LONDON—Sir W. G. Armstrong Whitworth Aircraft Ltd., makers of the Royal Navy's ship-to-air guided missile, *Seaslug*, announced recently that it has been so successful in recent trials with live warheads that there is now no need for it to hit every practice jet target.

During trials in Australia, three rounds with live warheads were fired against jet targets. The first two destroyed their targets; so the third was programmed to miss by a predetermined distance, in order to preserve the instrumentation in its target. This firing was also completely successful.

The *Seaslug* system is designed to destroy any enemy bomber which evades the fighter defences of the Fleet. It consists of a supersonic weapon fired from a multiple launcher mounted on a ship. The target is first tracked by radar; when required, a missile is fired from the command center in the ship. If necessary, missiles can be fired as a salvo. With long-range radar it can engage bombers up to the maximum height at which modern aircraft can fly.

To launch and accelerate the missile to supersonic speed, four solid-propellant boosters are used. These are located at the forward end in a wrap-around arrangement, and the nozzle of each boost is slightly offset so that the exhaust sweeps clear of the missile and also imparts a roll to reduce dispersion. Until arrival in the launcher, the boosts are in an unarmed condition and unaffected by shock loads. Loading into the launcher automatically actuates launching levers on each boost, completing the firing circuits.

The boost period lasts only a few seconds; toward the end of this phase the main sustainer motor is ignited. This is a high-performance solid-propellant motor. The high drag of the boosts then causes them to move rearward relative to the missile body and disengage. The flight control equipment is then operative.

Power for the guidance and control equipment is provided by burning isopropyl nitrate under controlled conditions to produce a gas supply. This is cooled, filtered and used to drive a turboalternator and a hydraulic oil pump. The turboalternator supplies power for such units as the guidance receiver (which is sealed and pressurized with dry nitrogen), roll st lization gyroscopes, acceleromet telemetry equipment, etc. The pump provides fluid pressure to m the control surfaces as directed by guidance system.



ROLLS-ROYCE rocket engine, similar to those to be tested at Spadeadam, developed for the *Blue Streak* LRBM.

Four wings are attached to sustainer motor section in a crucif layout, and there are four control faces fitted to the control ring in same planes as the wings. In addi to bringing the missile on course accordance with information from guidance receiver, the control sys is designed to limit manoeuvers avoid overstressing the airframe to maintain performance with va tion of speed and altitude.

In service, the missile is fitted v a proximity fuze. However, the v head may be replaced by a telem head which can monitor the flight formance through 24 or 48 chan as required.

External electrical and air supp to the missile enter at the boat of the missile, which also includes sustainer nozzle and electrical con equipment.

Four ships of the "Hampsh class of guided missile destroyer now under construction for the R Navy, and will be fitted with *Seas* The operational ship should be i range of not less than 5000-6000 t The total space requirement for system is 8000 square feet. *Sea* moves from magazine to launcher rails controlled by hydraulic hand gear; during movement it is war up, and cooling air is fed to the e tronic equipment.

It is power-rammed into the lau er, where final air and electrical c nections are made prior to firing. ship is fitted with search, tracking



FIRING OF Armstrong Whitworth *Seaslug* from H.M.S. Girdle Ness, the Royal Navy trial ship which has launched it hundreds of times.

ctrol radar. The firing crew is far ller than the crew of a gun turret n major warship.

A complete range of handling and kaging equipment is available and ady in use at store ships and land cots. It includes a special container able of taking the complete boosted sile and equipped with anti-vibra- and shock-proof mountings. Al- atively, the missile can be broken n into six major packages, each in pecial waterproof container.

The Royal Navy's trial ship, I.S. Girdle Ness, has carried out y trials with *Seaslug* over the last years. Several hundred missiles ae already been fired, and many air- t targets destroyed not only by mis- fitted with warheads, but also in ral cases by direct hits from *Sea- lug* with telemetry sections instead varheads.

• **Scoreboard**—Very low angle fir- have been successful. On more one occasion, when a salvo of rounds has been fired, with only ort interval between them, the first destroyed the target and the sec- hit the largest remaining piece of kage.

Transfer of the fully boosted mis- from ship-to-ship at sea has been satisfactorily. Special automatic equipment for ship installation per- all the functions of the missile to ested simply and quickly at peri- intervals.

In addition to Armstrong Whit- 's, the other principal contractors the General Electric Co. Ltd. of and, and the Sperry Gyroscope Ltd. Other firms participating are I. Ltd., Imperial Chemical Indus- Ltd., Vickers Armstrongs Ltd., McMichael Ltd.

• **Rolls-Royce builds Rocketdyne motors**—Rolls-Royce Ltd., of Derby, England, are building rocket motors for the *Blue Streak* LRBM. They have been adapted and re-designed by R-R from designs of the Rocketdyne division of North American Aviation, with whom R-R have a licence agreement. In tests which have been carried out at the U.K. Ministry of Supply Rocket Propulsion Department at Westcott, the design performance was fully realized.

Rolls-Royce now has about 250 workers at their new rocket motor and missile test center at Spadeadam, high on the Cumberland fells. When the build-up is complete there will be 500. R-R are managing this site on behalf of the Ministry of Supply.

• **Thunderbird**—The English Electric *Thunderbird* will be the first British-made missile system to come into service in the British Army. Two heavy anti-aircraft regiments are to be converted into guided weapon anti-aircraft regiments and equipped with this weapon by the end of 1960. The first begins its training in June at the School of Anti-Aircraft Artillery at Manorbier, Pembrokeshire, Wales.

In peacetime, the establishment of a *Thunderbird* regiment will be about 700 men. It will have two batteries, each with four missile launchers and a total of 44 vehicles and trailers. The two regiments will thus have only 16 missile launchers in all, which indicates that this missile is not to be introduced on a large scale, but is merely intended to give Army units experience.

Air defence of Army bases in Great Britain is the responsibility of the RAF, which is already equipped with the fully operational Bristol *Bloodhound* A.A. missile. *Thunderbird* will be operated by the Army in overseas theatres. It has been designed to form a mobile missile system which will move with the Army in the field and protect it from aerial attack. Even more important will be its task of attacking the enemy's reconnaissance aircraft, hindering the use of his ground-to-ground missiles.

The two batteries of a regiment can operate independently. In addition to the four missile launchers, each battery is equipped with a tactical-control radar, a tracking and illuminating radar, a battery command post, a launch control post, and facilities for assembling the missiles in the field and giving them simple checkout tests. This equipment is based on standard service vehicles, and can be transported by air (with the exception of the large tactical-control radar vehicle).

• **Homing**—Like *Bloodhound*, *Thunderbird* uses semi-active homing guidance. Both missiles utilize the British Thomson-Houston Co.'s Sting-Ray ground-operated target-illuminating radar. However, *Thunderbird* carries guidance equipment made by the Marconi Wireless Telegraph Co., whereas *Bloodhound's* is made by Ferranti, Ltd.

When in the field, early warning of enemy approach would be given by the RAF warning system. The target would be picked up by the tactical-control radar as soon as it was within range and information given to the Sting Ray target illuminating radar. When this was locked on to the target, missiles could be launched to home on radar reflections from the target. As there is only one Sting Ray per battery, each battery can only attack one target at a time. This is considered satisfactory at present, as reconnaissance aircraft normally operate singly.

Under development since 1950, *Thunderbird* was originally powered by a liquid-propellant sustainer, but now uses solid propellants. Cruciform fixed wings and pivoted tail surfaces are fixed to the body and there are four jettisonable solid-propellant boosters.

A more advanced Mk. 2 *Thunderbird* is under development, and will have a greater range and a guidance system less vulnerable to countermeasures. The Mk. 2 missile will probably be introduced in greater numbers, and it seems likely that batteries will then be provided with several target-illuminating radar sets, so that more than one target can be attacked simultaneously. This advanced *Thunderbird* may be used by the RAF as well as the Army.

Explore new areas at IBM in

MATHEM

At IBM, creative mathematicians are discovering important, new applications of mathematics in tl electronic computer field. Long before actual construction of IBM's unique Magnetic Charact Sensing Machine, for example, mathematicians were at work on a mathematical model, testing both tl over-all design and the logic circuitry needed for character recognition. In another project, mathematicia employed large-scale computers to simulate, in a matter of weeks, eight years of engineering work whi have yet to begin. Currently under study are vehicular penetration problems involving thousands variables. Projects of this sort demand keen, discerning minds. If you have a flair for creative mathemati you're the man we want to talk to.

You will enjoy unusual professional freedom and the support of a wealth of systems know-ho Comprehensive education programs are available, plus the assistance of specialists of many disciplin Working independently or as a member of a small team, your contributions are quickly recognized a rewarded. This is a unique opportunity for a career with a company that has an outstanding growth recor

CAREERS AVAILABLE IN THESE AREAS...

- Analog & digital computers
- Applied mathematics
- Circuit design
- Communications theory
- Computer system design & analysis
- Control system research
- Experimental techniques
- Field theory
- Human factors engineering
- Logic
- Mathematical & numerical analysis
- Operations research
- Probability theory
- Reliability
- Scientific programming
- Solid state
- Statistics
- Switching theory
- Theoretical physics

Qualifications: B.S., M.S., or Ph.D. in Mathematics, Physics, Statistics, Engineering Science, or Electrical Engineering—and proven ability to assume important technical responsibilities in your sphere of interest.

SSIGNMENTS NOW OPEN INCLUDE . . .

MATHEMATICIAN: to handle mathematical analysis of advanced scientific computer programming for solution of systems problems, differential equations, probability-type problems, photogrammetry problems.

STATISTICIAN: to solve analysis-of-variance and multiple-regression type problems; to design experiments for various engineering applications and select form of statistical analysis of greatest value; to give statistical support to engineering departments in such areas as reliability analysis and human factors engineering by developing statistical programs for the IBM 704. Statistical experience in engineering problems and thorough knowledge of statistical distribution functions necessary.

RESEARCH MATHEMATICIAN: to investigate statistical problems in control system research on digital computer; to study control problems of analog to digital conversion, with particular reference to matrix problems; to apply experience with networks, statistics, or communications theory to problems in computer design; to solve problems involving switching theory, probability and information theory, and coding.

ATICS

APPLIED MATHEMATICIAN: to undertake assignments involving knowledge of feedback control theory, data systems theory, servomechanisms, information theory, statistical models, heat flow, circuitry, magnetics, probability.

MATHEMATICIAN-PROGRAMMER: to specify and program elements of a sophisticated automatic programming system. Must have considerable experience in automatic programming research.

OPERATIONAL PROGRAMMER: to develop computer program techniques for real-time military applications, using game theory and systems simulation.

OPERATIONS RESEARCH MATHEMATICIAN: to evaluate closed loop systems consisting of computers, radar displays, and inertial equipment; to simulate advanced weapons systems in order to evaluate alternate design concepts; to analyze and design electromechanical systems, studying targets, tactics, and operational effectiveness. Experience in applying advanced mathematical techniques to weapons systems analysis and evaluation. Knowledge of probability and linear programming techniques.

For details, write, outlining background and interests, to:
Mr. R. E. Rodgers, Dept. 604-F5
IBM Corporation
590 Madison Avenue
New York 22, N. Y.

IBM®
INTERNATIONAL BUSINESS MACHINES CORPORATION

reviews

HUMAN TOLERANCE TO PROLONGED FORWARD AND BACKWARD ACCELERATION, N. P. Clarke and S. Bondurant, Aero Medical Laboratory, Wright Air Development Center, USAF, 34 pp., $1, available from OTS, U.S. Department of Commerce, Washington 25, D.C.

Astronauts will be uncomfortable, but able to endure the short spurts of high acceleration necessary to put them into orbit by three-stage rocket, according to this Air Force study of the best body positions for entry into space and return.

In tests on WADC's human centrifuge, some subjects were able to withstand forward accelerations of simulated three-stage rocket flights of 8, 10, and 12 g. Rates of onset acceleration were calculated to give orbital velocity—18,000 miles per hour—at the end of the third stage.

The centrifuge was set to speed up at a rate of 0.5 g a second to constant accelerations between 2 and 12 g. Acceleration was maintained until loss of a critical facility—vision, breathing ability, or impairment of judgment or performance by pain.

The best body position for forward acceleration appeared to be with the head and trunk tilted 25 degrees forward and legs sharply bent. In this position, no blackout was observed and subjects were able to endure 12 g for 5 seconds, 10 g for 23 seconds, 8 g for one minute, and 4 g for 15 minutes. Ten-g tolerance was limited by impaired vision and extreme difficulty in breathing.

Tolerance to backward acceleration, with legs bent and head and trunk erect, was limited by considerable discomfort from the restraint system, leg pain, and difficult breathing. Twelve g was tolerated for about 4 seconds and 10 g for about 12.

PREPARATION OF STANDARDS AND TEST PROCEDURES FOR PRINTED CIRCUITS, C. A. Dodge, S. E. Graf and W. W. Hansen, Stanford Research Institute for Wright Air Development Center, USAF, 119 pp, $2.50, available from OTS, U.S. Department of Commerce, Washington 25, D.C.

Research and development which led to the preparation of military specifications for multiple-contact printed circuit connectors are described in this report.

At the start of the program, questionnaires concerning the field performance of printed circuit connectors and terminations and laboratory testing techniques were distributed to commercial firms. Significantly, replies indicated that failure rate for connectors was below 1%.

The laboratory phase involved evaluation of samples of multiple-contact connectors suitable for use in printed circuit assemblies. Specification limits were derived from performance and incorporated in two tentative military specifications.

Where existing methods of testing connectors were not adequate, new, more suitable techniques were developed. Properties most important for printed circuit connectors were established.

Chairman Seeks Broad R&D Power



Rep. Overton Brooks feels his House group should have jurisdiction over all non-military research and development bills, and sees this as step toward Department of Science

by Erica M. Karr

WASHINGTON—A quiet but highly significant revolution going on almost unnoticed in the House of Representatives may alter the route of many government scientific research and development programs. In the middle is mild-mannered, soft-spoken Congressman Overton Brooks, Chairman of the House Committee on Science and Astronautics, who reports: "I'm pleased with the way things are moving."

Brooks claims for his committee jurisdiction over *all* bills involving non-military research and development. In Brooks' opinion it includes looking into such non-space areas as cancer cures or how to grow a better potato crop. He says House Resolution 580, setting up the permanent committee and spelling out its jurisdiction, gives the group full rein over such areas.

But this is in sharp variance with the opinion of the House Parliamentarian who has been assigning the committee only such R&D bills as are space-related.

The controversy grew out of the vague wording of the resolution, now part of House Rule II. After defining the specific agencies to come under the committee's legislative authority, the resolution wound up with the nebulously-worded item (G) which states in its entirety: "scientific research and development."

Most government agencies' R&D projects are blanketed within package legislation and assigned to the committee that handles bills for the specific agency. Brooks is now actively campaigning to get the agencies to separate their R&D requests. "We talking to the departments now, but will take a while," he declares. Sev major agencies and numerous smal ones are involved in R&D projects.

Neither the parliamentarian's offi nor Brooks will admit there is a basic difference of opinion, and nc space R&D bills continue to fl through the old, established comm tees. But Brooks is optimistic that shift is just a question of time.

• **Science department?**—The Hou Space chairman, as one of the pri drafters of the resolution, sees the evitably-broadened scope of his co mittee as the first move in establis ment of a Department of Science. is very important right now to establi such a department," he says. But wh bills setting up a Federal super scien agency are going through the Congr

THE HANDS IN THE POT

Altogether 23 government departments and executive offices are involved in some phase of our missile and space program. The network extends down from the President through his Science Advisory Committee, the National Security Council, National Aeronautics and Space Council, and Federal Council for Science and Technology.

Active agencies involved are the Department of Defense and its substructures and the civilian National Aeronautics and Space Administration.

The 16 supporting agencies and their functions in the space picture are:

1. State Department—Assistance in the promotion of international scientific relations, space control policies.

2. Treasury Department—Cooperation in areas of aeronautics and flight safety, recovery and rescue.

3. Agriculture Department—Basic and applied research in agricultural products and their use, new sources of food, use of chemical byproducts, nutrition.

4. Labor Department—Information concerning available technical manpower, location of same, trends as to size and composition of labor force.

5. Interior Department—Research into geological principles. Experimental programs on minerals and fuels, metals technology and metallurgy. Basic research on saline water conversion and water purification.

6. Commerce Department—Research and development in physical sciences; advisory to other government agencies on basic scientific and technical problems. Special weather services to the "active agencies"; basic research in climatology. Basic and applied research in geodesy, mapping, etc.

7. Health, Education and Welfare Department—Research and training in medical sciences, human behavior, and collation of such data on international scale. Evaluation of educational trends and needs, research into improved educational methods.

8. Inter-Departmental Committee Scientific Research and Development Promotes exchange of R&D informati particularly regarding government pers nel. Advisory on the administration government laboratories.

9. Federal Aviation Administration Aeronautical development and testi Research into flight safety and allied te niques.

10. Smithsonian Institution—Assistar in tracking of space vehicles. Basic search in space sciences, cosmology, c mogony, etc.

11. National Science Foundation Widespread basic research support throu grants, contracts, scholarships, inforr tion exchange, participation in continu International Geophysical Cooperat program.

12. Atomic Energy Commission—Ba and supporting research in the nucl sciences, including propulsion elements the space program.

13. United States Information Age

:onal mill, chances for their passage iis session seem slim.

When the science department does lcome a reality, the Louisiana Conessman feels, it should have jurisdicton over both military and civilian sace projects, representing a $5.5 bilIn annual government investment. 'cience is science whether it is milit'y or not," according to Brooks.

If and when military and civilian sace programs are merged, presumably t: Space Committee will be more tin willing to blanket in the military l:D as well.

Brooks is hardly awed at the prosp:t of biting off all of the civilian F:D measures as they funnel through t: House. "We're eager beavers," he s's. "We'll take it."

• **Lack of coordination**—One of Books' primary motives in wanting all F:D channeled through his committee ishis conviction that the importance o research to the national welfare has n: been properly assessed, and that as leg as it is the victim of a "bits and pces" approach, rather than a coordated effort, the United States area wl fall short of its potential in the tchnological race.

As an example he points to the lack o information on the country's acadnic and industrial scientific endeavo. "We should have a census of scie'e," he says, "to answer such questins as 'How many scientists are there ir each field? Where are they? What is th'r educational background, their exprience? Is the John Doe Company hrding scientists? Is scientific manpwer being used most effectively? Hw many future scientists will be gduated from the schools each year?'

We ought to devise some system so we can tell at any time.

"The National Science Foundation has done some work on this, but—for one thing—the little company gets overlooked. We had a representative of one small company testify before the committee that they spend $50,000 a year on research. How many others there are can just be a guess. We need to have a better idea of what the private companies are doing in the way of R&D."

The Budget Bureau estimates that research and development is financed roughly 50% by government, 50% by industry. The Ford Motor Co. alone, Brooks points out, spends between $20 million and $25 million annually on research. With the hodge-podge of country-wide research projects, and no one knowing what others are doing, there is bound to be "wastage in scientific ability," says Brooks.

Just how far companies would be willing to go to divulge the details of their scientific efforts in a public census is another question.

• **Goal 10%**—Brooks feels that while the government's gradual upstepping of R&D funds is a step in the right direction, a quickening of the pace is in order. "I don't think we are spending enough."

The Fiscal Year 1960 budget calls for a total R&D slice of slightly over 7%. Brooks would like to see it hit 10%, calling this "a good ratio." He feels it would be a good investment—"Adequate research will save the country money in the long run."

To help push the day closer, Brooks has introduced a "tithe for science" bill which would in effect add 10% for basic research to all R&D money measures.

Before this session of Congress is over, the House Space Committee has on its agenda, in addition to the research tithe bill, probes into the progress of the million-and-a-half-pound-thrust single-chamber engine and 6.2-million-pound clustered engine, development of the *Zeus* anti-missile missile, recovery of satellites and missiles and Federal scholarships for students majoring in oceanography, a field Brooks thinks could stand much more attention.

Congressman Brooks, now in his 23rd year in Congress, has spent 22 of them sitting on the Armed Services Committee, and was in on the beginning of the military's entry onto the space scene. His background of some of the complexities of the problems involved is, therefore, at least as good, if not better, than those of his colleagues on Capitol Hill.

His enthusiasm for the new field is perhaps even greater.

—ervices for exchange of international sc ntific information.

4. Civil Aeronautics Board—Techni advice in accident investigation and sy ems of determining cause or source of ight failures.

5. National Academy of Sciences—Consel and research on space sciences thugh space science board. Coordinatio of U.S. activities in International Gophysical Year.

6. Federal Communications Commissio—Advice on spacecraft transmission fre encies; direction of scientific, technic and engineering programs related to de lopment of electronic communicatio techniques.

n addition, the Library of Congress, Ce ral Intelligence Agency, and Office of echnical Services of the Department of Commerce disseminate technical inforation and documents produced in oth countries, translated and sometimes mi ofilmed.

Vanguard Orbit Try Fails As Regulator Breaks Down

WASHINGTON—The ill-starred *Vanguard* project last week recorded its eighth failure in ten attempts to place a satellite into orbit.

The failure occurred in a second-stage pressure regulator, marking the fifth time that the vehicle's second stage has failed to function properly.

NASA scientists had hoped to launch into orbit a 22½-pound sphere that would have recorded the intensity of direct sunlight, sunlight reflected by the earth's cloud cover and show, and heat emitted by the earth.

The launching vehicle had been modified so that the payload and third stage parted on ground command after one full orbit.

The countdown was delayed two hours after the ignition system failed to operate on the first attempt. At 4:16 p.m. EDT Tuesday, the vehicle was finally launched, but NASA officials were not aware of the rocket's failure until two hours later when western U.S. tracking stations were unable to receive its signals.

The regulator, a stock factory item, allowed the rocket to come apart, keeping it from reaching the necessary 18,000 m.p.h.

• **Official word**—The NASA announcement said:

"The satellite did not respond to interrogation by the minitrack station at San Diego and therefore is presumed not in orbit. On the basis of data which have been received, it is indicated that there was some malfunction in the second stage. The exact nature of the difficulty will be determined from a further study of the data obtained."

This satellite, like *Explorer IV*, was launched towards the northeast from Cape Canaveral, which would have given it an orbit with about a 50 degree inclination from the equator.

Geomagnetic Equator To Be Measured by Ship

BERKELEY, CALIF.—Measurements of the earth's magnetic field are being made aboard the S.S. Mariposa with equipment from the University of California. The equipment will determine the amount of cosmic radiation reaching the earth along the ship's path.

Since the radiation is affected by the earth's magnetic field, an accurate picture of radiation intensity will provide data on geomagnetism. It is hoped that the experiment will locate the geomagnetic equator. It is the first of two or three voyages to be made in efforts to take readings of radiation over a portion of the earth's surface.

Reach the heart of the missile market throughout the entire year.

missiles and rockets

3rd ANNUAL engineering progress issue

featuring the Guided Missile Encyclopedia

JULY 20, 1959



Your guarantee to high readership and constant reference . . . in the $7 billion missile market.

Here is the most exciting and popular issue of the year. Authoritative articles by recognized experts — from Astrometry to Ion Propulsion — PLUS the new and expanded Guided Missile Encyclopedia. Now you can reach the market in depth and quality as never before. Write, call or wire your *missile and rockets* representative today, and find out how you can put your sales message where it will reach the heart of the missile market throughout the entire year.

NEW YORK CITY: 17 East 48th Street PLaza 3-1100 • DETROIT: 201 Stephenson Bldg. TRinity 5-2555 • CHICAGO: 139 N. Clark Street CEntral 6-5804 • LOS ANGELES: 8929 Wilshire Blvd. OLeander 5-9161 • MIAMI: 208 Almeria Avenue HIghland 4-8326 • TORONTO: 12 Richmond Street E. EMpire 4-2001 • LONDON: 28 Bruton Street GRosvenor 8356 • PARIS: 11 Rue Condorcet Tru 15-39 • GENEVA: 10 Rue Grenus 34 66 73

M/R

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

AF Sees Improved System Management

Weapon System Project Offices are reportedly getting the job done more efficiently, although there's still the problem of just when production people should take over

by Betty Oswald

WASHINGTON—Who manages the Air Force weapon systems programs? The answer to this question depends on whom you talk to. It's the source of much of the current confusion on Capitol Hill over the operation of the AF's Weapon System Concept. Congressmen frequently charge that AF has delegated its responsibility to the contractors.

This just isn't so, according to authorities on the weapon system at Wright-Patterson AFB. As explained by Maj. Gen. W. A. Davis, recently designated as Director of Procurement and Production at Air Materiel Command: "Air Force retains control of the weapon system program while at the same time giving the prime or associate contractor sufficient latitude to accomplish his job. In this role, the Air Force must time-phase and integrate all actions of AF agencies as well as those of industry.

"Because of the magnitude of the job and the limited technical resources within the Air Force, there was no alternative but to turn to industry for assistance in performing a portion of our task. The Air Force has retained overall decision-making management prerogatives for weapon system management." An earlier article pointed out that the key to AF management rests with the Weapon System Project Office.

Executive responsibility for management of the weapon system rests in the first instance with the little-known office of Systems Management at Wright-Patterson. Part of ARDC, it manages programs through their development phase and until a decision is reached to produce for inventory.

Activity of this office does not include the ballistic missiles which are handled by the Ballistic Missile Division at Inglewood, Calif.

• 40 systems covered—However, the job is not a small one. It oversees jointly with AMC's Aeronautical Systems Center about 40 Weapon Systems Project Offices including such programs as *Dyna-Soar,* advanced space projects, the *X-15,* the air-to-ground missiles, and the air-to-air missiles.

In addition, its responsibility includes the electronic support offices for such programs as Air Weapons Control System 212L, which General Electric is developing for use overseas.

As of now, the Systems Management Office is headed by Maj. Gen. Victor H. Haugem, who will soon report to the Pentagon as Director of Planning for the Deputy Chief of the Air Staff (Development).

Basically, the office is divided into six parts, each of which is headed by a deputy. Divisions are for: research vehicles and advanced systems, elec-

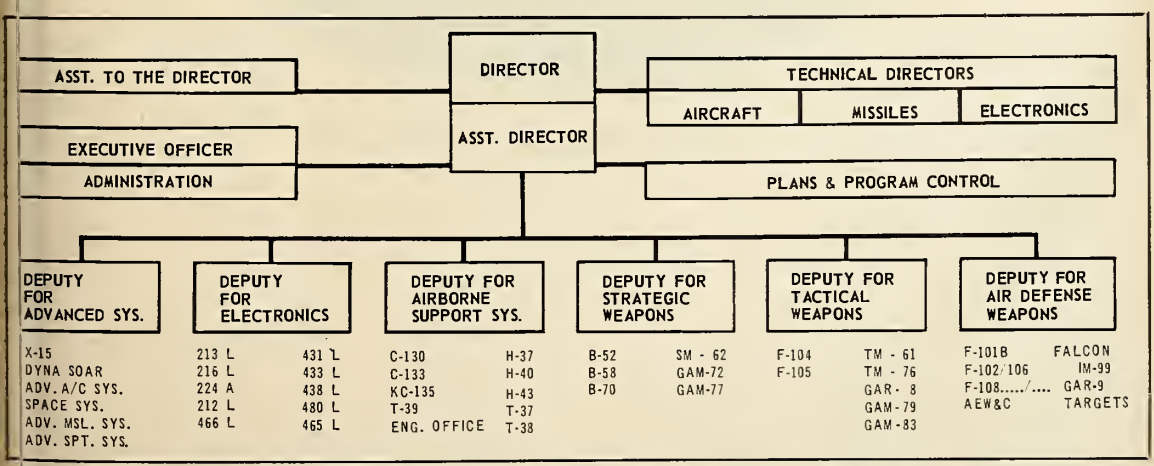


CHART of organization of the Air Force's Systems Management Office, a little-known but vital part of ARDC.

GLOBE-ILITY



Dawn in a
troubled harbor.
On the horizon,
units of a U. S. Navy
carrier task force.
Yesterday they were 700 miles away.
Today the lean ships and glinting jets are here to back up
U. S. policy. They came equipped to air-land Marines, win air
superiority, or trade nuclear blows.
Few bases are so formidable in so many ways.
None is better suited for guarding the
vast and scattered resources
which form the Free World's strength.

CHANCE VOUGHT
DALLAS, TEXAS

ADVANCED WEAPONS | ASTRONAUTICS | ASW | ELECTRONICS | MISSILES AIRCRAFT | G | RANGE SYSTEMS



500TH CRUSADER DELIVERED TO FLEET

The jet fighter that introduced 1,000-plus-mph speed to carrier decks is now with the Navy – 500 strong. Chance Vought *Crusaders* are deployed with the Sixth and Seventh Fleets as day fighters and photoplanes. Another *Crusader* version – the F8U-2N – is being armed and equipped for near-Mach 2 combat in darkness or bad weather. It will join the Fleet next year.

With the *Crusader's* dynamic design, Vought engineers broke down barriers that have stymied carrier aircraft performance. In the same way, the Navy has tuned U. S. carrier design to the changing requirements of defense. Since World War II, these floating bases have been improved 50% in all-weather operation, 100% in aviation fuel capacity and 200% in ammunition storage.

It was a supersonic step forward when these high-performance carriers were modified by the *Crusader*. The transition was completed at low risk and cost. And these fastest of all Navy fighters have since proved reliable, serviceable and economical, too, in long periods of foreign duty that have included Quemoy and Lebanon.

Design and production of high-performance aircraft make up part of the broad spectrum of Chance Vought fields of activity. Other areas include: advanced weapons, astronautics, electronics, anti-submarine warfare, range systems management, commercial process control systems.

CHANCE VOUGHT DALLAS, TEXAS

tronics, airborne support systems, strategic weapons, tactical weapons and air defense weapons.

Technical direction is provided by three civilian directors—one for missiles (everything except ballistic missiles), a second for aircraft and the third for electronics.

• **Step by step**—First step in the complicated process is the development of a general operational requirement for a specified weapon or support system. This is prepared by Headquarters USAF. The requirement is analyzed by ARDC which makes contracts with industry for design studies.

Based on an analysis of these studies, ARDC submits a development plan to headquarters for approval. Approval of this plan gives ARDC a Development Directive.

At this point, the partnership between ARDC and AMC is set up with the start of source selection processes. These procedures are spelled out in Air Force Regulation 80-3, dated April 28, 1959.

Under the rules as spelled out, ARDC, AMC and the using command meet jointly to establish a System Source Selection Board. ARDC assigns a senior officer to act as the nonvoting chairman of each board and direct the proceedings.

These Boards are used in two situations. They may be required to choose a group of contractors from industry to submit proposals, or they may evaluate specific proposals from contractors.

Rules provide that after the contractor briefings and other actions needed to acquire information, the Board completes its evaluation and presents it to the commanders of ARDC, AMC and the using command. Each commander then makes his recommendation in writing to the Vice Chief of Staff. In order to prevent leaks, references to selected contractors are by letter code only, with the code for the occasion identified by the senior board members.

Final decision is, of course, up to the AF Chief of Staff, Gen. Thomas D. White, and Air Secretary James Douglas.

• **Shifting responsibility**—After the contractor is selected, the Weapon System Project Office is organized and staffed by the Directorate of Systems Management and AMC's Aeronautical Systems Center. Executive management responsibility for weapon system integration is given the Directorate of Systems Management.

What "executive management responsibility" means in this sense is team leadership during the development phase of a weapon system. Systems Management Office is responsible during the entire design and development cycle until a final decision to produce is made. At this point, executive management responsibility shifts to the Aeronautical Systems Center. However, the directorate keeps its people in the Weapon System Project Office, since it continues to be responsible for production engineering proposals, the product improvement program, the making of technical fixes and for safety and grounding orders.

Tools used by the directorate during the development phase are development engineering inspections, known as DEI's and Mockups. These are used in an effort to insure the technical adequacy of the work of the contractor and the integration of subsystems. Emphasis on this part of the program has been increased sharply because of the necessity to push a program through without waiting for flight tests.

During the development cycle, Weapon System Phasing Group is headed by a representative of the Directorate. The group, which is not an action body, is designed to assure that each of the functional elements of the Air Force involved are apprised of problem areas and of the actions which must be taken by each functional unit to provide a fully operational weapon on schedule.

When Executive Management Responsibility shifts to AMC, chairmanship of this group shifts to the Aeronautical Systems Center. Perhaps the toughest job which now exists is to determine when this responsibility should shift. So far, the shift of responsibility has been decided by mutual agreement of ARDC and AMC. If the agreement isn't reached, responsibility remains with the ARDC group. This in turn leads to the charge frequently made that research and development people in their search for perfection often create the most perfect obsolete weapon.

• **Stubborn problem**—In general, however, reports from Dayton indicate that the program is now working better—that the jointly manned weapon system project offices are getting a job done, now that the system permits greater action. Nevertheless, it is seemingly agreed that the really hard problem hasn't been solved yet. Simply stated, this is: "When does a weapon move out of its test and development phase to a point where production people should take over?"

The corollary problem is: "How much of a slow-up occurs production-wise as a result of the shift of executive management responsibility from one agency to another?" The answer to this last question depends entirely on how closely ARDC and AMC officers have been working together in the Weapon System Project Office.

$30 Billion Defense Spending Boost Urged

To put the United States on a par with Russia militarily, the Democratic Party's Advisory Committee says the nation must spend an extra $30 billion over the next four years—mostly on missiles. The committee charges that the country's defenses presently are in "disastrous" shape.

The committee recommends: doubling planned and actual rate of production of *Atlas* and *Titan;* stop-gap development of *Snark* and *Regulus II;* speed-up *Polaris* and *Minuteman;* continue high priority of *Nike-Zeus* development; give SAC 24-hour airborne capability; and increase jet tanker production.

Hits and Misses

A **Martin** *Bold Orion* two-stage ALBM prototype—the 11th—was fired successfully June 19 from a B-47 over Cape Canaveral. Rocket was programmed to travel several hundred miles . . . At Vandenberg AFB, a Royal Air Force crew launched a **Douglas** *Thor* June 16 and the missile had to be destroyed seconds after lift-off because of a "mechanical malfunction."

A supplemental appropriation of $485.3 million has been requested for NASA by President Eisenhower. The money bill follows an authorization for that amount already signed into law.

Waste of $1.4 million through a "lack of foresight and faulty planning" is the Senate Preparedness Subcommittee label hung on the Navy's decision to close down a new *Terrier* missile depot in Boston Harbor. Said the subcommittee: "Obviously it is not good business to construct a modern missile facility and then turn around and close it down. It is no wonder that the cost of national defense rises . . ."

Titan Base Contract

Ralph M. Parsons Co. has the $767,000 A&E contract to design a new $84 million *Titan* installation at Larson AFB, Wash.

The Martin Co. has set up an "activation division" under Vernon Rawlings to act as integrating contractor for construction and activation of *Titan* weapon systems in the field. The first job will be at Vandenberg, and will be under the direction of BMD.

OCBM has granted fast tax write certificates on 65% of $1.2 million **Lockheed** for missile R&D work Van Nuys, Sunnyvale, and Santa Cr to **Thiokol** on 60% of $600,000 rocket engine R&D at Denville, N and to **Boeing** on 75% of $1.5 mill for missile and space vehicle R&D.

Black Paint Job For *X-15* Re-entry

Jet-black, silicone-based paint us on **North American's** *X-15* resear plane, designed to withstand re-en temperatures in excess of 1000°F, expected to last through four or fi flights.

Ryan Aeronautical Co., now bla forming metal parts in an outdoor at San Diego, is building a new exp sive forming machine that will rese ble a deep diving bell. If it tests out expected, the next step will be pr duction-type equipment for operati in the factory, perhaps in a year two.

The Changing Scene

Acoustica Associates Inc., whi had 3 employes four years ago, h opened its fifth plant—a 50,000 squa foot building devoted exclusively to trasonics at Plainview, L.I. The co pany now has 425 employes . . . A n liquid epoxy resins plant with a 15 m lion pound annual capacity has be put on stream at Marietta, Ohio, **Union Carbide Plastic Co.** . . . In diversification move, **General Dynami** has acquired the 17 plants of **LaVer W. Hench & Associates** for "sever million dollars." The plants produci oxygen, hydrogen, argon and oth gases will be operated by GD's Liqu Carbonic Division . . . **Raytheon In** is building a new plant at Portsmout R.I., for its Navy ASW operation . . **Magma Products** of Santa Fe Spring Calif., has sold a 51% interest **Thompson Ramo Wooldridge.** Magn makes specialty chemical and electron products and holds an ARPA contrac . . . **Dynatronics** is moving to a ne plant at Orlando . . . Step-up in th hiring rate of all types of employes underway at the **Sperry Semiconducto Division** of **Sperry Rand** in Norwal Conn., as part of an accelerated e pansion program . . . **Dynamic Gear** building a $200,000 plant at Amit ville, N.Y. . . . and a plant with 28,0 square feet of space is under constru tion by the **Autonetics Division Nort American Aviation** at Downey, Calif for an environmental test laboratory.

A Rare Grouping



SPACE MEN garbed to receive earthly honors at Adelphi College's recent commencement from Dr. Paul Dawson Eddy (foreground), college president. Left to right: John P. Hagen, chief, *Vanguard* Div., NASA; Willy Ley, editor and author; Hugh L. Dryden, deputy administrator, NASA; Lt. Gen. Bernard A. Schriever, commander, USAF, ARDC; Dr. Wernher von Braun, director, Development Operations Div., ABMA; Hans H. Hueter, director, Systems Support Equipment Laboratory, ABMA; Lt. Gen. C. S. Irvine, (Ret.), former AF deputy chief of staff, Materiel. Honorary degrees: Doctor of Laws—Dryden and Von Braun; Doctor of Science—Schriever, Irvine, Hueter, Hagen; Doctor of Humane Letters—Ley. Von Braun spoke on "Education in the Space Age."

Big Push for Automatic Checkout

Fully transistorized systems are rapidly being developed—one is operational

by Charles D. LaFond

WASHINGTON—The big push is on ndustry to develop solid-state auto- ic checkout systems. The stagger- complexity and the vast number of erent missile weapon systems de- oped in recent years has spawned an ost equally large array of auto- ic checkout systems.

The initial testing, pre-launch or -flight testing of weapon systems forced the use of radically new hods and techniques, particularly ause of the constantly increasing d for greater speed and near 100% ability.

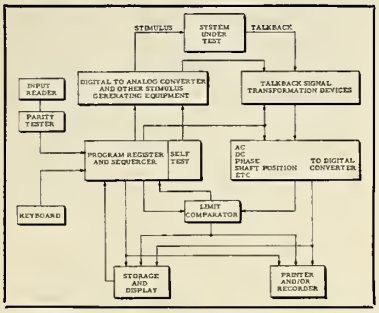
As a result of this increased com- xity, it is no longer feasible in view time, expense, and personnel train- problems to use highly skilled kers to perform the tests, evalua- , and adjustment of sub-systems systems. The need for completely omatic checkout devices and pro- ures was obvious several years ago , as a result, progress and develop- nt have been rapid. We are now in hase of transistorizing most of the re checkout systems.

Solid-state switching devices have hed a point where it is now practi- to design and construct completely matic checkout systems with much ter reliabilities. The new systems be considerably more flexible, rate at higher speeds, and provide er performance. Finally, mainte- ce will be faster and greatly simpli- because of the use of decks of ted circuit cards, overall modular struction and vastly improved self- king features.

An M/R survey of many of the ntry's leading producers of success- checkout systems has indicated the owing:

• Conventional systems for many lications certainly will not be made olescent by the higher speed tran- rized systems in development.

• Those manufacturers taking the e expedient course in developing conventional checkout systems now have an operational capability.



BLOCK DIAGRAM of a generalized solid-state automatic checkout system.

• Almost all manufacturers paralleled conventional systems development with an R&D effort at their own expense to design fully transistorized systems. To date, M/R has found only one—by Curtiss-Wright Corporation—that is operational. Others have developed prototypes and in some cases the military has proffered contracts to marry systems to missiles and aircraft.

• There exists an urgent need for a government requirement for designing future missile systems to accept automatic testing. The burden should not rest solely with designers of automatic checkout systems. (It should be noted that the cost of matching specialized individual test units with a weapon system is approximately 15 times that of automatic universal-type systems.)

• There also exists an urgent need for government standardization of automatic test procedures.

• Greatest stumbling block in developing very high-speed transistorized checkout systems has been in the state-of-the-art levels of the various major sub systems—computer technology is vastly more advanced than other units. In particular, one problem area has been the transient reaction time associated with switching matrices. In computerizing high-speed testing, the system must have high-speed programmable devices. Another thorn has been the access problem to meters—that is, the ranging and scaling by pulses in both stimulation and test equipments. Finally, development of a satisfactory programmable power supply has been slow.

• As might be expected, checkout system development has followed a pattern of self-standardization in general design and in functional subsystems. Real variance occurs in unit configurations only with final application.

• **Generalized system**—In general, information governing automatic test procedures is provided by paper or magnetic tapes, from punch cards or is manually directed into some kind of program register and sequencer. Some checkout systems use a supplementary wired patch board panel; with others, the patch board provides complete direction. To insure proper functioning of the primary information input, some type of parity check is made.

Information normally is stored to indicate not only the nature of the tests to be performed but certain tolerance limits of the response. A control of the timing sequence to perform various tests often is included. A central gating system frequently is provided to insure that tests are conducted in a sequence that cannot damage or destroy the system under test.

Finally, certain self-test procedures are included to check the operation of the checkout system itself. This usually includes some kind of a cutoff device which will stop the sequence of tests in case of a checkout-system failure until such time that the defective unit (or units) has been corrected.

Next week: the fully transistorized automatic checkout system developed by Curtiss-Wright Corp. will be presented. Its application to a Nike *system will be explored in detail.*

Input signals to the system under test are generated in several ways. A digital-to-analog converter is used to transform a digital value in a program register into either an ac or a dc voltage. At times, special signals, peculiar to the system under test, must be generated. At this time, the program register may be used to direct the appropriate signal. After feeding various stimuli into the system under test, response may have to be transformed before being converted into digital values.

Transducer outputs may require corrections for nonlinearities. Following this, a series of converters is used to convert the system response into digital form. These values can then be compared to the limit values in the program register and results can be displayed visually and printed.

Many systems also incorporate a manually operated phase. When in the manual mode of operation, the programming tape is not employed. This gives the system considerably more flexibility and enables it to be used in different phases of development or production in a missile weapon system program.

In most automatic checkout devices, there is of necessity a similarity in functional subsystems. To better understand how the typical checkout device is constructed, major subsystems are described below.

• Programmer—The programmer is the central element of a checkout system, providing storage for the various parameters and control information characterizing the test procedure. Information concerning one or a number of steps may be stored at one time. A large number of techniques for storing information are employed: transistorized flip flops, magnetic cores, magnetostrictive lines, or a combination of storage media may be appropriate.

• Stimulus generators—A multitude of stimulus-generating equipment may be employed, according to the nature of the tests being performed. In general, the application of stimuli, as indicated earlier, is directed by the programmer. Typical generators might be high-frequency units with various types of modulators, mechanical stimuli motors, temperature controlling equipment, pressure generators, rate and acceleration generators, etc.

• Signal transformers—The talkback signals often must be transformed before conversion to digital form. Transducer outputs, for example, may need to be amplified and linearized before conversion. Some r-f and power measurements may require an intermediate conversion before digital information can be derived.

• Analog-to-digital converters—As already indicated, analog-to-digital converters are provided. In addition, other types of converters must be used to convert to digital form the position of servos and synchros. Both mechanical and photoelectric encoders may be used.

• Comparators—Many means are available for comparing the magnitude of two digital numbers. One method is to scan the two numbers from the most significant end and note the first position in which the two differ. The number that has a one in that position is the larger but this assumes certain sign conventions.

Probably the most frequently used logic system is the method of subtracting one number from the other and observing the sign of the difference. The advantage of this method is the yield of the magnitude of the difference which may be necessary for display or recording.

In checking limits, both the upper and lower must be compared. The two operations can be performed sequentially by one device or simultaneously by separate converters. For very high speeds, completely parallel systems may be employed.

• Readout or display—Readout of checkout system can be in one or both of two forms, temporary or short term. Readout may be by warning lights, numerical display, or audible alarm. It may be permanent—such as printed tape, punched card or tape, or magnetic tape.

• Printer and/or recorder—A permanent record of the tests is normally required for future reference and further analysis. This calls for use of printers or recorders.

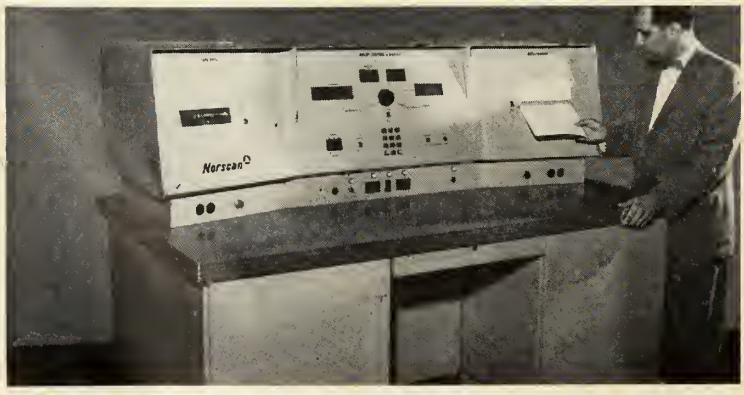
• Storage unit—If information is to be displayed and held at each step, or if it must be printed and recorded, some form of intermediate storage is necessary. Solid-state flip flops together with power amplifiers (required to activate displays) can be used for this purpose.

• Solid-state design—In the current state-of-the-art, almost all of the various checkout equipments described can be constructed using only solid-state active elements. There are a few exceptions, such as the r-f generators and talkback transformation devices.

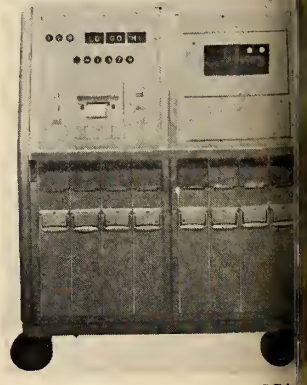
In designing the checkout system with solid-state components, the use of mechanical devices is minimized as much as possible. For example, dc amplifiers employ silicon transistors rather than mechanical devices for stabilization. In general, there is an optional use of either silicon or germanium transistors depending on the temperature requirements in the system. Magnetic elements such as shift registers and coincident current memories can be used, and magnetic regulation is employed in the system power supplies.

Packard-Bell Electronics Corporation, Los Angeles, has been designing and developing a number of units

Typical Fully Transistorized Checkout Systems



NORTHROP CORP., Nortronics, fully transistorized Norscan console (without stimuli-generating equipment) now in prototype form.



STROMBERG-CARLSON SCA using flexible functional module

eckout systems. In their design phi-ophy, they use etched circuitry as tensively as possible. In addition, ty employ the largest possible odules consistent with etched circuit thniques and with minimal spare part ventory requirements. Their reason: provides a significant increase in re-bility by minimizing the need for ring between boards. They also em-oy etched bus-board for interboard ring to eliminate individual wires.

Another problem area eliminated Packard-Bell is the use of positive tact connectors. For each module uiring individual interboard wiring, nnections are made physically and ctrically to the etched circuit, thus minating faulty contact difficulties en associated with etched board con-uction.

• **Trend index**—Along with the de-opment of solid-state checkout sys-ms, new concepts for the use of these vices are being incorporated. Curtiss-right Corporation of Santa Barbara, Calif., with their now-operational *Nike*-stem checkout equipment, and Nor-nics of Hawthorne Calif., with its ototype Norscan system, are both ilizing a "trend" or "confidence" ex. Employed in a similar manner, t idea is a step beyond that of more ntemporary go-no go type testing.

Nortronics has described its con-fence index as follows: The test read-t that is made is compared not only ainst established no-go limits but is ighed in relation with the reading de just prior to it. For example: uld a low voltage be fed into an plifier which doubles the voltage plitude, the comparative limits of t amplifier output are adjusted to npensate for the low input per-tting the amplifier gain to be on the h side, with a resulting acceptance o the two units because the summed ult is within the design limits. This comparison in Norscan will be accomplished by a processor which makes the necessary arithmetic computation.

If a no-go reading is obtained, the test equipment goes into a hold configuration and isolates the malfunction in the system under test to the next-lower level. If isolation to a still lower level is desired, it may be accomplished by using a mode selection capability incorporated in the test set. In this case, the operator can remove the subsystem causing the problem, connect into the test equipment individually, and perform more specific tests, or a different set of tests for that particular subsystem.

If a go indication is received, readout indicates to the operator just how good the go signal was. This data is provided in the form of a two-decimal digit presentation reading from 99 to zero.

In the initial phases of any developmental program, the system designer must establish the design center he is trying to achieve. He then arbitrarily establishes no-go limits. Until the test program has proven what these limits actually should be, the trend or confidence index is a means of utilizing past experience to indicate that a particular reading does or does not have too much effect on the accuracy or reliability of a particular system.

• **Exact limits**—The final values used in an index of this kind are derived by simulating a system in a computer (such as the IBM 704) and then by varying the parameters that are to be tested to determine their effect on the overall system. By this means, exact design limits can be established and variation effects of these parameters can be determined.

Each parameter is assigned a weighing factor. Then, as the system is tested and data recorded, a weighing factor is assigned to each one of the reading. Following the tests, a summation is made of all test limits with their weighing factor resulting in the two-decimal digit presentation.

Another important part of the original derivation of values in the index is the separate determination of values for reliability, accuracy and safety. These may be presented as three separate readings or may be combined in one overall index number.

• **Reliability**—Link Aviation Inc. of Binghamton, N.Y., believes that each specific system must be analyzed in detail before an intelligent definition of the checkout requirements can be specified. In general, design of any automatic checkout system requires primary compliance with system reliability as well as the fundamental concept of inherent versatility.

Systems must not only be simplified to permit maximum utilization by semi-skilled or unskilled personnel, but they must be capable of performing all tests necessary for the checkout of the system of subsystem and the various components in the subsystem. Thus the company believes that the more contemporary go-no go type checkout gear best meets these requirements.

But Link has indicated also that means should be provided for the generation of additional programs which may prove to be necessary. These would be performed by operators at the engineering level. With respect to reliability of the check out equipment, of necessity, it must be considerably better than that of the equipment under test. Link has stated the following requisites to be obtained with such high reliability:

1) System self-check should be accomplished as a requisite to any system test and should be executed from the most straightforward manner possible. The capability should be such that the self-check could be made by depressing a push button any time and without replacement of the tape or cards being used at the moment.

2) Redundancy bit checking should be included in the design of any checkout system in the manner which will interrupt the test routine when a discrepancy in coded signals is detected. Audible and visual alarms should be activated at the same time to provide suitable indication to the operator.

3) In some systems where considerable hazard is likely from the generation of faulty commands or where a dangerous situation can result from component failure in the checkout equipment, a policy of permissive progress should be employed. This requires the testing equipment to generate signals indicating successful completion of each command before the next information can be read and acted on.



RTH AMERICAN AVIATION, Autonetics, fully transistorized type GS-1 (C2-4A) includes simulation equipment. It is now in production.

Space Observatory in Three Years

NASA is spending $3.5 million to solve the remaining problems and bring a revolution in astronomy; 1.5 million pound thrust engine clusters are believed adequate

by Hal Gettings

WASHINGTON—Today's space research programs offer a golden opportunity to astronomy. We can now foresee—possibly within three years, according to Dr. Leo Goldberg, of the University of Michigan—astronomical telescopes on satellites orbiting the earth.

Eugene Root, Lockheed Aircraft, has predicted that during the next decade "astronomical observations from space vehicles will be an accomplished fact (and) will revolutionize conventional astronomy." He indicated that future astronomical techniques may bring the answer to the evolution of the universe.

According to Prof. Lovell, the British astronomer, satellite-borne radio telescopes will be able to look back billions of years to obtain information on the state of the universe as it existed then.

The earth's atmosphere and ionosphere act as a screen to most of the electromagnetic spectrum of radiation from celestial bodies. The establishment of space observatories will put man on the other side of this curtain —and reveal many of the secrets of the universe hidden from him today.

Artificial satellites and planets make possible a whole series of experiments and observations which are unique and lead to tests of the very foundations of physical theories. Space research introduces the element of controlled experimentation into what has always been fundamentally an observational science.

Much work has already been done; much remains to be done if the proposed three-year schedule is to be met.

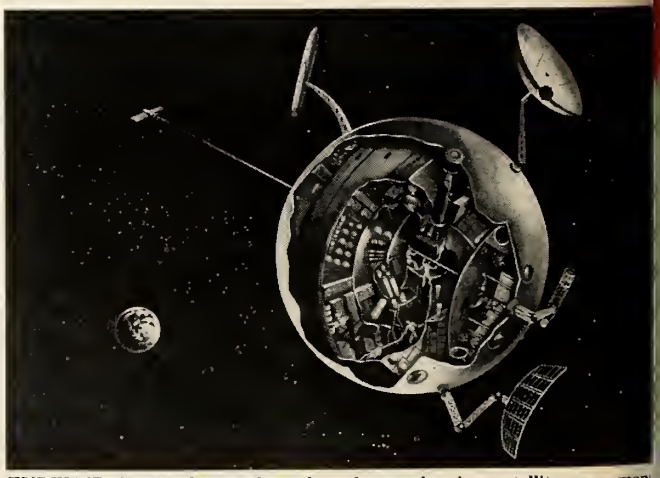
• **Step number one**—The first step has been taken with the spectroscopic photography of the sun's radiation in the light of Lyman—a line of hydrogen. This was done by a rocket camera fired to an altitude of 123 miles. A technique has also been developed to scan a selected spectrum and telemeter the observed intensities back to earth—a method leading itself to satellite observation. Work is currently being done on development of 8-inch and larger telescopes with necessary television equipment to transmit observations to ground stations.

Approximately $3.5 million has been budgeted by NASA for study and development of problems directly concerned with astronomical satell (performance requirements, protot telescopes, command-control and d handling and transmission, vehicle sign and construction).

• **Problems**—Many problems m be solved before successful space servatories can be established. Pr ably the major one is a vehicle capa of placing a payload of several th sand pounds in orbit. It is expec that the 1.5 million-pound thrust gine clusters now under developm and scheduled within the next t years can do the job.

A host of instrumentation proble must be solved before the observat becomes a reality.

The satellite telescope must only be stabilized so that it will pc



FURTHER in the future than the telescope-bearing satellites are man observatories like this 250,000-pound vehicle envisioned by Rocketdyne ar

curately in any desired direction in ace; the direction of pointing must o be controllable from the ground.

An adequate power supply must be ovided with reasonable long lifetime. e technique of using solar cells has en notably successful in the case of *nguard 1.* The same technique could used on an expanded scale to pro- ce 10-20 watts of power, which uld be satisfactory at present. Radio- ive sources and chemical fuel cells o offer promise.

Most of the problems connected h the storage of data and its trans- sion to earth have already been ved to an extent with earlier rocket l satellite experiments.

There still remains the extremely icult problem of designing optical tems and detectors that will operate h high efficiency for radiation of y short wave length.

• **Experiments**—The Space Science ard of the National Academy of ences and its ad hoc committees e been working to prepare an out- of what seem to be, at present, most important space experiments. y are aware, of course, that it is realistic nor even possible to list the many exciting astronomical ex- ments that could be performed n space vehicles. According to Dr. dberg, chairman of the Astronomy Radio Astronomy Committee, this ine is intended only to point out possibilities to potential investiga- who may realize the very great dity with which space technology dvancing.

• **The sun**—The sun is certainly an ct of very high priority for study. the only star whose detailed sur- features can be studied and its tion has a very direct and prac- influence upon our daily lives. Every advance made towards the understanding of the sun serves also to expand our knowledge of the other stars. Although a vast amount of knowledge has been accumulated about the sun, many of the most fundamental questions concerning its structure and activity are completely unanswered. Our knowledge is most deficient with respect to the outermost layers, the chromosphere and corona, both as regards the structure of these layers and the nature and origin of the often catastrophic disturbances that take place within them.

Many interesting experiments are being planned for the observation of X-rays and ultraviolet radiation from the sun. Perhaps the most urgent is the reconnaissance of the spectrum with scanning spectrometers. This experiment need not await the development of refined stabilization techniques since a great deal can be learned from analysis of radiation averaged over the whole disc of the sun. As soon as accurate pointing capability is acquired, small regions on the surface can be isolated for more detailed studies.

A second series of experiments would involve recording images of the entire sun in monochromatic radiation at ultraviolet and X-ray wavelengths. Similar monochromatic photographs made in visible light from the ground have already constituted a major source of information, particularly with respect to the transient disturbances.

An interesting byproduct of the solar spectrum studies would be the determination of the densities of the constituent atoms at altitudes above 200 kilometers in the earth's atmosphere.

The observation of radio waves at frequencies below about 20 mc, which are reflected back into space by the earth's ionosphere, are also of interest. Particular importance is attached to the solar radio bursts in the very low frequencies. The dynamic spectra of these bursts, which originate high up in the chromosphere and in the corona, have been observed to a low-frequency limit of 40 mc. The so-called type II and type III bursts, which begin at high frequencies and occur progressively later at the lower, have been interpreted as resulting from corpuscular streams propagated outward through the solar atmosphere at speeds varying from a few hundred to a few tens of thousands of kilometers per second.

• **Moon and planets**—Investigations of the moon and planets will be carried out with space probes and by actual exploration. The moon will be the first object for investigation, and the next few years will probably see a variety of experiments including:

1) Return of lunar surface samples to earth.

2) Measurement of density and composition of possible lunar atmosphere.

3) Study of composition and structure of surface and interior of the moon.

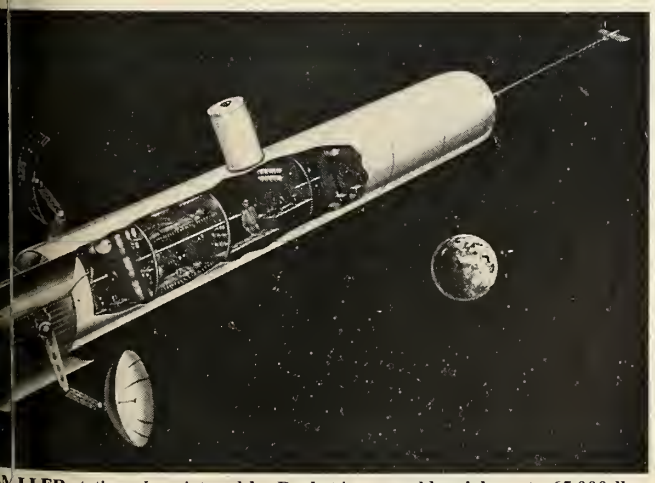
4) Measurement of lunar magnetic fields.

5) Investigation of presence or absence of dormant life spores.

The planets may also be explored from satellites and space probes with packages of instruments to obtain pictures with different wave lengths of radiation and for the detection of numerous phenomena such as magnetic fields, planetary ionospheres, lighting flashes, aurorae, etc. It has also been proposed that radar pulse probes be used to display the surface roughness of planets.

The success of many of the planetary probe experiments will depend rather critically on the amount of power available for the transmission of information back to earth. For example, it would be useless to send a space probe close to Mars to televise its surface unless the resolving power of the image received is smaller than about 25 miles; otherwise just as good or better results can be achieved with a 50-inch telescope mounted in a high-altitude balloon.

In the very immediate future the most profitable investigations of planets from the vicinity of the earth will probably be carried out by balloons rather than satellites. Considerable work in this area is continuing under Office of Naval Research projects "Stratoscope," "Skyhook," and "Stratolab." Commander Malcolm Ross, with Dr. Strong of the University of Maryland,



LLER station also pictured by Rocketdyne would weigh up to 65,000 lbs., ering a launching booster vehicle with about 6 million pounds of thrust.

feels that much more can be done with this program and that balloons should be used for all observatory work below 150,000 feet. As in many other programs, money has been the limiting factor.

• **Stars and nebulae**—Satellite investigations of the stars, nebulae, and interstellar medium and external galaxies are at least an order of magnitude more difficult experimentally than those dealing with the sun, because of the relative faintness of the sources and the stringent requirements for accurate guidance and control. Furthermore, astrophysical measurements from rockets have to date been limited almost entirely to solar spectroscopy and, therefore, the galactic experiments are not so well defined as the solar experiments. For these reasons, galactic and extra-galactic research from satellites will probably proceed in two stages. It is extremely important as a first step that the ultraviolet radiation from night sky be mapped quickly, even relatively low angular and spectral olutions. A start has already been n with rockets by the Naval Rese Laboratory.

A number of astronomers proposed experiments for compre sive sky surveys designed to yield m urements of the radiation density number of wave lengths and with ing degrees of angular and spe scopic resolution. If the wave len are properly chosen, valuable infor tion can be obtained on the phy state of interstellar matter, on the u violet energy distribution of bright, stars, and on the relative contribut to the integrated radiation backgr of starlight, galactic light, extra-gal nebulae and zodiacal light.

After the sky surveys, the next s of galactic investigation would c with the establishment of accur controlled telescopes in satellites has been estimated that it will be sible within three years to mou telescope on a stabilized platform sufficient control and pointing accu to permit the imaging of indivi stars. Two groups are already at w on the design and development such telescopes.

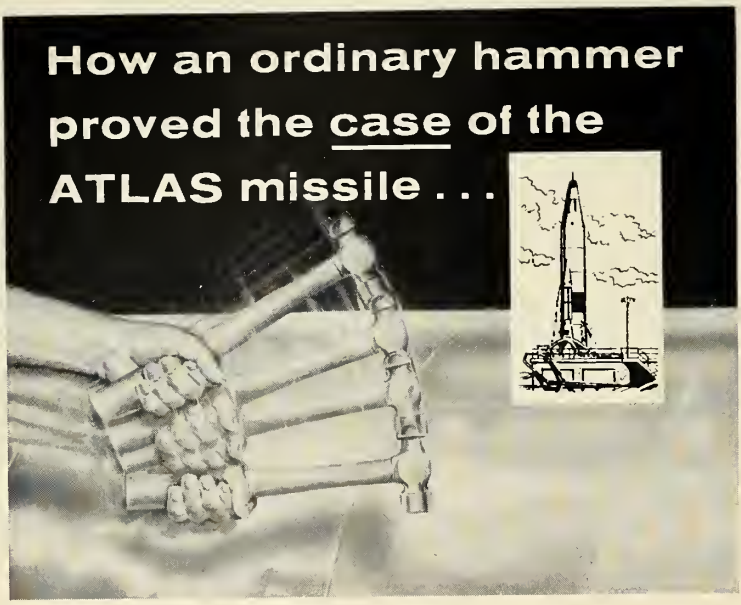
The first few years of sate astronomy will probably be devote the astrophysical analysis of ultrav radiation. This is an area where loons cannot be used since the u violet frequencies are absorbed ozone and photochemical reactions low 150,000 feet.

As the technology of instrume tion advances, it may be expected there will be important application the field of astronometry—the pre measurement of the positions and tions of the stars.

• **Solutions**—Three sources of nificant systematic errors would eliminated by a telescope mou above the atmosphere: imperfect tr parency and seeing and atmosph dispersion. Images would be sm and fainter stars would be reached. additional great advantage would the attainment of high optical resol power in the ultraviolet. Condit would be particularly favorable for serving faint white dwarf stars, whe single or components of binary st

A survey for binary stars am "single" stars would be more p trating than from the bottom of atmosphere. In particular, it shoul easier to discover faint companion s and possible planetary compani The possibility of discovering m faint red dwarf stars would also enhanced in the absence of atmosph absorption in the red and infr regions of the spectrum.

How an ordinary hammer proved the case of the ATLAS missile . . .



The body of the missile, essentially one big fuel tank, is similar in principle to an inflated football. Convair-Astronautics broke new ground in missile design by developing a super-strong structure with a comparatively thin stainless steel skin to keep weight to a minimum. This stainless steel skin is so thin that the interior has to be pressurized to preserve the shape of the body as propellants are consumed in flight, or when the missile is being transported on the ground.

Some critics, however, thought the body was too fragile—"You could dent it with a hammer." So, recently, when the Scientific Advisory Board, engaged in a re-evaluation of all missile programs, arrived at Convair-Astronautics to take a reading on the ATLAS, they found that Convair had thoughtfully placed a number of hammers within easy reach of a finished missile. "Go ahead, bash it," invited Convair. The SAB members swung lustily. *Not a dent was registered*, for, although the walls are thin, the stainless has a minimum tensile strength of 200,000 psi.

This stainless steel skin material, supplied by Washington Steel, required extremely close control of mechanical properties and gauge tolerance which are regularly produced through Washington Steel's long experience with precision rolling equipment.

Stainless Steel—the Space Age Metal

Washington Steel Corporation

6-H Woodland Avenue
Washington, Pa.

Report from West Germany

The following dispatches were sent m West Germany by M/R's executive tor, now touring Europe.

by Clarke Newlon

RAMSTEIN, GERMANY, Hq. 4th Allied ctical Air Force—Russia has "hun- ds" of 700-mile ballistic missiles facing stern Europe, according to intelligence orts which reach Maj. Gen. Gabriel llon Disosway, commander here. They not in the satellite nations but are bile, some of them poised on rail cars, l can be moved at a moment's notice.

These are in addition to IL-10 Beast ck planes, Mig 15s, 17s, and 19s, 28 jet bombers and Yak-25 all-weather rceptors. The planes are all missile riers, and although the IL-28 poses the atest strategic atomic threat, nearly all st be assumed to be nuclear-capable— are the ballistic missiles.

Facing some 3000 Soviet and satellite mbat aircraft, Gen. Disosway, a native Pomona, Calif., has 1500 U.S. and nch combat planes, but figures those s are not too great. Also under his op- tional direction is a brigade of *Nike- rcules* air defense missiles operated by Army, but carefully coordinated under 4th ATAF defense plan. Air bases at hn, Bitberg and Sembach have the -mile air-breathing, nuclear warhead rtin *Matador* at the present but will n change over to the more modern *ce,* which requires no ground guidance.

Russian and satellite ground forces are pped with 20-mile air-breathing mis- . All in all the West faces a Soviet at of probably 20,000 combat air- t (150 heavy bombers, 1000 medium mbers and the rest fighter planes) plus divisions of ground forces, plus also tever longer-range missiles Russia may e. It takes, incidentally, about 15 min- for a Soviet bomber to reach Ram- from the edge of the Iron Curtain.

Contrary to published reports, Gen. sway did not say that the U.S. nned" to move three U.S. fighter bases France (Etain, Toul and Chaumont) use the French would not permit the ge of nuclear warheads. He did say his headquarters, which includes three bases, "had plans" to move and prepared to move.

Also on the military-political front, he that his C-130 cargo carriers had run high-altitude missions into Berlin, one March and one in April, contrary to et edicts, and that he thought the should run them regularly to prepare an airlift if one is necessary. The Russian fighters mildly harassed the first flight, did not bother the second.

He added: That Germany would be too close for IRBM's. (The German minister of defense once remarked: "You don't put artillery in the foxholes of the ground forces"). That 700-mile ballistic missiles for NATO nations would be most welcome, especially since the *Mace* program has been knocked back $100 million by the House. That the F-102, of which he has thus far one squadron stationed at Bitberg, will carry both the *GAR-1* and the *GAR-11 Falcon*. The *GAR-1* is conventional but the *GAR-11* packs a nuclear punch.

Germany Would Make *Hawks* Under License

ERDING, GERMANY, Hqs. Luftwaffen Gruppe Sud—West Germany is not working on a defense against the ballistic missile because it believes this is a NATO problem but German industry is working on a radar defense against low-flying aircraft and has made some progress, according to Brigadier Johannes Steinhoff, deputy chief of staff for operations, Ministry of Defense.

At this headquarters of the German Air Force Group South, the Luftwaffe ace whose face is badly scarred from a Messerschmidt jet flameout and crash near the close of World War II, said:

The German government is working to lift the restrictions of building missiles (now limited to two meters in length and 30 centimeters in diameter) so that Germany can manufacture the Raytheon *Hawk* under license: that Messerschmidt, Heinkel and Dornier have formed a combine to manufacture the Lockheed F-104 in Bavaria. Germany will buy 66 F-104's direct from the Lockheed plant, plus 20 two-seat trainers. They plan to manufacture about 250 in southern Germany. The Air Force controls all air defense, even including ack-ack, and will operate the three *Nike-Ajax, Nike-Hercules* battalions it will get from the U.S. These units have already been trained in the States and the first battalion (*Nike-Ajax*) will be operational in the spring.

That one German unit is already in training for the *Matador;* that the French Fouga-Magister trainer will replace the U.S. T-6 and that the Italian built (Fiat) G-91 will replace the U.S. Republic F-84 as an interim combat fighter plane until the F-104 enters GAF service, probably in 1961-62.

That under Germany's depot system, the GAF does only about 20% of its maintenance with the other 80% being farmed out to industry. That the GAF gets its equipment from three sources: grant aid from U.S., purchase from USAF and purchase direct from the U.S. manufacturers. Germany will shortly begin paying most of its own way, one of the reasons the GAF is holding up a decision on purchasing the Republic F-105. It is too expensive to buy and maintain. This deal is not completely cold, however, and some arrangement might be worked out, including European pool manufacture.

There are about 40,000 total personnel in the GAR now. It is expected to have about 100,000 with 20-22 wings, half tactical and half defense, by 1963-64. All units will be committed to NATO.

French Atomic Complaints

LAHR, GERMANY, Hq. First Commandement Aerien Tactique (C.A.TAC) —The French ban on atomic storage for missiles and aircraft also extends to French NATO units stationed in Germany, Maj. Gen. Raymond Brohon, commander, said here. The urbane French officer, who flew with the RAF during World War II and who spent four years in the Pentagon on the NATO Standing Group, also somewhat bitterly echoed the words of his chief, Gen. deGaulle, regarding the U.S. restrictions on atomic information exchange.

"You are refusing to give your allies what is known to your enemies," he said.

He also thought that France, when able to produce its own atomic bomb, might carry out testing (in the Sahara desert, perhaps) regardless of any agreement which might be entered into by Russia, the U.S., and Great Britain.

General Brohon also felt:

That using the F-84 (an old lady) by his forces for the next two or three years would be a waste of the human element. (His pilots are too well trained for that). That he would like the F-104; that he now has 1.2 pilots for each plane and wants the NATO standard of 1.5.

That C.A. TAC will soon have four batteries of *Nike-Ajax* air defense missiles. He has no roles and missions problem. All are controlled by the Air Force although he had to request personnel from the French army to man three of the batteries. That in spite of the fact some of his French NATO units are deployed in Algeria, C.A. TAC maintains 10% of its force on 15-minute alert during non-working hours—more, of course, during the working day.

—reviews—

HYPERSONIC FLOW THEORY, Wallace D. Hayes and Ronald F. Probstein, 464 pp., $11.50.

What started as an 80-page review paper has grown into a formula-packed, amply illustrated book on the fundamentals and present state of knowledge of hypersonic flow theory. It is aimed at research workers and students as a text in graduate courses and serves as an introduction not only to HFT but also to modern approaches in theoretical aerodynamics in general. However, a course in gas dynamics or compressible fluid theory is prerequisite.

Subjects covered include small disturbance theory, constant-density solutions, theory of thin shock layers, other methods for blunt-body flows, other methods for locally supersonic flows, viscous flows, viscous interactions, and free molecule and rarefied gas flows.

TARGET FOR TOMMOROW, Dr. I. M. Levitt, Fleet Publishing Co., New York, 328 pp., $4.95.

Dr. Levitt, director of the Fels Planetarium of Franklin Institute and contributing editor of M/R, starts with what is and then essays to predict what's next in the unfolding of man's space goals. Beginning with an analysis of rocket and satellite development to date, the book's orbit takes in conquest of the moon, life on other planets, man-made space stations and satellite weather bureaus and analyzes the technical problems involved in space pioneering. Although the presentation is solidly grounded in scientific fact, Dr. Levitt writes clearly, simply and colorfully, painting an excellent backdrop for the coming space drama.

DECIMAL CLASSIFICATION OF ASTRONAUTICS, The Council of the International Astronautical Federation (IAF), available from H. H. Koelle, Chief, Future Projects Design Branch, Development Operations Division, Army Ballistic Missile Agency, Huntsville, Ala.

If you've had trouble—as most people do—in locating astronautics material in your filing system, this classification system could be an invaluable aid.

The classification was adopted by IAF to give astronautical scientists a tool for filing of references, technical papers, preprints and working material in a simple and logical frame of reference. It is specifically tailored for small research institutes, working groups, small specialized libraries, individual departments or laboratories in large companies and, specifically, for the individual scientist and engineer who is interested in keeping up to date in the general field of astronautics and its applications on a broad basis.

west coast industry . . .

By FRED S. HUNTER

A good many secondary power people feel this has been a neglected phase of missile development. "It gets third class treatment," said one. "It's just a component to be put together with bits and pieces we have on hand." Secondary power, of course, is a critical factor—the auxiliary power system caused most of the delay in reaching the free fall stage on the *X-15*—but while it may not have received top recognition in the early stages of missile development, it's moving up the scale now.

Aerojet-General Corp. has designed and . . .

produced an auxiliary power unit for the *Titan* ICBM. It is a hydrazine liquid propellant unit, which feeds into a gas generator, thence to a turbine. It has a dry weight of 95 pounds and develops approximately 30 shaft horsepower. In tests conducted to check the temperature danger level for the first shaft bearing, which takes most of the heat load, Aerojet has operated the unit continuously for one hour and 15 minutes without any noticeable temperature rise. In operation, it has achieved a variation of one fourth of 1% plus or minus in frequency and voltage variation in demonstrating a requirement of 1% plus or minus. This unit is scheduled for installation in lot G of the *Titan*. In the final analysis, however, it is still more likely that operational *Titans* will use batteries for secondary power.

Batteries have won the battle . . .

for secondary power for the *Atlas* ICBM. Wet cell batteries are used in the *Atlas* to drive a Bendix AC inverter. After spending something in the area of $20 million, Convair-Astronautics halted expenditure of further funds for Sundstrand's development of a monopropellant power system for the *Atlas*. Sunstrand had come into the *Atlas* secondary power picture through its purchase of the American Machine & Foundry Co.'s Pacoima division. Latter had been working on a bipropellant system for the *Atlas*. Sunstrand changed to monopropellant after it took over. Convair is buying silver salt batteries from Yardney Electric, The Eagle-Picher Co., the Cook Co. in Denver and AMF. It wants a battery with indefinite shelf life.

The DC-3 of the target drone field . . .

might be a good way to describe the OQ-19. The Radioplane division of Northrop Corp. has been turning out OQ-19's since 1946. It is nearing production of its 50,000th target drone and the end is not yet in sight. Currently, it is in production of more than 2150 OQ-19's for the Air Force. This contract, including spares, comes close to $6 million and deliveries run through November. For the Army Signal Corps it is building 612 SD-1 surveillance drones, and these are reworked OQ-19's. Currently being flight tested at El Paso is the new RP-78, designed for improved altitude and higher speed performance. It employs the OQ-19 control system.

Employment increase from 10,000 to 12,000 . . .

is projected at the Autonetics division of North American Aviation in the next 12 months. Among the bigger Autonetics programs is guidance for the *Minuteman*, the forthcoming solid-propellant ICBM. But the big show on *Minuteman* right now is the mobility program. This stems from the Strategic Air Command, which recognized the need for mobile launching for the *Minuteman* to supplement the underground launching sites originally planned.

Most indications are that about one third of the *Minuteman* striking force will be mobile by rail, truck, barge or what have you. New contracts are ahead, and they may be among the biggest expenditures of the entire *Minuteman* program (M/R, June 1, p. 19).

The Navy may have a requirement . . .

for a turbofan engine in the 9000 to 12,000-pound-thrust area for the missile carrier in the *Eagle* project.



SENTER

Maj. Gen. William O. Senter, director of Procurement and Production at Headquarters, Air Materiel Command, for the past two years, will leave Wright - Patterson AFB for an assignment in Washington, D.C.

Maj. Gen. Waymond A. Davis was promoted to that rank from brigadier general to succeed Senter. Davis was AMC's deputy for production. Also announced was appointment of **Col. Henry MacDonald,** AF *Jupiter* Liaison Officer at Huntsville, Ala., as AMC's dep-



DAVIS

for production.

Gen. Senter will become assistant dep chief of staff, materiel, at Headrters, USAF.

Earlier, announcement had been made Davis would become director of ls and Programs. According to AMC, e orders have now been revoked, and ouncement of the officer to fill this tion will be made later.

The Director of Procurement and Proion at AMC is responsible for comon of Air Force purchases which age close to $10 billion a year.

The Lockheed Electronics and Avionics sion (LEAD) has filled two major neering management positions.

Paul F. Pearce was named manager of ect engineering and **Gunnar Wenner**e will head product development. e ce joined LEAD with an extensive a ground in managing the design and e lopment of electronic systems. Wenerg's electrical engineering career s 17 years including a decade in varieengineering management capacities at e.

Callery Chemical Co.'s newly established West Coast office, part of an expansion of its Defense Products Department, will be headed by **Dr. Robert G. Brault.** With Callery since 1954, Brault formerly was supervisor of subcontract research and coordinator of



BRAULT

nig-energy fuel projects at the firm's Re arch and Development Laboratories n allery, Pa.

"Determination to consolidate an important position for itself in the field of missile weapons systems, and to become a major subcontractor for U.S. missile work," is behind organization of a new missiles and systems division and appointment of **Robert D. Richmond** as vice-president of Canadair, according to the company. Richmond, formerly chief engineer of special weapons, will head the new division.

This move follows eight months after termination of Canadair's *Sparrow* missile program.

The new division, Canadair says, is set up to be "strongly competitive with United States sub-contract firms and thereby gain a share of contracts which are made available to Canadian companies under the production sharing arrangements which exist between the two countries."

William C. Benson, newly named project engineer, ground support equipment, for Solar Aircraft Co., came to the firm from Beech Aircraft Corp., where he was manager of support equipment sales. His appointment is part of a program to "bolster Solar's capabilities in the growing area of ground support and handling equipment."



BENSON

George E. Smith who has a 20-year background in manned aircraft, pilotless bombers and ballistic missiles, has been named general manager of The Martin Co.'s Cocoa Division at Cape Canaveral, Fla. Smith succeeds **G. T. Willey,** recently named vice president and general manager of Martin's Orlando Division.



SMITH

Smith will direct the company's test operations and related activities at the Atlantic missile range.

Maj. Gen. E. Blair Garland, USAF ret., will join Philco Corp.'s Government & Industrial division as manager of a new military communications group.

This special technical unit will handle Philco's 19-million-dollar AIRCOM (international communication system) modernization contract from the Air Force and similar contracts.

Philco also named **Henry E. Hockeimer** as AIRCOM project director. New AIRCOM staff members are **Donald B. Clyman,** administration and services manager; **Morton L. Long,** engineering manager, and **John Pell,** installation manager.

Martin E. Dykeman will direct a program to broaden applications of glass, ceramics and Pyroceram materials in aircraft and missiles for Corning Glass Works' New Products division.



DYKEMAN

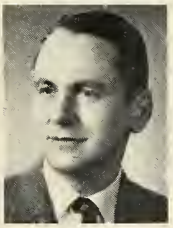
The aircraft and missiles group formerly concentrated almost exclusively on materials and process development.

Dykeman has been with Corning Glass Works for 19 years, most recently as a sales engineer handling optical products such as glass infrared missile domes.

German scientist **Dr. Herbert Kromer** is Varian Associates' latest addition to the Central Research team organized last year under **Dr. Louis Malter.**

Krömer will be senior research scientist. His nine years of experience in the semiconductor field both in the United States and abroad include several years as a research physicist in the semiconductor group at RCA laboratories, Princeton, N.J.

Appointment of **David Y. Keim** as chief engineer-Military Products of Stromberg-Carlson's Electronics Division has been announced. Keim previously was Engineering Department head, Microwave and Electronic Equipment, Sperry Gyroscope Co.



KEIM

Dr. Earl L. Steele, a physicist expert in semiconductor devices, has been appointed assistant manager of the development laboratory for the semiconductor division of Hughes Aircraft Co.'s Products Group. Dr. Steele, formerly research chief for Motorola, Inc., is the author of many technical papers on diodes, transistors, and rectifiers, and is an editor of the IRE Transactions on electron devices.



CHERNIAK

George S. Cherniak has been appointed Director of Space Technology Laboratories, Inc.'s Flight Test Operations at the Atlantic Missile Range, Cape Canaveral. He was formerly head of STL's *Atlas* Project Office at the Cape.

A Personal Invitation to
ENGINEERS



from ROBERT McCULLOCH
President

"If you would like to be a member of a select corps of Engineers, working for an interesting, growing company . . in one of the country's most stimulating areas . . I invite you to write to Temco. Temco's growth is sound and planned, its products are diversified and challenging, our facilities are modern. Every benefit, for you professionally and in good living for you and your family, is here. Below are some of the areas in which jobs are open now."

SYSTEMS ANALYSIS & DESIGN

Graduate Electronics Engineer or Physicist to perform theoretical electronic system analysis and design of new projects in the missile and electronic system field. He will be responsible for analyzing the customer's requirements and establishing basic as well as overall design parameters to be followed throughout the development of the project. The System Design Engineer will consider the various operational aspects of the system, including environments as well as collateral and concurrent effectiveness when used with related systems.

GUIDANCE DESIGN

Graduate Electronics Engineer or Physicist to perform design and development of circuits and components necessary to the optimum functioning of missile guidance systems. He will design transistorized pulse and video circuits for use in missile and other electronic system projects. He will be responsible for developing applicable circuitry, working from specified and/or general requirements laid down by the particular system concept as dictated by the needs of the customer. The field of emphasis will be in the development of radar techniques.

Write BILL G. HICKEY
Supervisor Technical Employment
Room 506M, P. O. Box 6191

TEMCO
AIRCRAFT CORPORATION • DALLAS 22, TEXAS

propulsion engineering

Aluminum welding problems? . . .

Air Reduction Company's new book on aluminum won't solve all your problems, but it'll point you in the right direction. The 116-page book covers all aspects from aluminum history and familiar welding problems to state-of-the-art and unusual problems that missile and aircraft people might encounter. Examples of the topics discussed: joining aluminum, the whys and why-nots; aluminum alloys, their classifications and characteristics; the basic welding processes, each covered in detail.

Equipment for aluminum welding . . .

is discussed in the book, also. Air Reduction's staff discusses manual and machine holders, automatic equipment and accessories for the Heliweld process; manual and automatic Aircomatic processes, and their accessories. The book also goes into power supplies for aluminum welding, discusses special products available, and ends on a safety note.

Plastics stable at 1000°F . . .

aren't here yet, but they're on the way, missilemen learned early in the month at Wright Air Development Center's symposium on high-temperature polymers. Missilemen also learned that the most promising polymers in this field, not surprisingly, are inorganics.

High-temperature plastics are experimental . . .

and they will remain strictly laboratory curiosities for some little time, the Air Force says. However, major advances have been made in the past year in this field that is only about four or five official years old. The Air Force, and other armed services, too, want poylmers that can be used as structural plastics, lubricants, hydraulic fluids, and adhesives. They must stand up under high temperature, pressure and friction.

Polymerized oxygen-aluminum . . .

is one of the most promising of the inorganic materials—the one that has come the farthest and is progressing most rapidly, the Air Force indicates. Aluminum-oxygen-based polymers are terrific at high temperatures, one scientist says. However, there's a catch: the fundamental polymer is terrific so far, but now scientists have to find satisfactory side groups which will make the polymer into a usable, finished material. Technically, the polymers are polyaluminoxanes.

New liquid oxygen truck . . .

is available from the Cambridge Company. It holds 2100 gallons, which the Lowell, Mass., firm equates to 234,000 ft.^{3}. The vacuum tank is jacketed with aluminum, cab is plastic.

Ammonium perchlorate output increases . . .

at Pennsalt Chemicals' Portland, Ore., plant as soon as expanded facilities under a $2 million budget jump materialize. Some new buildings already are underway, and Pennsalt says it has started ordering equipment. Company officials won't say how much the perchlorate production will increase, but hint it will be in the "thousands of tons." Sodium chlorate output also will be upped, about 25%.

New fuel cell "is practical" . . .

so says General Electric vp Guy Suits in describing the company's recently announced device. Suits says the cell operates at 60% and higher thermal efficiencies, produces low voltage direct current directly, with no moving parts, from hydrogen and oxygen. He calls it a simple, portable, lightweight, small-volume generator highly reliable for specialty missile and military applications.

Metal coatings process is updated . . .

by Alloyd Research Co. The company has modified and improved an old process for depositing coatings of molybdenum, chromium and tungsten from the vapor state. This makes possible tough, reliable coatings of these metals on intricate shapes.

contract awards

ARMY

2?00,000—**Morrison-Knudsen Co.**, Boise, I.ho, **Paul Hardeman, Inc.**, Los Angeles, Jinson, **Drake & Piper, Inc.**, Minneapo- l **Olson Construction Co.**, Lincoln, Neb., si **F. E. Young Construction Co.**, (joint viture) for construction of an additional r.e underground *Titan* launching sites a Lowry AFB, Colo.

3,0,000—**Douglas Aircraft Co.**, Santa Monica, Calif., for launching equipment.

31:00—**Diversified Builders, Inc.**, Cocoa, F., for construction of *Saturn* block-house at Patrick AFB, Fla.

5022—**American Telephone & Telegraph C. Western Electric Co.**, for *Nike* spare pts.

60·00—**Raytheon Manufacturing Co.**, Andver, Mass., for test equipment, mechanic inspection equipment, material handig equipment and production equipnt to support second generation *Hawk*.

9·00—**Rheem Manufacturing Co.**, Downey, Calif., for warhead.

8 46—**Western Electric Co., Inc.**, N.Y., f *Nike* spare parts and components (six-tn contracts).

9.50—**Reynolds Electrical & Engineering C Inc.**, El Paso, Tex., for *Nike-Zeus* nifications and additions (power portti).

5 76—**Douglas Aircraft Co., Inc.**, Charlce Ordnance Missile Plant, Charlotte, N., for *Nike* spare parts and compon ts.

3945—**MB Manufacturing Co.**, New Havi, Conn., for one item of vibrator test sem equipment for simulating shock a vibration to missile motors.

9,3—**Greenhut Construction Co.**, Pensaco, Fla., for construction of Model IV B lacher shelter for F/M launch facility aSanta Rosa Island, Eglin AFB, Fla.

6.5—**Hartley Boiler Works**, Montgomery, A., for construction of test tower in Bg. 4619 at Redstone Arsenal.

0,3—**Sierra Oxygen Co.**, Reno, Nev., for 94 cu. ft. of liquid oxygen.

3,7—**Gilfillan Bros., Inc.**, Los Angeles, fo repair parts.

6,9—**West Florida Electric Service Compny, Inc.**, Panama City, for installation of n engine generator set and associated wrk at the Anclote site portion of the Eln Gulf Test Range.

4,·—**Andy Electric Co.**, Andalusia, Ala., fo 500 KW engine generator installation fo Guided Missile Test Range, Site D-3 at Cape San Blas, Fla.

2,3—**Princeton University**, Princeton, N., for design and analysis of experim ts.

0,3—**Earl & Wright, Inc.**, San Francisco, fo preparation of concept plans and dgn for SAC missile facility.

3,5—**Bowen-McLaughlin-York, Inc.**, York, Pa for extension of vehicle engineering se ices.

3,5—**Polarad Electronics Corp.**, L.I., N.Y., fo a spectrum analyzer and microwave fle intensity meter.

3,2—**Raytheon Co.**, Newton, Mass., for elctron tubes.

5,6—**Ryan Aeronautical Co.**, San Diego, fo target missile.

NAVY

230—**Fred A. Haycox Co., Inc.**, Lynnhan, Va., for construction of guided miles school annex, Fleet Air Defense Trning Center, Dam Neck, Va.

90,3—**Sperry Gyroscope Co., Div. Sperry Rad Corp.**, Great Neck, L.I., N.Y., for spcial tools, jigs, fixtures and test equipnt for *Sparrow I* missiles.

31,2—**General Electric Co.**, Schenectady, N., for fabricating and furnishing self-adptive flight control system.

51.0—**Microwave Associates, Inc.**, Burlington, Mass., for research and development in the field of solid state microwave techniques (two contracts).

$96,789—**Lockheed Aircraft Corp., Missiles & Space Div.**, Sunnyvale, Calif., for research and development.

$53,946—**Philco Corp.**, Philadelphia, for high-resolution electronic viewing system.

$40,671—**Arthur D. Little, Inc.**, Cambridge, Mass., for research and development study of proof testing of missiles.

$36,891—**Temco Aircraft Corp.**, Dallas, for planning and conducting wind tunnel investigation program and formulating a method of determining aerodynamic loads.

AIR FORCE

The Ralph M. Parsons Company, Los Angeles, for architect-engineering services in connection with the fifth operational squadron base for the *Titan* weapon system at Larson AFB. Total value of the complete facility estimated at $48,000,000.

$38,900,000—**Airborne Instruments Laboratory, Div. Cutler-Hammer, Inc.**, Mineola, N.Y., for the development and design of airborne electronic equipment. (Other companies assisting with this project are: **Aerojet-General Corp.**, Azusa, Calif.; **Filtron Company, Inc.**, Flushing, N.Y.; **Haller, Raymond and Brown, Inc.**, State College, Pa.; **Raytheon Manufacturing Co.**, Santa Barbara, Calif.; **Sperry Gyroscope Co., Div. of Sperry Rand Co.**, Great Neck, N.Y.; **Sylvania Electronic Systems**, Waltham, Mass.; **Temco Corp.**, Greenville, Tex.).

$5,000,000—**Collins Radio Co.**, Cedar Rapids, Iowa, for construction of communications stations for the Strategic Air Command in California and Massachusetts.

$5,000,000—**Kollsman Instrnment Corp.**, for astro trackers plus associated tooling and test equipment for use with **North American's** *Hound Dog* weapon system.

Computer Equipment Corporation has received its largest contract for the development of an advanced space/time velocity data recording system. (Amount not disclosed.)

$915,222—**Aerovias Sud Americana, Inc.**, St. Petersburg, Fla., for the "rocket run," a coast-to-coast airlift of test missiles and engineering research personnel (awarded by MATS).

$500,000—**Cal-Tronics Corp., Div. of Acme Precision Products, Inc.**, for design and production of a group of automatic production diode testers.

$366,597—**Microwave Associates, Inc.**, Burlington, Mass., for study and investigation of design factors in high-powered gaseous discharge switches, research and development of a high-powered beacon magnetron and microwave tube (three contracts).

$150,000—**Texas Instruments Inc.**, for study of a major semiconductor substate device—the TI-developed ultraminiaturized semiconductor solid circuit.

$139,954—**Cornell Aeronautical Laboratory, Inc.**, Buffalo, for continuation of research on hypersonic flow by means of a shock tunnel.

$138,613—**Union Carbide Corp., Linde Co., Div.**, N.Y., for 33,920,000 cu. ft. of liquid oxygen.

$124,073—**The Houston-Fearless Corp.**, Los Angeles, for production of four camera systems and precision mounts.

$73,165—**Aerojet-General Corp.**, Azusa, Calif., for spare parts kit for AJ10-33 liquid rocket sled engine in support of project WS-133A.

$54,717—**Motorola, Inc., Western Military Electronics Center**, Phoenix, for subminiaturized receiver sets.

$50,760—**Technicolor Corp.**, Hollywood, Calif., for construction of a 70 MM continuous contract printer for the AFMTC Photographic Laboratory at Patrick AFB.

$45,690—**Aerojet-General Corp.**, Azusa, Calif., for nonpersonal services for relining thrust chambers in support of project WS-133A.

$32,000—**Miami Engineering Div. of Miami Shipbuilding Corp.**, for a mobile frequency control and analysis van for use in monitoring frequency interference during missile test operations at Atlantic missile range.

$25,706—**Southern Research Institute**, Birmingham, Ala., for research on infrared spectra of heterocyclic nitrogen compounds.

NASA

The civilian space agency announced that it awarded the following contracts during the month of May:

$7,500,000—**Convair Astronautics Div., General Dynamics, Inc.**, for eight two-stage *Vega* boosters plus an additional *Vega* for captive firing tests.

$5,000,000—**Jet Propulsion Laboratory**, for technical supervision of the *Vega* project, planning *Vega* interplanetary missions, and providing a third stage for *Vega*.

$4,400,000—**Air Force Research & Development Command's Ballistic Missile Div.**, for already authorized space probes. To be used toward firing of *Thor-Able* and *Atlas-Able* vehicles.

$1,000,000—**Army Ballistic Missile Agency**, for advanced research into four areas: (1) Propulsion and propellants (2) Guidance studies involving celestial mechanics of trajectories in lunar interplanetary misisons (3) investigation of thermal properties of materials in space re-entry research (4) effects of space environment on physical and chemical properties.

$660,000—**Aerojet-General Corp.**, for 20 sounding rockets (*Aerobee Junior* and *Aerobee-Hi* vehicles) which can send 150 pounds to 150 miles in ionospheric investigations to be fired from both Fort Churchill and Wallops.

$560,000—**Army Ordnance Missile Command**, for multi-frequency radio beacons to be used in earth satellites investigation of the ionosphere.

$350,000—**National Academy of Sciences**, for financing research associateship program by providing study grants at the graduate and post-doctorate levels.

$300,000—**Jet Propulsion Laboratory**, for research and development on improved tracking and receiving equipment for deep space missions.

$200,000—**Massachusetts Institute of Technology**, for assistance in making technical evaluations of facilities and instrumentation in tracking network for Project *Mercury*, the manned space flight program.

$180,000—**Bureau of Ordnance (Navy)**, for 16 third-stage *Delta* rocket motors, 12 of which would be used in the *Delta* launching vehicles. The remaining four to be mounted on *Sergeant* rockets for high-altitude firings from NASA's Wallops Space Flight Station (Va.) to check out sphere ejection and inflation.

$150,000—**Office of Army Surgeon General**, for medical aspects for the successful *Jupiter* shot in which monkeys Able and Baker were sent 300 miles in space and recovered safely.

$120,000—**New York University**, for study of general instability of stiffened circular cylinders.

$110,000—**Jet Propulsion Laboratory**, for a transmitter to be installed at Goldstone, Calif., tracking installation. The project calls for an orbiting 100 ft. inflatable plastic sphere off which radio signals would be bounced cross-country within the next year.

$110,000—**California Institute of Technology**, for basic studies of cylindrical and conical shells.

—when and where—

JULY

Tenth Annual Basic Statistical Quality Institute, University of Connecticut, Storrs, July 12-24.

Radio Technical Commission for Aeronautics and Los Angeles Section of the Institute of Radio Engineers, Third Biennial Joint Meeting, Ambassador Hotel, Los Angeles, July 16-17.

The American Rocket Society, Propellants and Combustion Committee, "Propellants, Thermodynamics and Handling Conference," Ohio Union, Ohio State University, Columbus, July 20-21.

Second Annual Institute on Missile Technology, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 26-Aug. 7.

The Denver Research Institute of the University of Denver, 6th Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 30-31.

AUGUST

Institution of Investigation of Biological Sciences, Sponsor: Air Force Office of Scientific Research, Aeromedical Div., World Health Organization and United Nations Educational Scientific and Cultural Organization, Montevideo, Uruguay, Aug. 2-7.

Association of the U.S. Army, Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Aug. 3-5.

William Frederick Durand Centennial Conference, Problems of Hypersonic and Space Flight, Stanford University, Stanford, Calif., Aug. 5-7.

Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

Institute of Radio Engineers, Western Electronic Show & Convention, Cow Palace, San Francisco, Aug. 18-21.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare, (classified), San Diego, Aug. 24-26.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Co.'s Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkeley, Sept. 2-4.

Air Force Association and Panorama; Send Reservations to AFA Housing Bureau, P. O. Box 1511, Miami Beach, Sept. 3-6.

Standards Engineering Society, Boston Section, Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, Conference and Exhibit, Chicago, Sept. 21-25.

Industrial Nuclear Technology Conference, Sponsored by Armour Research Foundation of Illinois Institute of Technology, Nucleonics Magazine and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

American Rocket Society, Solid Propellants Conference, Princeton University, Princeton, N.J., Sept. 24-25.

Institute of Radio Engineers, 1959 National Symposium on Telemetering, Civil Auditorium, San Francisco, 28-30.

OCTOBER

Society of Automotive Engineers, tional Aeronautics Meeting, Air Manufacturers Forum and Airc Engineering Display, The Ambass Hotel, Los Angeles, Oct. 5-10.

Electronics Industries Association Co ence, University of Pennsylvania, versity Park, Oct. 6-7.

Stanford Research Institute, First H Temperature Symposium, Asilo Conference Grounds, Monterey Pe sula, Calif., Oct. 6-9.

National Electronics Conference, S sored by American Institute of E trical Engineers, Illinois Institute Technology, Institute of Radio gineers, Northwestern University University of Illinois, Hotel Sherr Chicago, Oct. 12-14.

Advertisers' Index

AC Spark Plug Div., General Motors Corp. 14
Agency—D. P. Brother & Co.

AiResearch Mfg. Co., Div.- The Garrett Corp. 3
Agency—J. Walter Thompson Co.

Avco Corp. 51
Agency—Benton & Bowles, Inc.

Boeing Airplane Co. 11
Agency—Fletcher Richards, Calkins & Holden, Inc.

Burroughs Corp. 23
Agency—Campbell-Ewald Co.

Chance Vought Aircraft, Inc. . . 36, 37
Agency—Tracy-Locke Co., Inc.

DuKane Corp. 6
Agency—The John Marshall Ziv Co.

International Business Machines Corp. 30,
Agency—Benton & Bowles, Inc.

Ling Electronics, Inc. .....
Agency—John Ramsey Co., Adv.

Lockheed Aircraft Corp., Missile System Div. 26,
Agency—Hal Stebbins, Inc.

Northrop Corp. .....
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Republic Steel Corp. .....
Agency—Meldrum & Fewsmith, Inc.

Servomechanisms, Inc. .....
Agency—Hixson & Jorgensen, Inc.

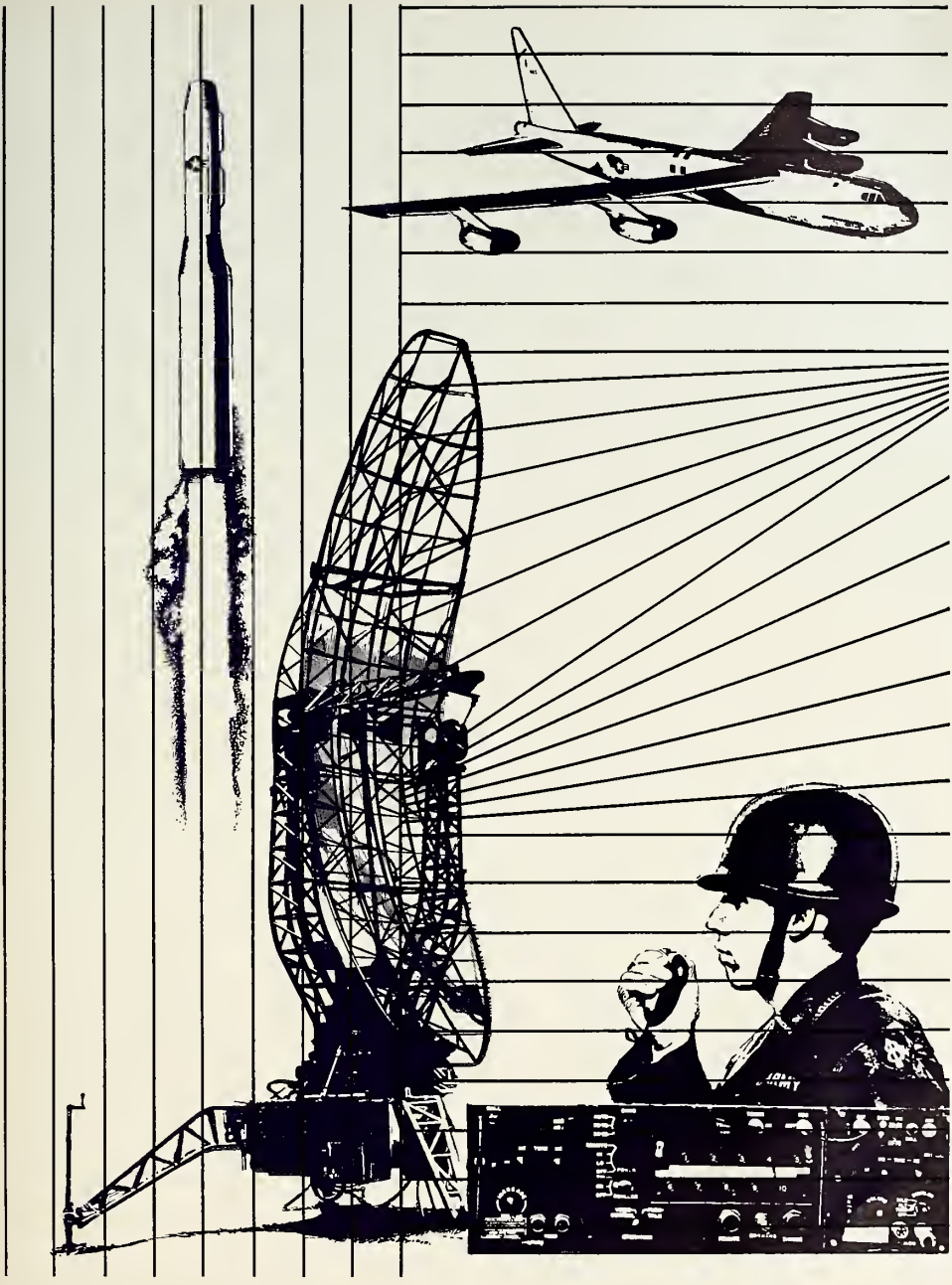
Temco Aircraft Corp. .....
Agency—Rogers & Smith Adv. Agents

Washington Steel Corp. .....
Agency—Cabbot & Coffman, Inc., Adv.

CLASSIFIED

DESIGN ENGINEER

Graduate engineer with aircraft accessory experience to design and develop aircraft fuel, oil, and hydraulic valves to customer specifications. This is a position of responsibility with a prominent Cleveland manufacturer of aircraft and missile fluid system components. **Send resume to Box 125, Missiles & Rockets Magazine, 1001 Vermont Ave., N.W., Washington 5, D.C.**



Avco Steps Ahead . . . in Electronics—From guiding missiles to their targets to defending bombers from missile attack, from interplanetary communications to communications for field troops: Avco's work in electronics is wide and diversified. It results from Avco's combination of expert personnel and complete facilities for research, development, and manufacturing. On many fronts, Avco lends unique support to America's electronic progress.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY.

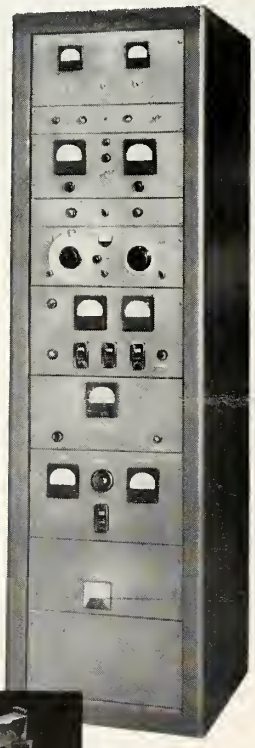
Avco

AVCO MAKES THINGS BETTER FOR AMERICA / AVCO CORPORATION / 750 THIRD AVENUE, NEW YORK 17, N. Y.

Fully Automatic Vibration Systems for Production Line Testing!

LING

SINE-O-MATIC SERIES



Sine-O-Matic Model RP-1/2 (Vertical Case) —Model 6-C Shaker
Ling Model RA-250 Sine-O-Matic, with Model 6-C Shaker, provides output of 25 pounds force. Systems in 100 and 150 pound ratings available in similar packaging.



Ling packaged sine-wave systems can be converted to random motion at any future time for a moderate cost!

- Extended frequency range—from 5 up to 10,000 cps.
- No impedance changing or manual power factor correction required over entire frequency range.
- All components except shaker are housed in single, compact control console, either desk type or vertical.
- Consoles equipped with swivel casters for mobility—can be easily moved, as required.
- Sine-O-Matic systems meet all specifications called for under MIL-E-5272...can be profitably used by *all* equipmen or components manufacturers!
- Fully automatic programming and push-button operation—ideal for production line testing!

SINE-O-MATIC SHAKER FORCE OUTPUTS

Sine-O-Matic Model	Shaker	Rated Continuous Output in Watts	Amplifier Plate Dissipation in Watts	Sine Wave Pounds-Force Vector
RA-250	6-C	250	200	25
RA-500	A-88	500	600	100
RP-1/2	227	1,000	2,000	150
CP-3/4	219	3,000	4,000	500
CP-3/4	A-174	3,000	4,000	1,200
CP-5/6	A-174	5,000	6,000	1,500

LING

ELECTRONICS, INC.

Factory Sales Offices:
9937 West Jefferson Blvd., Culver City, California
TExas 0-7711
120 Crass St., Winchester, Mass. • WInchester 6-3810

JULY 6, 1959

JUL 1959
HOUSTON PUBLIC
LIBRARY
Houston, Texas



HAWK NOW OPERATIONAL

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

ssile Boom in New England .. 13
ght Future for Cryogenics 21
ing & Arming Reliability 30





INSTANTANEOUS RESPONS

Grove Regulators... For over twenty years—from
first missile experiments in the Navy Experimental Stat
at Annapolis to the launching pads at Cape Canaver
setting the standards for the control of high pressure flu
...the regulators which served as the critical controll
World War II flame throwers and torpedoes...and ma
missile development work possible...Grove High Pr
sure Regulators...frequently imitated but never equal

Grove Powreactor Dome Regulator—Model GH-408 · 50-6000 psi inlet...5-3000 psi reduced pressure

GROVE VALVE and REGULATOR COMPANY

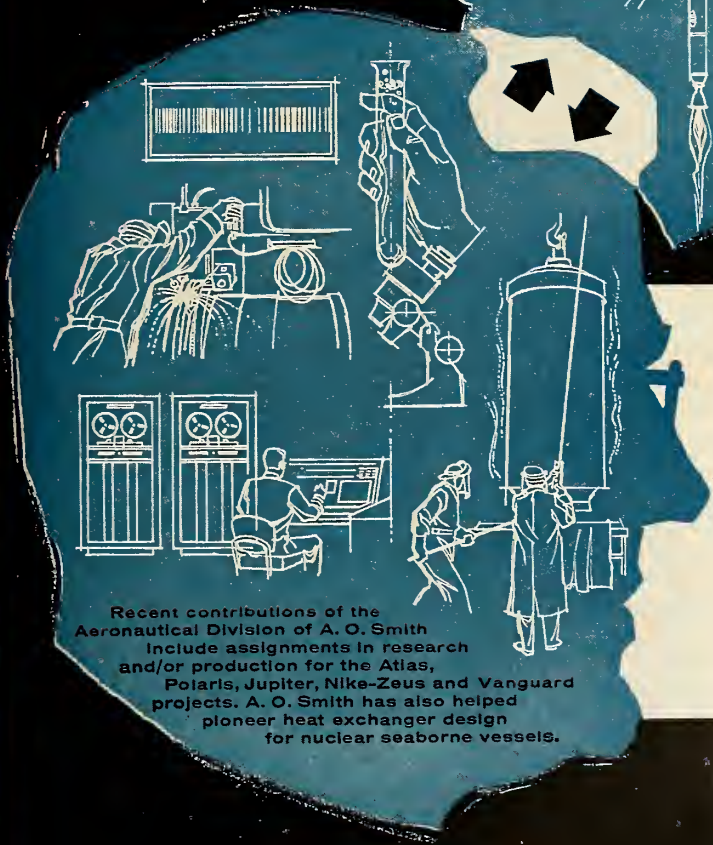
5529 Hollis St., Oakland 8, California · 2559 W. Olympic Blvd., Los Angeles 6, California

Offices in other principal cities

Subsidiary of Walworth

meeting of minds

to find the means...



Recent contributions of the Aeronautical Division of A. O. Smith include assignments in research and/or production for the Atlas, Polaris, Jupiter, Nike-Zeus and Vanguard projects. A. O. Smith has also helped pioneer heat exchanger design for nuclear seaborne vessels.

A. O. Smith Aeronautical Division continues to demonstrate unique capabilities to work with research and development groups in government agencies and prime and sub contractors in the airframe, propulsion and missile fields.

In three quarters of a century's service to all industries, A. O. Smith has garnered exceptional experience in basic research, welding, metallurgy, heat treating and other areas that delivers a big payload in R&D speed-up as well as establishing sound production procedures.

A. O. Smith facilities and experience are available to any accredited member of the aviation-missile-rocket industry. For more details, call or write —

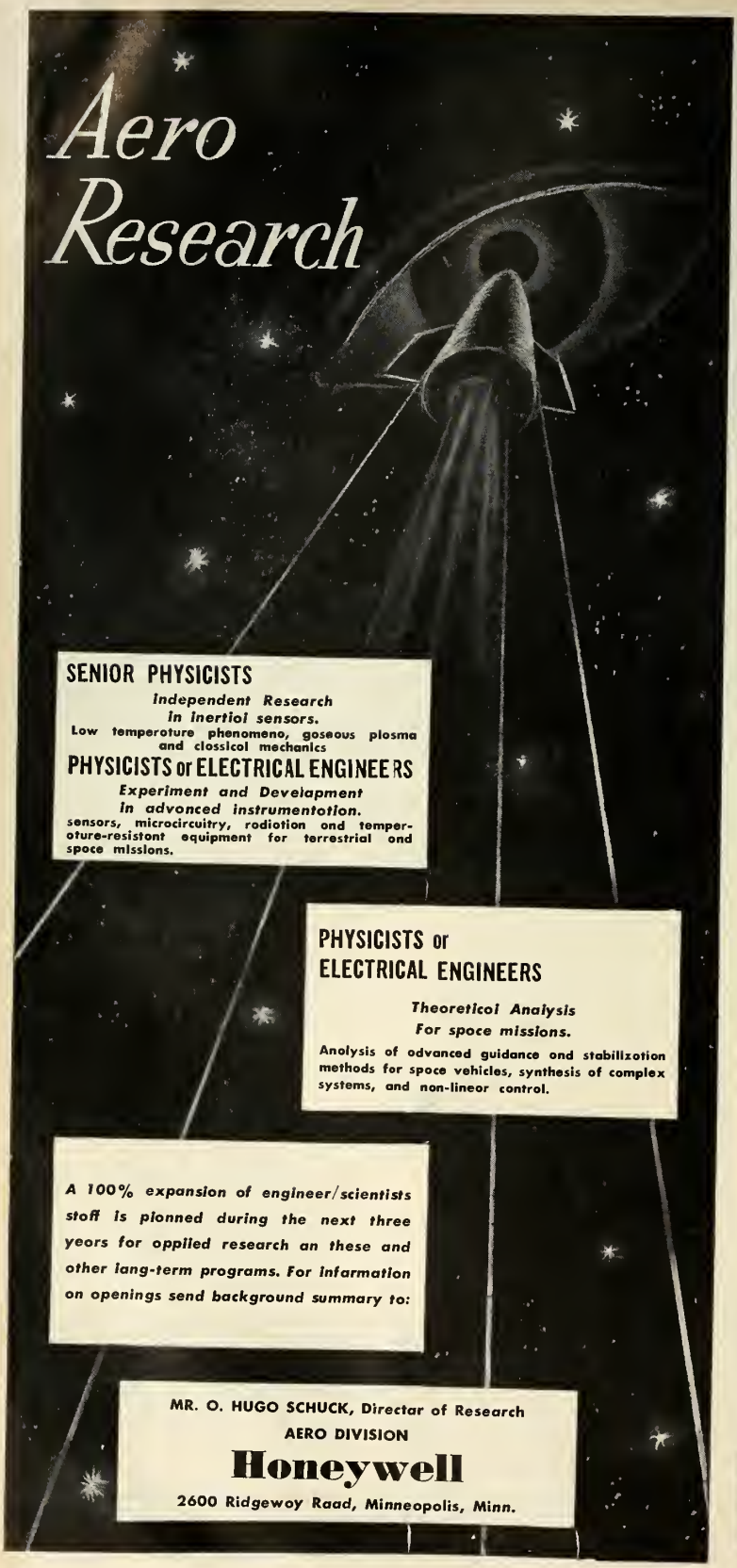
Through research ... *a better way*

A.O.Smith

CORPORATION

AERONAUTICAL DIVISION

Milwaukee 1, Wisconsin



Executive Editor ..... CLARKE NEW
Managing Editor .... DONALD E. P

NEWS STAFF

News Editor ..... REED E
Defense and Legislative ..... BETTY O. JAMES
West Coast ..... RICHARD VAN
Copy Editor ..... ERICA
Editorial Assistant ..... DAVID NE

ASTRIONICS

Guidance and Control .... CHARLES D. LA
Support Equipment ..... HAL GE

ASTRONAUTICS ENGINEERING

Chemistry & Propulsion ..... JAY H
Astrodynamics ..... PAUL M

MISSILE SUPPORT

Installations and Equipment
East Coast ..... WILLIAM E. H
West Coast ..... FRANK MC

BUREAUS

Los Angeles ..... FRED H
Paris ..... JEAN-MARIE
Geneva ..... ANTHONY VAN

CONTRIBUTORS

British Astronautics ..... G. V. E. THOM
Propulsion ..... MICHAEL LO
Industry ..... JAMES J. HAGGERT
Soviet Affairs ..... DR. ALBERT
Space Medicine ..... DR. HUBERTUS STRU
Astrophysics ..... DR. I. M. L
Research ..... HEYWARD CANNEY

ADVISORY BOARD

DR. WERNHER VON BRAUN . ROBERT P. HAV
DR. PETER CASTRUCCIO DR. ARTHUR KANTRO
KRAFFT EHRICKE DR. EUGEN SA
R. F. GOMPERTZ ALEXANDER S

PRODUCTION AND ART

Art Director ..... WILLIAM MA
Assistant Art Director ..... BACIL G
Production Manager ..... J. F. W
Ass't Production Manager ..... ELSIE

BUSINESS STAFF

Assistant Publisher ..... E. D. MUHL
Advertising Sales Manager ..... W. E. BR
Circulation Director ..... L. L. BRE
Promotion Manager ..... J. E. MU
Advtg. Service Manager .. MRS. GLADYS BU
New York
Eastern Advtg. Mgr. ..... P. B. KI

ADVERTISING OFFICES

New York ..(17 East 48th St.) P. N. ANDE A. B. SCHE
Detroit ...(201 Stephenson Bldg.) K. J. W
Chicago .....(139 N. Clark St.) G. E. Yo
Los Angeles .(8929 Wilshire Blvd.) J. W. C C. R. MARTZ
Miami .....(208 Almeria Avenue) R. D. H
Toronto (12 Richmond St. E.) ALLIN ASSOCI
London .....(28 Bruce St.) NORALL & P
Paris .....11 Rue Condo
Geneva .....10 Rue Gre

Missiles and Rockets Volume 5 Number

Published each Monday by American Avia Publications, Inc., 1001 Vermont Ave., N Washington 5, D.C.

WAYNE W. PARRISH ....*President & Publis*
LEONARD A. EISERER *Executive Vice Presid & General Man*
A. H. STACKPOLE .....*Vice Presid*
FRED HUNTER .....*Vice Presid*
ERIC BRAMLEY .....*Vice Presid*
ROBERT R. PARRISH .....*Vice Presid*

Printed at the Telegraph Press, Harrisburg, Second class postage paid at Washington, D and at additional mailing offices. Copyri 1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Post Union Nations—1 year, $8.00; 2 years, $12.0 3 years, $14.00. Foreign—1 year, $10.00; years, $18.00; 3 years, $26.00. Single cop rate—$.75. Subscriptions are solicited onl from persons with identifiable commerci or professional interests in missiles an rockets. Subscription orders and changes address should be referred to Circulatio Fulfillment Mgr., M/R, 1001 Vermont Ave Washington 5, D.C. Please allow 4 week for change to become effective and enclos recent address label if possible.



COVER: Raytheon's *Hawk,* like Martin's *Lacrosse,* is going to Army's units (see p. 28).



YANKEE Ingenuity in missile field is reflected in wealth of new plants (see survey, p. 13).



ALUMINUM shells for *Redstones* are formed at Reynolds plant. (see aluminum story, p. 18).



ARTILLERY units are receiving Martin *Lacrosse* solid-fueled guided missiles (see p. 29).



DEMON Automatic checkout system built by Curtiss-Wright is used on *Nike-Ajax* (see p. 33).

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

JULY 6 HEADLINES

New England's Missile/Space Manufacturing Boom
A state-by-state survey shows the Northeast's share of the business is over $1 billion a year, employing more than 150,000 people —and still growing 13

Parting Words from Maj. Gen. John W. Sessums, Jr.
The retiring vice commander of ARDC looks into the missile future in an exclusive interview 16

NASA Seeks to Aid Small Businesses
Officials of the space agency plan to keep tabs on company capabilities and keep them informed on upcoming contracts 26

***Hawk* and *Lacrosse* Are Added to Army's Arsenal**
Artillery units are organized in Texas to train in their use 28, 29

ASTRONAUTICS ENGINEERING

Aluminum Use in Missiles Is on the Increase
Lightweight, low-cost material is already used by hundreds of millions of pounds; greatest market may be in missile support 18

The Bright outlook for Cryogenics
Other systems are in the works, but the advantages of cryogenics will make them the most efficient for years to come 21

***Nike*-Zeus Will Cost $1.5 to $2 Billion Plus in FY '61**
But Administration could decide to kill only anti-missile missile under development 24

'Whisker' Research Is Pressed by Government and Industry
Five to 10 years may bring usable materials with strength up to six times that of steel 27

ASTRIONICS

The Remarkable Reliability of Fuzing and Arming
An outline of the accomplishments and tricky requirements in a secrecy-shrouded and largely government-controlled field 30

A Close-Up of Two Automatic Checkout Systems
Curtiss-Wright's DEMON and Nortronics' NORSCAN are fully transistorized, modularly constructed and completely self-checking 33

SPECIAL SECTION

For the reader's convenience, an index of M/R stories by categories for the first six months of 1959 37

THE MISSILE WEEK

Industry Countdown 11
Washington Countdown 12

DEPARTMENTS

Editorial 7
Reviews 32, 45
Missile Business 42
People 43
Contracts 45
Propulsion Engineering 47
Soviet Affairs 48
When and Where 49
Memo from the Assistant Publisher 50

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY... IN TEST

Testing is a vital part of every stage in the development of missile and space programs at Lockheed Missiles and Space Division.

The Division maintains one of the most completely equipped test laboratories in the world. Equipment includes: altitude, temperature and humidity chambers; shaker and vibration systems; G-accelerators; and apparatus capable of performing chemical, metallurgical, plastic, heat transfer, hydraulic, pneumatic shock, acceleration, sinusoidal and random vibration, structural, electrical and electronic tests. Static field testing; research and development testing on controls; testing in ordnance and hydraulics and high-pressure gas and propulsion systems are conducted at the 4,000 acre, company-owned test base in the Ben Lomond mountains near Santa Cruz, Calif.

Unique Flight Test Concept—Flight testing is conducted at Cape Canaveral, Florida; Alamogordo, New Mexico; and Vandenberg AFB near Santa Maria, California, in a unique manner. All components and sub-systems of a new project are initially tested on known-performance, production missiles. Thus, when the final system is ready for first flight, its individual components already possess flight-tested reliability. This new concept of flight testing is a major contribution and has enabled Lockheed to produce extremely complex missile systems in record time and at greatly reduced expense.

Underwater launch tests, for the Navy POLARIS FBM, are carried on at the Sunnyvale facility and at the Navy test base on San Clemente Island. These include studies of cavitation, wave simulation and skip motion. In addition, structural and other tests are performed at Hunter's Point Naval Shipyard, California.

Engineers and Scientists—Lockheed Missiles and Space Division has complete capability in more than 40 areas of science and technology. Its programs reach far into the future and deal with unknown and challenging environments. If you are experienced in one of the above areas, or in related work, we invite you to share in the progress of a company that has a continual record of achievement and to make an important individual contribution to your nation's competence in space technology.

Write: Research and Development Staff, Dept. G1-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for Navy POLARIS FBM, DISCOVERER Satellite
Army KINGFISHER, Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLA. • ALAMOGORDO N. M. • HAWAII

Who Owns Man's Brain?

In the Constitution of the United States, a sometimes almost forgotten document in these regimented days, is a paragraph which reads (Article 1, Section 8):

"To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

We bring this up in connection with the important controversy over patent rights accruing under contracts to the National Aeronautics and Space Administration. Hearings were held in Washington recently (M/R, June 1) to permit industry attorneys to express their opinions of, and objections to, patent regulations laid down under the Congressional Act which set up NASA—particularly the manner in which they differed from the regulations governing patents under military contracts.

Briefly, under the military regulation an inventor or a company is entitled to the rights to any invention achieved under a military contract, with the Government holding license rights. That is, the company owns the patent but the Government gets free usage.

Under the NASA regulations, with a few minor exceptions, the Act provides that any invention achieved during work on any NASA contract is the exclusive property of the Government. This applies to prime and subcontractor alike, no matter how far removed.

Further, any person inventing an article which may have a utility pertinent to the conduct of aeronautical and space activities—whether he is a NASA contractor or not—must declare under oath that his work was not related to any contract with NASA before he can get a patent on his invention.

Although this is a nutshell version of the two regulations, we think it shows that the NASA Act opposes completely the principles of both the Constitution and fair practice. We cannot believe that government has an automatic and complete right to the fruit of the by-product labors of its employees, direct or indirect. Nor do we believe that the burden of proof should fall upon the individual—in this case the inventor.

That NASA itself is not entirely in agreement with the law may be judged from a statement by Administrator T. Keith Glennan regarding the conflicts between the rules of NASA and the military. He said:

"Two such contrary patent policies followed by Government agencies working in closely related fields of research and development, can be detrimental to the kind of cooperation that we must have from industry, if our joint effort is to go forward with effectiveness and dispatch. We are well aware of the attitude of industry toward this question. On the other hand, it must be recognized that these rules are written into the law, and we cannot ignore them."

Congress has made it clear that it wants the National Space Act to operate for a while before it makes any changes. We suggest that this should be among the first alterations—and that industry must take the lead in making the situation clearly understood by the law-makers.

Indemnification—Another Problem

While we are on the subject of Congress, industry and space, let's consider another problem which the country must face up to, and fairly quickly—indemnification legislation.

Very shortly we shall have ICBM bases in this country equipped with missiles designed to carry nuclear warheads. Nuclear-armed IRBM's are already on station in England and soon will be in Italy. Very shortly also we shall be testing and launching atomic-powered rockets for spacecraft and atomic-powered aircraft.

It is not inconceivable that in all this monkeying around with a power we really know little about, and even less how to control, some horrendous accident could occur.

Who is responsible? The Government? The prime contractor? And to what limit? Any corporation could easily be wiped out by the claims which might accrue. And suppose the fault could be traced to some gadget, made by a small subcontractor and in itself harmless—except that it malfunctioned. Insurance companies will touch no such case.

Two measures have been introduced in the House which cover the situation to some extent by limiting the responsibility of both Government and industry. But they do not really cover all of the aspects—and they appear unlikely to come up at this session.

This is another problem on which the aircraft/missile/space industry must unite to push for a solution.

Clarke Newlon



A missile streaking through the sky . . . a ship plowing through the ocea . . . a submarine gliding through the depths . . . all guided with unerring a by Autonetics' inertial navigation systems.

Twelve years ago development was under way on the first Autonetics' autonavigator—a system to guide a supersonic missile to a distant target.

Since then, refined versions of this system have shown remarkable ca for guidance over, on and under the terrestrial surface in any craft, at an under any conditions . . . a significant advance in the state-of-the-art.

It was an Autonetics' autonavigator that guided an aircraft on the first su daylight cross-country flight by stellar-inertial autonavigation. Another

Inertial navigatio



ssed the Navy's exhaustive sea tests aboard the USS s Island in 1957. And in 1958, Autonetics' systems he USS Nautilus and Skate on their historic voyages e polar ice.

Autonetics is producing in quantity the systems to e Air Force's GAM-77 missile. Its engineers are de- systems for America's Polaris-carrying subs and the an intercontinental ballistic missile. Even more d systems will provide the accurate stellar-navigation ded to guide man on his travels through Outer Space.

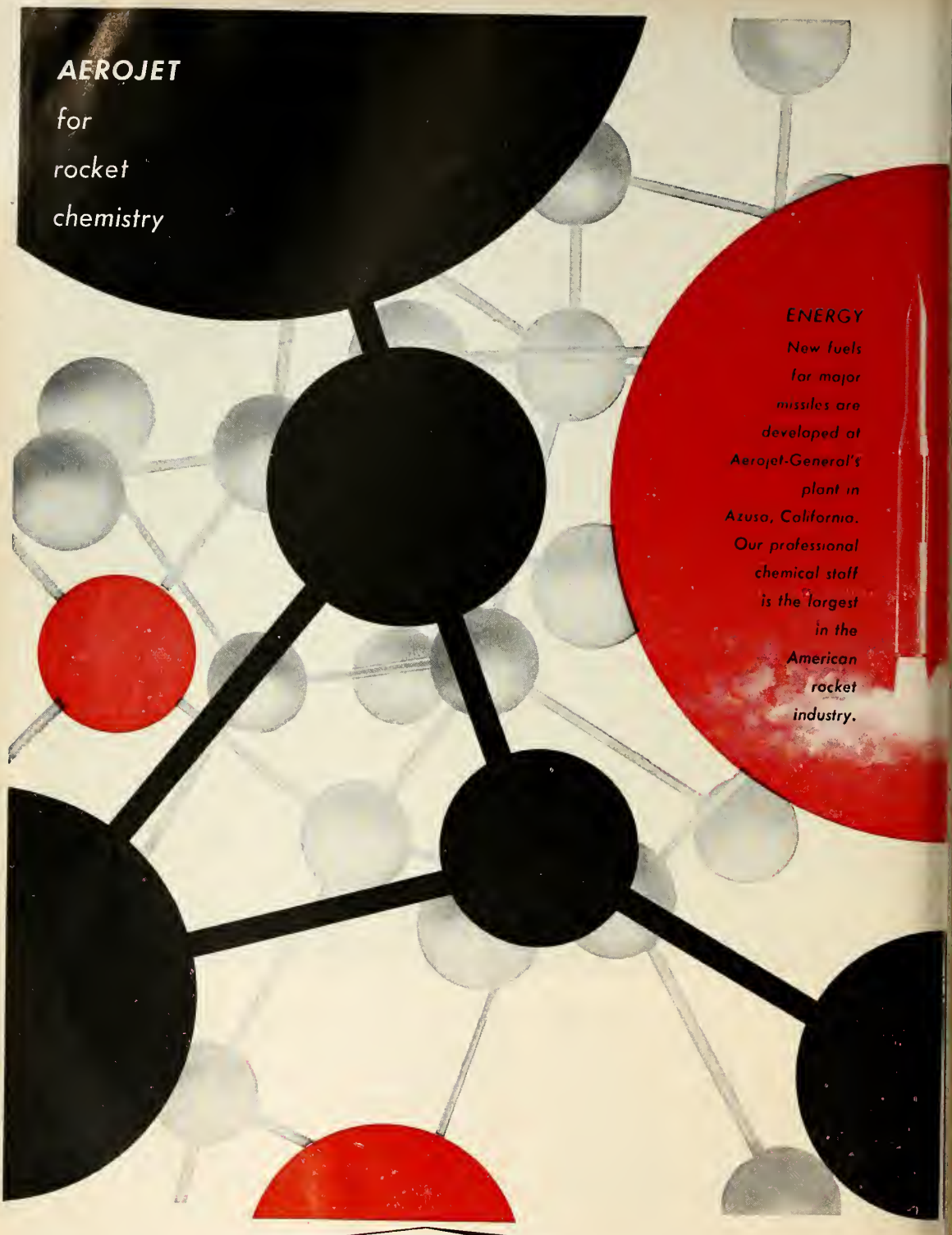
But the imaginative engineering that brought inertial navigation so far, so fast, is only half the Autonetics' story. New ideas had to be implemented by new manufacturing techniques. Many components of inertial autonavigators—gyroscopes, accelerometers and computer elements—called for precision that was once impossible. Now Autonetics has put it on the production line.

These are the achievements that have given here-and-now reality to inertial navigation... and have made Autonetics first in the field.

y Autonetics

A DIVISION OF NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA • REGIONAL OFFICES: WASHINGTON, D. C. AND DAYTON, OHIO

INERTIAL NAVIGATION / ARMAMENT CONTROL / FLIGHT CONTROL / COMPUTERS AND DATA PROCESSING



AEROJET-GENERAL CORP.

THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)

Industry Countdown

STRUCTURES

Project Rambler is scratched . . .
NASA rejected the proposal of $1 million-plus high-altitude sounding rocket as duplicating capability of other already well-advanced research programs, such as *Scout*. Embodying new concepts in fibreglass construction and new launching techniques, *Rambler* was submitted recently by a team composed of the **University of Michigan, Vickers, Lear, Sparton Electronics, Wyandotte Chemical** and **Curtiss-Wright.**

• • •

Amputated in DOD's . . .
"master defense plan"—two *Bomarc* bases at Winooski, Vt., and Madison, Wis.

• • •

Don't throw away industrial . . .
security regulations. The program struck down by a Supreme Court ruling last week probably will be reinstated shortly either by Presidential executive order or rush Congressional action. Regulations may be changed to allow alleged security risks to confront their accusers.

• • •

Co-op NATO missile/aircraft . . .
production lineup which appears imminent probably will see Italy making airframes and MSE; France—airframes and assembly; Britain—engines; Holland—electronics; Germany—electronics and heavy equipment; Belgium—support equipment and parts.

• • •

Great Britain is dickering . . .
for purchase of the **Martin** *Bullpup* air-to-surface missile. Whether it will be manufactured in England under license or exported still remains to be decided . . . France is getting ready to spend a reported 16 billion francs over the next six years on space research; may be in the market for hardware. Program, if funded, will be run by National Fund for Scientific Research.

• • •

PMR operating contract . . .
will be awarded by Navy to **Bendix Aviation** and **Texas Transportation Co.** (a new corporation reportedly set up by retired military men.) Contract is similar to **Pan American's** at Cape Canaveral.

• • •

Just revealed . . .
Martin *Titan* skin structure is about 40% magnesium-thorium sheet and extrusions, accounting for about 2000 of the ICBM's total poundage. **Dow Chemical**-developed HM21A and HK31A sheet is used in transitional sections, between fuel and oxidizer tanks and between second stage and nose cone. HM31A extrusions are used for external conduits between fuel and oxidizer tanks in both stages and for internal stringers, longerons and hinges.

PROPULSION

Advancing technology bypassing . . .
boron compounds is apparent reason for Navy's sudden cancellation of $13.5 million sodium borohydride contract with **Metal Hydrides Inc.,** Beverly, Mass. Other materials are offering higher I_{sp} without the handling and oxidation problems of boron compounds. MHI, which had produced 1.7 million pounds of the missile/aircraft propellant under the contract originally due to expire in May, 1960, plans to go into commercial production.

• • •

Powerplant for first *Mercury* . . .
capsule has been delivered by **Rocketdyne** to ABMA. The *Redstone* liquid-fueled rocket engine delivering 75,000 pounds of thrust will lift a capsule carrying animals down a 100-mile course.

ELECTRONICS

Really hot competition . . .
can be expected for **Douglas'** ALBM guidance contract. While early version may be simple command system, inertial is certain to be an eventual requirement. Specs probably will demand a complete digital system for stellar acquisition, interpretation and readout measured in seconds rather than minutes. Manufacturer who produces quickly, therefore, has a lucrative opportunity. Secondary requirement probably will be for versatility in stellar acquisition both in the bird and the launch aircraft.

• • •

Won by RCA . . .
Boeing *Minuteman* electronic subsystem contract . . . and insiders say RCA also will get multimillion-dollar Project *Mercury* tracking due to be announced by NASA July 15.

• • •

Advanced infrared detector . . .
utilizing photosensitive semiconductor energized by microwave electromagnetic fields has been developed by **General Bronze Electronics.** Wide bandwidth unit (infrared through ultraviolet) with parametric amplifier claims sensitivity approaching the theoretical limit.

SPACE MEDICINE

Space-environment chamber . . .
being installed early next year at **Republic's** astronautics research center to simulate conditions for humans 150 miles up, will cost $500,000 and be built by **Tierney Engineering Inc.,** Union, N.J. Chamber will be 14 feet in diameter, 30 feet long.

Washington Countdown

IN THE PENTAGON

Navy's plans for own ALBM . . .

as broken exclusively in M/R (June 22, p. 9) have come under "roles and missions" fire with the order presumably given to the Navy to keep its hands off because it is a "strategic" weapon. Many industry sources say the project has been driven "underground" and Navy now is busy adjusting for "new requirements" which will permit it to enter the ALBM picture. Original Navy thinking, sources told M/R, is that Navy had planned to get its own ALBM into production at least a year before the AF-**Douglas** version by using prototype hardware of some of the companies edged out in the AF competition.

• • •

Demotion of William Holaday . . .

onetime U.S. missile czar, is now all but complete. Holaday has been "relcased" from his post as special guided missile assistant to Defense Secretary Neil McElroy and the post has been abolished. But he remains as chairman of the somewhat strengthened Civilian-Military Space Liaison Committee. Holaday's removal strengthens the hand of R&E Director Herbert York.

• • •

A Far East AF missile base . . .

is being planned for Okinawa. Cost estimated to date: Nearly $10 million. The one-time Japanese base is within easy IRBM and ICBM range of Peiping, Shanghai and the big Soviet industrial and military centers in eastern and central Siberia.

• • •

Next *Discoverer* launching . . .

may be held up while ARPA and Air Force scientists try to find out why *Discoverer IV* failed to go into orbit. *Discoverer V* normally would have been launched toward the end of July. Whenever it is launched, it will be used to check out the *Discoverer* system before any new attempt is made to recover mice after putting them into orbit.

• • •

French nuclear-tipped missiles . . .

may be carried by the Mirage IV—the new French fighter-bomber now under development. The bomber, capable of carrying a nuclear bomb, will have a range of more than 1350 miles—great enough to reach Moscow. Production is 27 months away.

Reconnaissance satellite tests . . .

are nearer than some think. The Air Fo is already constructing test stands for Lo heed's *Sentry* at Vandenberg AFB. It se $14.4 million for *Sentry* facilities. Many c sider the U.S.-Soviet race to develop a rec naissance satellite one of the great battles the Cold War.

• • •

U.S. wants to construct . . .

installations for **Lockheed's** *Midas*—the mis warning satellite—somewhere in Great Brit The Air Force wants more than $19 mill for *Midas* facilities in FY 1960.

ON CAPITOL HILL

Be starred ex-military officers . . .

will not be called to testify for awhile the House investigation of the alleged "mu tions lobby" gets underway. (See M/R Ju 29) First witnesses during the next week so will include Defense Secretary Neil M Elroy, Attorney General William Rogers a members of Congress.

• • •

Congress is expected to grant . . .

an extra $137 million for **Western Electri** *Nike-Zeus* program. That will put a total $437 million in the FY 1960 budget for *Ze* The extra funds will be used for producti facilities and pre-production planning. (S page 25)

• • •

Behind NASA's First Real Fight . . .

with Congress over the $68 million cut their budget is an effort to keep on schedu Project *Mercury's* attempt to put man space. By contacting newspapers, science ar civic groups, and friendly Congressme NASA hopes to re-instill Congress's po *Sputnik* fervor for space projects.

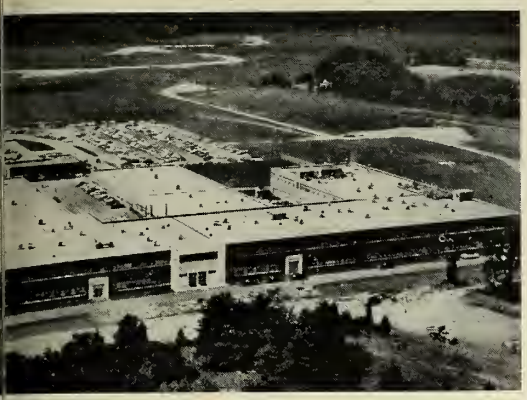
AROUND TOWN

Some of the reports. . .

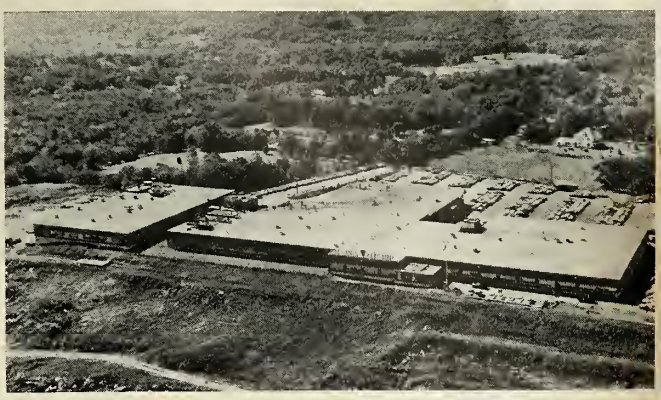
that are being passed as the "latest" in th nation's capitol:

. . . Governor Nelson Rockefeller of Ne York will emerge in his struggle with Vic President Nixon for the GOP presidenti nomination as the foremost advocate for "Bi Defense."

. . . The long-range tide in defense plan ning is turning away from massive retaliatio in favor of greater preparation for limited wa



THEON'S plant at Wayland, Mass. This company, prime actor for *Hawk* and *Sparrow*, is area's top missile employer.



SYLVANIA'S engineering and research facilities at Waltham, Mass. Firm also has one plant location in New Hampshire.

New England's Missile Boom

The Northeast's $1 billion-a-year-plus business —first in a series of regional surveys

by William E. Howard

BOSTON—A missile/space manufacturing boom born of scientific brain-power is surging through New England's economy.

All over the six-state area, hard-hit a few years ago by a mass exodus of textiles, there is a fever of activity. The region now has more than 600 electronic manufacturing firms with a product value topping $1 billion—5% of the entire nation's output. There are an estimated 76,000 electronics employees receiving $290 million annually in wages.

Approximately 2600 firms are engaged in missile/aircraft component production, supplying parts and subsystems for virtually every missile/space project. The work force in this field runs into the tens of thousands.

In addition, New England houses some 600 basic research and development firms, big and little, which have additional thousands of scientists and technicians intently exploring new horizons in astrionics, propulsion, nucleonics, astrophysics and related sciences destined in the driving new missile technology.

• **One billion and growing**—What's the scope of the missile industry, as such? Experts on the New England Council for Economic Development estimate that the Northeast's missile volume is well over $1 billion and the figure is still growing.

So fast has the growth been that officials are hard put to come up with any definite figures. But their estimates indicate that upwards of 150,000 persons throughout New England are hard at work in the field.

Eighty percent of the $1 billion electronics manufacturing in the region is believed to be missile-related. Pinpointing where the activity lies, though, is difficult. Many companies are strictly components producers supplying both consumer and military markets.

From wave-scoured shores of Maine to the exclusive exurbanite sanctuaries of southern Connecticut, new plants are sprouting behind scenic old fieldstone fences and in dozens of brand new industrial parks. Around Boston, hub of electronics and R&D, carpenters and masons are rushing to complete more than $50 million of new construction to meet a seemingly never-ending demand for more space for production and laboratories.

Not to be overlooked are New England's clanging shipyards. They are turning out missile cruisers and frigates and *Polaris* submarines under contracts running into the hundreds of millions of dollars. The region is also heavily dotted with defense installations—SAC, SAGE and Navy bases and other facilities that keep a legion of suppliers busy.

Under construction way "Downeast" at Cutler, Me., for example, is a $64 million VLF Navy radio station for *Polaris* FBM submarine communication.

• **Raytheon largest**—The area's biggest single missile employer is **Raytheon Mfg. Co.**, which has two prime contracts—the Army *Hawk* and Navy's *Sparrow III*. This week it was awarded a $161 million contract for more *Hawks*. More than half of the company's 35,000 employees in New England are in defense production and more than 3000 are working in the Missile Systems Division plants located at Lowell, Tewksbury and Billerica, Mass. This Raytheon division alone farms out an estimated $10 million to more than 600 Massachusetts subcontractors.

As the nation's only electronics company with two prime missile contracts, Raytheon going into 1959 had a backlog exceeding $300 million. The company has added 6000 employees since Jan. 1, 1958, and is preparing to hire another 1,500 to 2,000 to man a new ASW plant to be constructed at Portsmouth, R. I.

growth reported in six states . . .

Across the Bay State in Pittsfield, **General Electric's Ordnance Division** of 3,500 employees is pushing development of *Polaris* inertial guidance and fire control under a multi-million dollar contract. This division also has an $8 million development contract for the huge *Talos* magazine, feeder and checkout systems to go aboard the nuclear cruiser Long Beach. The cruiser, incidentally, is being built by **Bethlehem Steel** at Quincy, Mass., under a $100 million contract. This shipyard also is commencing work on a $108 million nuclear frigate which will be armed with *Terrier* missiles.

GE is in the process of negotiating a $10 million follow-on for the *Talos* system and is working at Pittsfield on a $10 million *Atlas* tracker. Missile contracts in the division total over $50 million. At Lynn, Mass., GE is turning out engines for *Quail* decoy missiles and a complement of missile support equipment including leak detectors, electronic strip chart recorders, insulation test equipment, switchboard instruments and inertial systems components.

Looming large in the region's missile industry is **Avco,** which last month opened a $23 million research center at Wilmington, Mass. Holder of a $111 million contract for development of the *Titan* nose cone, Avco employs 1700 and is also deeply involved in shock wave research.

Just off Boston's "Golden Industrial Semicircle"—a congregation of companies along Route 128—**RCA** is producing miniaturized electronic missile controls and components in a spanking new $3 million plant. Other leaders of the area are **Sylvania Electric, CBS Electronic** and **Transistron.**

Recently this important new industrial area saw the formation of **Goodrich-High Voltage Astronautics Inc.** to research, develop and manufacture ion propulsion engines for space vehicles.

• **Connecticut supplies parts**—In a figurative sense, much of the work being done in Massachusetts is to supply the electronic "brains" for missile and space projects. By the same token, Connecticut is caught up in a big effort to provide "innards"—the hundreds of thousands of metal parts and subsystems.

Precisely how important missiles are to the Nutmeg State's economy is evident in a recent report of the Connecticut Development Commission. A survey by that agency shows 224 firms providing parts or services to prime and major subcontractors. These firms employ a total of 11,000—including 27,000 technical workers—but the precise percentage actually engrossed in missile work is not known.

However, it is believed to be substantial, even when stacked up against the state's total manufacturing work force of nearly 400,000. The CDC says 57 of the state's 169 cities and towns have missile operations underway.

In addition to parts, the state is showing a steady growth in missile electronics and related research.

At Groton last month, the George Washington, first nuclear fleet ballistic missile submarine which will fire its first **Lockheed** *Polaris* next year, slid down the ways at the **Electric Boat Division** of **General Dynamics Corp.** The sub cost $100 million and the company is working now on a sister ship, the Patrick Henry, and will soon start a third, the Ethan Allen. Employment at EB is up over 8000 and the company has scores of suppliers and subcontractors through the Northeast.

A few weeks ago the Office of Naval Research handed Electric Boat the managership of an industry-Navy team working on SUBIC (submarine integrated control system) aimed at reducing FBM sub crews from 100 to 12 men. Concept of the project is to create "balanced man-machine partnership" utilizing greater electronic sensing and data processing equipment and a television-type visual display of information.

Largest Connecticut missile employer is the **Pratt & Whitney Division** of **United Aircraft** at East Hartford. Many of the division's 35,000 employees are producing J-57 and J-52 engines for *Snark* and *Hound Dog.* **UA,s Hamilton Standard Division** at Windsor Locks with nearly 12,000 employees is producing *Nike* parts, secondary power packs, air conditioning systems, fuel controls, pneumatic valves and starters for other missile systems.

Other large companies with important missile assignments include **Kaman Aircraft,** Bloomfield, which is studying electronic countermeasures for *Polaris* missiles; **Landers, Frary & Clark,** New Britain, producing 2.75 rockets; **Naugatuck Chemical Division, U. S. Rubber Co.,** R&D solid propellant rocket liners; **Norden-Ketay,** Stamford, analog-to-digital converters for *Atlas;* **Lycoming Division of Avco,** Stratford, nose cones for *Nike-Hercules Polaris* rocket case compo *Talos* forward-sleeves and *Titan* bodies, cylinders and heat sinks.

A recently-issued CDC report 358 Connecticut firms employing 000 scientific and technical work research labs—nearly all inv electro-mechanical, metallurgical, ical and aerodynamic work, much related to missiles. Interestingly en Connecticut has one researche every 25 production workers.

• **New Hampshire**—Electroni the fastest growing industry in Hampshire, with employment numbering 8750—more than 10 the state's 83,000 total work More than 25% of the electronics duction is missile-oriented, chief the component field.

Leaders include **Sanders Assoc** Nashua, which started out with a dozen employees in 1945 and grown to around 1000. Sanders won a subcontract from **Bendix tion** to develop the guidance "se for *Eagle.*

Transistors and capacitors are produced at a **Sprague Electric** in Concord; **Sylvania,** with one sistor and diode plant at Hillsbo looking around the Granite Stat another plant location; **Rayth** Hookset facility is manufact power suppliers and transformers its other divisions.

At Manchester, precision resi are coming off the production lin **Tel-Labs Inc.** and in Concord, **Richard D. Brew Co.** is making lines. With an in-house-developed chine tool, **Ber-Kit Industries,** chester, is finding a profitable m market for precision screws.

A fourth FBM submarine, the Lincoln, is being constructed at P mouth Navy Shipyard.

State development officials re that employment is "tight" in Hampshire. As textiles have decli electronics have taken their place.

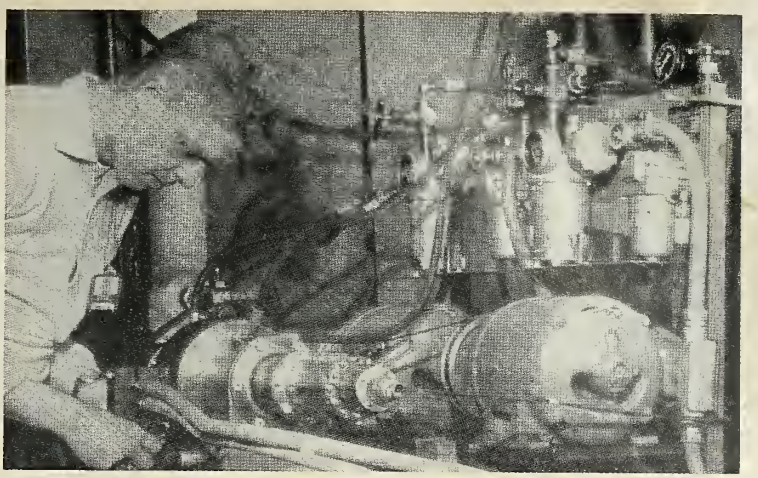
• **Vermont**—Across the state in Vermont, firms are busy suppl machine tools for the missile indu **IBM** has a large plant at Burlin making relays for data processing vices, and at Bennington **Sprague tric** is producing electronic com ents and ceramic sheathed wire.

• **Maine**—Only a few Maine f are turning out missile parts, acc ing to the state's Department of nomic Development. **Alloy Prod** Sanford, **Portland Machine Tool Maine Metal Finishing,** Gorham, the principal ones supplying spec items to various weapons contract

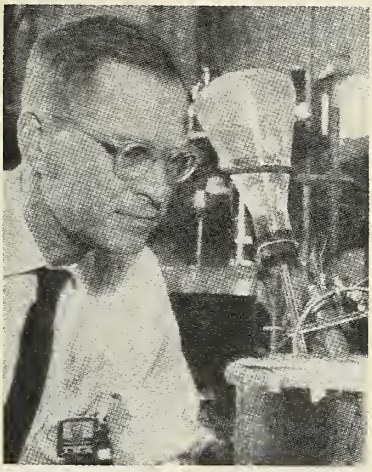
But the DED says the Pine State is "getting ready for the mi age" by becoming an important in the nation's defenses. In addi

the VLF Navy radio facility, a
iarc base is being built at Bangor
the first *Snark* squadron to be-
e operational in the nation is now
y for action at Presque Isle AFB
he potato-growing north country
Aroostook County. SAC bases are
ted at nearby Loring AFB and
estone AFB.
Four hundred technicians are work-
at a $20 million SAGE control
er—New England's first—located
opsham, Me.
Rhode Island—The Rhode Island
elopment Council reports there are
o 30 small electronic firms—many
hem engaged in defense produc-
Speidel Inc., Providence, which
a total work force of 1000 has a
ing electronics division which as-
les components for missiles, ac-
ing to RIDC.
Also in Providence is **Federal Prod-**
Inc., a gauge maker employing
which is firmly established in the
le component field.
Brainpower factor—Traditionally
ervative New Englanders are still
what awestruck by the young mis-
space giant rearing up in their
t. Where did it grow from? The
ronics industry founded after
d War II, some experts will tell
But other researchers probing into
uestion of why New England sud-
has a booming new industry be-
the answer lies in the areas top
ural" resource—the wealth of
power generated from its long-
lished universities, technical
ols and research centers.
The New England Council notes
one-sixth of the nation's entire
rch facilities are clustered in the
n, along with 13% of the universi-
and colleges which award higher
es. "There is a very definite cor-
on, in our opinion," says one
al of the agency, "between educa-
l facilities and the growth of our
science-based industry."
Many new companies are being
d and founded by the graduates
I.I.T., Harvard, Yale, Worcester
echnic and scores of other New
and institutions of learning. And
of these newer firms lean heavily
sic research and specialized areas
issile/space technology.
When **RCA** opened its new **Missile**
ronics and Controls Department,
rlington, Mass. In the "Golden
trial Semicircle" company Presi-
John L. Burns commented, "Few
y areas in the country offer a
er stimulus to intellectual curiosity
riginal research."

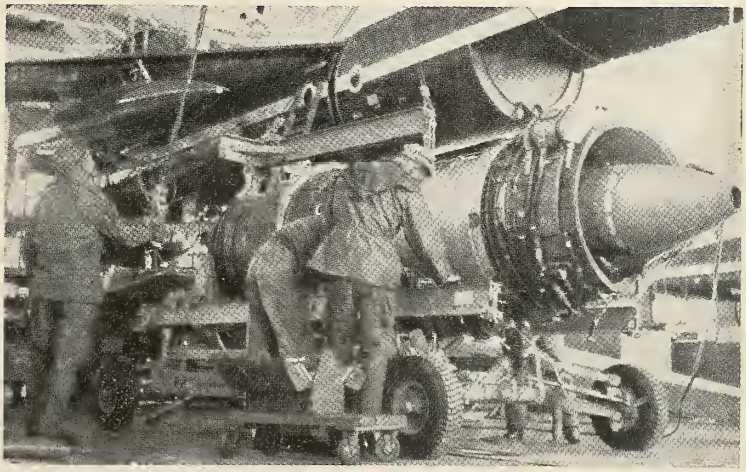
Week:
Closeup of Boston's "Golden Semicircle"



TYPICAL OF developmental research work being carried out by numerous New England companies is this fatigue testing of high temperature bearing material.



INSPECTOR at work in Pratt & Whitney laboratory, East Hartford, Conn.



FIRST OPERATIONAL *Snark* **squadron in the nation is ready for action at Presque Isle AFB in the potato-growing north country of Aroostook County, Maine.**

Interview With General Sessums

"He is the rare kind of commander who always seems to know exactly what everyone under him is doing . . . and regardless of how occupied he may be with important decisions, if he feels someone has done a good job, he always finds the time to put it in writing in the man's record."

The words were tinged with regret as they came from an officer the other day. For he was speaking unhappily about the retirement of his boss—lean, nimble-witted Maj. Gen. John W. Sessums, Jr., as vice commander of ARDC, a post he had held for the past five years.

Mechanical engineer-trained (University of Tennessee, Air Corps Engineer School) Johnny Sessums has been intimately associated with aircraft and, in recent years—missile—research and development throughout his 30-year career. And his firm guidance will be missed. In the early '30's while in the Canal Zone he flew—and crashed on its second flight—a homemade monoplane with an engine he had constructed from outboard motor parts. During World War II, he headed up the AF's Aircraft Production Division for three years then shipped overseas as chief of plans for the 22nd Tactical Air Command.

Returning in mid-1945 to the U.S., he promptly was made assistant to the chief of R&D at AMC, Dayton. Six years saw him rise to deputy commanding general of ARDC at Wright-Pa son AFB, and in 1954—to vice c mander of the entire ARDC comm Along the way, in addition to his w personality, silver-haired Johnny sums has earned the reputation mechanical genius. His associates he is "conscientious in everythin does."

ARDC Commander Lt. Gen. I ard M. Schriever noted Sessums one of the earliest advocates of listic missiles and called the ret general "a voice in the wilderne the late '40's and early '50's." A was in the process of stepping back civilian life last week, General Ses was invited by M/R editors to over the missile development hor

Q. The next 10 years hold promise of big things. Let's take ballistic missiles. We're pushing ahead with *Atlas* and *Titan*—the so-called first generation ICBM's—and in a few years will come solid-fueled *Minuteman*. What do you believe will be the third generation?

A. If I had to bet on it, I would say the pre-packaged liquids. And it is my firm belief that we are going to find the air-launched ballistic missile is really the pay-off.

Q. You mean strategically and from a cost standpoint, too?

A. Yes. The overall cost of defending the country can be greatly reduced with a system using CAMAL, the nuclear-powered, continuously airborne, missile-launching, low level airplane, and the ALBM. With a fleet of these planes, you would need only a few bases. The planes don't have to be accommodated on the ground all at one time—they stay in the air most of the time. On patrol, they could be a terrific deterrent. Not only can they get closer, which helps solve your targeting problem, but by getting closer the magnitude of the problem of detection and destruction reduces very rapidly. Such a force operating on a global basis would be able to strike at all enemy target complexes. It would be a most difficult task for any enemy to locate the constantly moving patrol. I think that with such a force it would be very difficult for any aggressor to launch a surprise attack on the U.S.

Q. Letting your imagination go a bit, how feasible is the CAMAL-ALBM as an anti-missile missile?



A. Of course, the CAMAL concept of operations is not defensive in nature, rather it is a weapon system designed to deter the enemy from launching his ICBM's. It is true that CAMAL would be able to assume tasks of a defensive nature because it will be a very versatile airplane capable of carrying very high payloads. We are talking now, for instance, of intercepting missiles at 18,000 miles an hour and 700 miles high. This is quite a problem—the defensive missile which may be going even faster than that will always have the disadvantage of taking off last. So, you can't assume you are going to get him half way; you are going to have to get him somewhere between half-way and home plate. CAMAL would put you out to where this half-way business becomes the ocean—instead of the U States.

Q. That certainly is desirable. would CAMAL have a capabili combatting a number of ICBM's ing in; a capability superior ground-based system?

A. The Kitty Hawk of the launched missile business is the mile type that we are developing The studies that were carried o **Martin, McDonald** and **Convair-l heed** in competition for the A contract indicate that an airplan CAMAL's size ought to be ab carry several.

Q. And the size can be expect diminish with future developmen

A. Certainly. With the first bomb, you may remember, we terrible time folding the thing int biggest airplane we had. Compar now to atomic artillery shells now can be shot from a gun. Yo expect increased efficiency in ALBM's propellants, which will r the size of the missile. So, you c we are either going to come do the size of the missile or be a shoot it further with a bigger if we keep it roughly at 10,000 p size.

Q. Visualizing an airplane out over the ocean hunting missiles, going to be a devilish compu problem. The airplane would computer.

A. You may be right; you ha a problem. But it seems to me th to lick it is by building your det in the plane. This would elimina need for the ground communi

rol system we have now, with s of large capacity computers and munication relays for detecting tracking. If you have the weapon oard and the detection equipment oard, all the computer does is put ignals in the missile, and the plane can fire instantaneously, assuming have the authority to launch. All need is a signal, like SAC now or the positive control system.

). It is still going to take a big air- to carry it all.

. Well, it is going to take a big ane to carry a nuclear reactor and ding. This is another point: you say if you have a fleet of these s patrolling the perimeter of an y country, they will just send their rs and shoot them all down. It is to be a long time before there are ic fighters—when you start out 60,000 to 100,000 pounds of ding before you start to fill in the e and the airplane. So, I would ne any counter weapon would be issile. It might be submarine- hed. But, if your CAMAL has rity to defend himself—take on gs—then I would think that as as a missile was launched at him, ould be able to get the missile whomever launched it.

. This looks like an interesting ect to tie in the Air Force early ing system, and possibly with the task of anti-submarine warfare.

. There are a great variety of pos- ies. And the thing that appeals is that it offers a chance to save money by reducing some of the weapons systems we have now, offensive and defensive.

. Of course, any saving with a a like this would be very far in ture. We would still have to go with ICBM base building, cost- n enormous amount.

. Yes. It is just like General Le- says. He will take any new n that is proven. This is true of and *Titan*. He's not about to take -52's off the line, until *Atlas* and have been proved. You have to them in the hands of trained and with a demonstrated capa- first. Target selection (planning of attack and all these things) o a factor and poses a much er problem than the average in- al realizes. The CAMAL airplane ew development—it hasn't been own yet. The ALBM is a new pment. It will be some time be- we get a really satisfactory air- ed ballistic missile. Before you ne built, you can see another is going to be a big improve-

On the point of training. In pinion, how many years will it be before we can muster a 15-minute ICBM retaliation system?

A. Well, the nucleus of the capability will start when the first *Atlas* becomes operational. That means crews have been checked out on the mechanism. But just having a group of men trained in the mechanics alone is not enough. You are going to have to build up all the accouterments—targeting is a problem we are learning more about every day. I would say soon after we kick off, we ought to have some capability. That capability should increase at a rapid rate as facilities and additional personnel become available.

Q. Let's switch over now to what's ahead in propellants and materials. On improving the specific impulse of solid fuels, what's the outlook on aluminized perchlorates?

A. They have shown considerable improvement—something like 20 per cent. I think we are going to see other additives that will be very effective. A great deal of research is going on in the boron field, both as a fundamental fuel and additives, which may produce even better results. We have gotten higher than 260 I_{sp} with solids. But with perchlorates, you must remember they are extremely sensitive and the higher specifics become, the more sensitive they get. This creates a problem in making them meet storage and handling requirements. If they are so sensitive that if anyone just tapped a rocket accidentally and it went off, it wouldn't have much military use.

Q. Where are you having heat problems with solids—just in the nozzle area?

A. In the nose cone, of course.

Q. How about the casement side?

A. Well, we aren't having any particular problem, other than trying to get the weight down.

Q. And with liquids?

A. The big problem here is the motor chamber pressure. A number of people are working on chambers of up to 1000 psi. And with this order of magnitude they are getting into entirely new developments to keep the engine from blowing up.

Q. Actually, most ARDC work is strictly related to materials. What are the goals in this area of an applied research nature?

A. Beryllium development is a good example of our applied research efforts. It is really a wonder metal, but it is very hard to extract from its ores and not too many exploitable sources have been discovered. Furthermore, we have brittleness and joining problems. Substitution of beryllium for steel has provided us with an extremely sensitive, light weight gyro. Many other specialized applications, such as brake systems, nose cones, satellite structures, are visualized which could reduce their weight by 50% or more.

Q. Has the toxicity problem been licked?

A. No, but the beryllium industry and the AEC over a period of years have developed many safeguards from which we and our contractors are learning.

Q. Are we trying to build an industry, like we did with titanium? Everyone knows how titanium slumped. Now, are we building up the beryllium effort at the expense of other important metals such as the refractories—like columbium—so all our eggs will be in a beryllium basket?

A. Not at all. We are also concentrating on applied research in the refractory metals. As for building an industry, you will recall that, initially, aluminum and magnesium were primarily aircraft materials. Both have become a boon to the civilian economy. I expect the same pattern for titanium. But money is always a problem. With the J57 Pratt & Whitney engine, there was a large premium for the titanium in it—so large a premium, in fact, that a decision was made at higher levels to cut the percentage of titanium to where it would cost only $150,000 or so premium over the price of the engine. It would have been fine if we could have afforded to create a terrific market for titanium.

Q. What about "whiskers?"

A. Research in "whiskers" is one of our longer-range programs. Such studies may shed new light on problems, such as fatigue, which have long plagued the Air Force. A string of iron molecules making up one of these "whiskers" is out of the ball park for anything we've known in the past for strength—over 2,000,000 psi, many times the strength of any known steel.

Q. What would you say will be the basic material for space vehicles of the foreseeable future?

A. Obviously, it is going to be a long time before we can grow molecules into sheet sizes. So, I think you will see stainless steel alloys, with their terrific strength properties, particularly in honeycombs, being used for quite some time. ARDC, of course, is investigating all approaches of the entire spectrum of basic materials. And you never know what will be coming up, because there are literally billions of possible combinations. In the high-temperature area, we are looking into the refractory metals, ceramics, and graphite and trying all types of cooling tricks —evaporative, porous, ceramic-coating and regenerative systems. Any of these could be a real answer if we come up with ways of improving their characteristics—either by alloying or protective coatings, or both.

Missile Aluminum Uses Increase

The lightweight workhorse of the aircraft industry proves to be a versatile metal for missiles, with support equipment offering the greatest market

by Paul Means

WASHINGTON—Aluminum, long the economical lightweight workhorse of the aircraft industry, is now proving to be one of the most versatile materials for missile and rocket development.

The metal is used in almost every type of missile component and support equipment—from solid propellants to warheads, from the largest missile hull to the tiniest electronic component. Aluminum parts carry, fuel, launch and track today's missiles and space vehicles.

Aluminum accounts for approximately 10% of the average missile's weight—second only to steel. The amount of aluminum used is increased in the newer missiles, and as missiles advance from the R&D stage to production.

With more and more missiles moving along the production line, a vast new market is opening up for the aluminum industry.

In 1958—the first year that missiles were produced in any quantity—the Department of Defense purchased 342,202,000 lbs. of aluminum, 24,451,000 lbs. of which were specifically designated for the A-2 missile program. In 1959, DOD expects to purchase 307,492,000 lbs. of aluminum, 19,199,000 lbs. of which are earmarked for missile use.

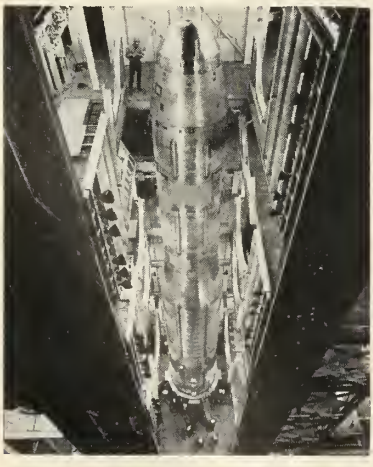
Much of the aluminum not specifically designated for missile development finds its way into missile checkout, ground support, tracking and electronic equipment. Also not included in the totals are National Aeronautics and Space Administration aluminum uses not specifically purchased from one of the services.

Expectations are that DOD and NASA aluminum purchases for missiles in 1960—when IRBM's, ICBM's, and space vehicles go into quantity production—will skyrocket, offsetting declining aluminum purchases for military aircraft.

The number of primary aluminum producers, which expanded from four to six in 1958, are: **Aluminum Company of America, The Anaconda Company, Harvey Aluminum Inc., Ka Aluminum & Chemical Corp., Or Corporation,** and **Reynolds Metals** The new producers were Harvey Ormet, which is jointly owned by **Mathieson Chemical Corp.** and **Re Copper & Brass Inc.**

In back of these companies over 26,000 firms—including most the major missile contractors—have the capability to fabricate aluminum into its desired forms.

• **Myriad applications**—A comp list of missile parts made wholly partly out of aluminum would be most impossible to compile. A par list would include: light and he gauge sheets for hull and nose co ponents; rod, bar, wire, and sc machine stock for electronic con and guidance units; angles or extru shapes for internal bracing; foil in el trical components; forgings for fi honeycomb aluminum for wing tail assemblies; powder for ignition s tems and solid propellants; and alu num in many forms for brackets, f tanks, motor heads, rocket motor tub



ALCOA integrally stiffened, extruded aluminum plate forms the *Titan's* hull.

Representative Uses of Aluminum in Missiles

MISSILE	WHERE ALUMINUM IS USED	OVERALL WT.—LBS. (Takeoff)	WT. OF ALUMIN USED—LBS.
AEROBEE-HI	nose	231	100
ATLAS	powerplant	200,000	3500
BOMARC	hull, skin, wings, tailskin, fuel tanks, motor components	8500	1500
BULLPUP	major parts	600	300
CORVUS	inner hull, motor fins	not available	not available
CORPORAL	booster components	12,000	4000
DART	motor head, wing spars, wing spoilers, wing bobbin rods	100	5
FALCON	fuel tank, body, fins	100	49
GENIE	not available	104	
HAWK	midsection body, propellant	1200	170
HONEST JOHN	skin, bulkhead, fittings	6000	960
JUPITER	skin, fuel tanks, fins, powerplant	100,000	17,500
JUPITER-C	skin, fuel tanks, fins, powerplant	60-80,000	3,500 (powerplant)
LACROSSE	wings, tail surfaces, structural body, brackets, frames	500	250
MATADOR		13,800	5000
MIGHTY MOUSE	motor, tube, fins	19	2
NIKE-AJAX	skin, bulkhead, fins, fittings	1000 (without warhead)	460

-propellant core molds; and spin chers for satellite launchers and e probes.

Aluminum uses in support equipment include: shipping containers, ries for loading and unloading; way carriers, field loaders and car-; field liquid oxygen producers; ge units and trailers; lightweight r generators, launching towers, devices, photomapping vans, ing radars, acquisition radars, ronic control vans, fire control pment, and even portable field ers for personnel.

t is in the latter area—missile support equipment—that aluminum companies feel they have their greatest existing market.

Two of the most attractive qualities aluminum are its weight, of course, its cost.

Aluminum has a specific gravity of 7 (one third the volume of steel). ght savings in structure allow for weight in propellants and payAluminum also has a great variety of uses, requires little maintenance, resists corrosion, is non-toxic, has a tensile strength of 13,000 per square inch—a factor which be raised to 90,000 lbs. per square with alloys and special heat treats.

Low cost gains attraction—Aluminum's economy as a structural metal comes important when the missile is duced in volume. Prototypes are ly handicrafted and time and labor utshadow material costs. Materials is stage are not necessarily picked economy.

ut as missiles move into full-scale duction, time and labor costs drop, the proportion of materials cost to overall cost goes up. It is then that inum's low basic price, easy mability, and light weight will recommend its use wherever possible to cut unit costs.

And the price of aluminum has been lowered somewhat in recent years by improved methods and foreign competition. It presently sells for about 24.7 cents a pound.

Another advantage of aluminum is that it is in plentiful supply. Major expansion has taken place in recent years in primary aluminum production facilities. This was done partly by the producers to meet expanding demands of commercial and industrial aluminum users, and partly with guarantees from the government to meet military requirements.

The Federal government gave contracts to the aluminum producers after the beginning of the Korean War to expand aluminum facilities under which the government, for a period of 5 to 6 years following initial production from the facility, is required to purchase metal from the new facilities which the producer is unable to use or market in its normal operations.

• **Capacity swells**—The capacity for producing primary aluminum more than doubled between 1950 and 1958. Additional capacity of 433,000 tons was installed in 1958, representing a 24% increase during that single year.

New facilities installed during 1958 included Kaiser's hot-line at Ravenswood, West Va., the installation of two 16 million-pound plate stretchers, one by Alcoa and one by Reynolds, and a 6000-ton extrusion press installed for the Navy at their Hannibal, Ohio, plant by Reynolds.

Major facilities to be installed during 1959 include Olin Mathieson's new rolling mill at Hannibal, Kaiser's 30 million-pound plate stretcher at Ravenswood, and Alcoa's 14,000-ton press at its Lafayette, Ind., plant.

One drawback of aluminum for missile use is its comparatively low heat resistance. The metal melts at 1220°F, and begins to suffer measurable loss of strength above 400°F.

Though other metals and alloys have a higher heat resistance, very few can withstand surface temperatures created at very high Mach numbers for any length of time.

Much of this problem has been overcome by research into the effects of high temperatures for short periods on aluminum, and with newer missile designs and flight paths.

Almost every major form in which aluminum is available is used in missiles and missile support equipment: sheet, plate, castings, extrusions, forgings, rod, bar and wire, electrical conductors, insulated wire, foil and powder.

And the fabrication of aluminum in these various forms for complex forced aluminum fabrication companies to devise new special handling techniques and very careful quality controls.

• **Tight controls**—An example of this is the extreme tolerances that Reynolds must meet in fabricating the aluminum shells for *Redstone* and *Jupiter-C*.

To insure quality, Reynolds, which has been fabricating missile hulls since 1952, employs one inspector for every four technicians working on rocket casings. Each of the more than 20,000 parts, and each stage of assembly, is checked before joining.

Quality control starts for Reynolds, as it does for the other aluminum producers, when the aluminum sheet and plate is produced for missile parts. The metal must be perfect, devoid of scratches and blemishes. Electronic instruments search for possible weak spots that might fail under pressure. Width and thickness of the sheets and plates are measured to tolerances within a few thousandths of an inch, and samples are chemically analyzed.

The sheets are then taped to protect the surface from dirt, scratches, and fingerprints. This tape is not removed until the final assembly is ready for cleaning and finishing.

Reynolds then trims the aluminum sheets to their required length of 220 inches fitting a tolerance of 0.002 inches.

The trimmed sheet is then rolled to form a cylinder, then the ends are welded. Next, the shell is strengthened by spotwelding an aluminum reinforcing bar along the longitudinal weld.

Then the shell is trimmed to exact length, fitting a tolerance of plus or minus 0.015 inches. Aluminum stiffener rings, shaped on a radial draw forming machine, are spotwelded into the shell. There are approximately 24,000 spotwelds on a *Redstone* shell. The shells

SE	WHERE ALUMINUM IS USED	OVERALL WT.—LBS. (Takeoff)	WT. OF ALUMINUM USED—LBS.
KHERCULES	skin, bulkhead, fins, fittings	2000 (without warhead)	750
DLUS	not available	28,000	25 (known)
SAL	wings, fins, hull skin, motor, wing roots, wing components	13,000	3200
DONE	nose, fuel, body, engine housing, tail fins, hull	40,000	4500
RCANT		22,000	1320
DEFINDER	power tube, hull	155	75
IAS	skin, fins, frame	36,000	3900
ALOW I	midsection, body	300	95
ALOW III	midsection, body	350	260
LC	fins, inner hull	3000	500
RR	shell, structurals, fins		19%
RFR	structural parts, outer skin	3300	528
TA	skin	220,000	not available
HC	skin, tanks, bulkheads, power plant	100,000	11,025
ANUARD	skin, fins	22,600	3700
UN	rocket motor tubes	107	not available

Source: Kaiser Aluminum & Chemical Co.

are then welded into sections, which require tolerances of 0.031 for a 34-foot section.

After the sections with the bulkheads are welded together, with X-rays checking the welds and extremely high tolerances demanded throughout, the piping and tanks are hydrostatically tested for leakage, pressurized to make sure the metal and welds withstand pressure, and optically inspected by instruments to check alignment of all assemblies.

These rigid quality controls follow the shell through final finishing for delivery to **Chrysler Corp.,** the prime contractor.

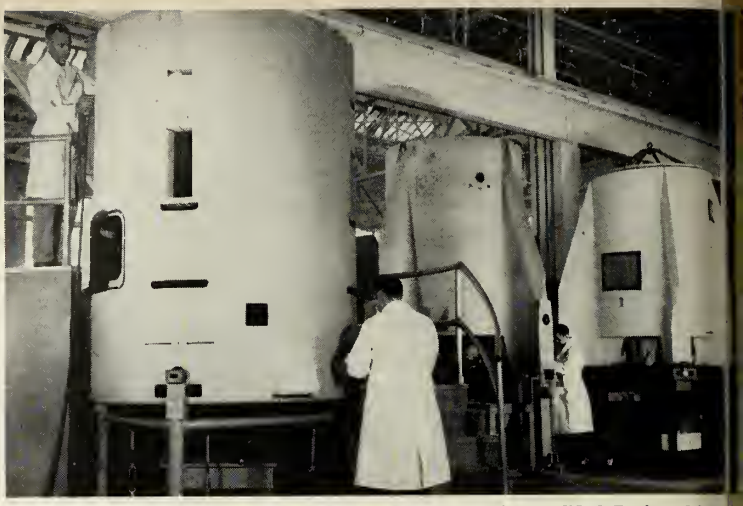
Other large missiles using aluminum plate or sheet as their frame and covering include *Thor, Jupiter, Titan, Snark, Bomarc, Polaris* and *Minuteman.*

•**Milling and aging**—The *Titan* uses integrally stiffened, extruded plate produced by Alcoa's 14,000-ton press at Lafayette. The 20-foot shapes emerge as inverted vee's. They are flattened into 34-inch widths, and shipped to **The Martin Co.,** at Denver for stretch-forming, chemical milling and welding. Mechanical milling reduces the skin to a uniform thickness. The two faces of the aluminum skins are milled to required dimensional tolerances including the flat surface of the web between the ribs.

After inspection, they are stretch-formed in sections as large as 5 feet wide and 24 feet long, inspected for contour, and aged for final strength. Heat treating to a final T-6 condition follows and after additional aging, the panels are finally chemically milled.

Alcoa Aluminum plate is used for *Thor* and aluminum sheet is used for *Jupiter.*

Smaller missile shells can be made of a single precision aluminum cold forging as **Hunter Douglas, Division of Bridgeport Brass Co.,** does for the *Sidewinder* motortube. This tube is typically straight within .020 inches, its inside diameter within .006 inches, wall thickness within .0015 inches. It has a yield strength of 72,000 psi minimum.



REYNOLDS fabricates the aluminum tail sections for the modified Project *Merc* *Redstone* scheduled to take the first American on a ballistic rocket flight.

• **Use in solids**—Another not too widely known application of aluminum in the missile industry is as a component in solid-fuel systems.

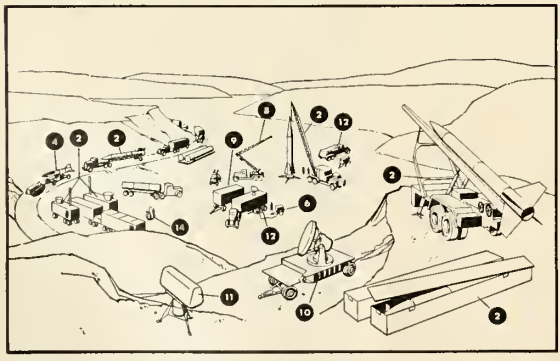
Polaris' solid-fuel motor, for example, uses a composite fuel made up of very fine aluminum powder in combination with conventional polymer bondings. The fuel is encased in aluminum firing chambers to increase the heat.

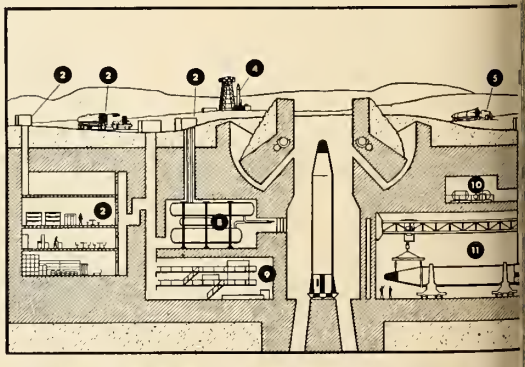
Powdered aluminum constitutes 15% of the propellant by weight used in the Army's *Hawk.*

• **Promise in support**—But according to a recent study by Kaiser, missile support equipment offers small and medium-sized aluminum f cators their greatest opportunity. the case of tactical missiles, alumi will gain widespread application cause of the entire missile bat must be readily portable and, in cases, capable of being airborne.

Aluminum's light weight, dur ity, and ease of maintenance in storage make it a favored metal t used in ground transport equipn designed to take the missile not from factory to test or installation but also from base to base as assig

Small missiles make wide use aluminum containers for shipm The *Sidewinder* is shipped in aluminum container 18 inches sq by 35 inches long. The *Falcon* shipped in an aluminum case measures 88 inches overall. The to-surface torpedo *Petrel* uses an minum case that telescopes into a for reshipment.





SUPPORT equipment aluminum uses include: 1—shipping container; 2—gantry; 3—highway carrier; 4—special loader, carrier; 5—LOX producer, storage and trailer; 6—power generators; 7—launch tower; 8—firing device; 9—photomap van; 10 & 11—track and acquisition radar; 12—electronic control van; 13—fire control equipment; 14—field showers. Fixed base uses clude: 1 & 6—personnel access; 2, 3 & 8—fuel transport, int and storage; 4—static testing; 5—missile transport; 7—quar and storage; 9—control room; 10—power generation; 1 warhead loading. Drawings supplied by Kaiser Aluminum C

A Bright Future for Cryogenics

Their advantages should enable them to stand off challenges of exotic systems at least until 1970

by Frank G. McGuire

Los Angeles—The outlook for cryogenics? Bright and clear. That's the opinion of propulsion experts, and they make a convincing argument to support their optimism. Despite the approach of nuclear rockets, ion and photon systems, and other exotic propulsion devices, it seems the chemical systems will be with us for a long time.

Part of the key to the future of cryogenic propellants lies in the definition of the term, from a scientist's point of view: "As they exist in a normal atmosphere on earth, cryogenics are liquified gases whose boiling point is considerably below vapor pressure at ambient temperatures . . . and which must be refrigerated in order to be stored under normal conditions." Storable propellants, on the other hand, do not have the characteristic of boiling off in a normal atmosphere on earth.

The significant words in both cases are "on earth." According to Robert S. Kraemer, group leader in **Rocketdyne's** preliminary analysis department: "When we get out into space, the environment is completely different, and we find that what is 'storable' in space is not 'storable' on earth."

This environmental difference eliminates (or greatly reduces) a major disadvantage of cryogenics and adds a handicap to the storables. The low-temperature nature of such high-performance propellants as LOX (–297°F), ozone (–169.5°F), liquid hydrogen (–423°F), and fluorine (–306.3°F), must, may lend itself very well to making these chemicals storable in space. Propellant combinations with higher, non-cryogenic boiling points, such as nitrogen tetroxide and hydrazine, will have great usefulness in immediate-retaliation missiles, but will not dominate the space flight field and may even yield to cryogenics in some missiles.

(There is evidence that almost anything will boil off in space—even solid propellants and possibly metals. It has been felt necessary to place a diaphragm over the exit nozzle of solid-propellant rockets that will coast for a long time in space, to prevent excess vaporization of the material.)

● **Stressing insulation**—Despite low temperatures in space, it will be necessary to insulate cryogenic propellents against direct solar radiation to prevent boil-off, and to insulate storable propellants to prevent freezing. Either boil-off or freezing would abort a mission. One method, proposed by Rocketdyne, features the use of lightweight plastic foam which acts both as insulation and as a load-bearing structure. The fluorine/hydrogen tanks in Rocketdyne's suggested space vehicle are mounted directly in the rigid foam, which insulates the tanks and provides support for the vehicle's outer walls. (The outer walls will be painted with a reflective coating to minimize solar radiation effects.)

To reverse the insulating action, the foam "umbrella" that protects the propellants from solar heat is rearranged to provide a reflecting surface to focus solar heat on tanks containing storable propellants to prevent freezing. It was calculated that just about as much insulating foam would be needed to prevent storables from freezing as to keep cryogenics from boiling off. The difference is merely in the design of the foam shield around the tanks. As a result, fuels and oxidizers formerly thought too touchy for space flight—such as fluorine and hydrogen—are just as storable for space missions as nitrogen tetroxide and hydrazine.

The new insulating powder recently developed for propellant tanks was not used in the Rocketdyne design because of the need for structural strength to support the vehicle walls. Actually, slightly larger amount of foam is needed for cryogenics than for storables, but the amount is "negligible," according to Rocketdyne.

● **Looking away**—A further step taken to control solar absorption by space vehicles is the technique of orienting the vehicle so that it presents as small a surface as possible to the Sun. While the vehicle is pointed nose-first at the sun, reflectors are extended from the sides at the nose to form a shaded area over the propellant tank area. Known as making the vehicle "solar statically stable," the technique is an easy one to carry out and involves keeping the solar-pressure-center aft of the center-of-mass. This method keeps heat away from the cryogenic-propellant tanks. When the reflectors are extended from the sides at the tail, they focus heat onto storable-propellant tanks to prevent freezing.

The Linde Company, manufacturer of cryogenic liquids, also has considerable confidence in the future of cryogenics as rocket propellants. According to C. T. Fallon, manager of cryogenic engineering, the firm expects to begin operation of its liquid hydrogen plant at Torrance, Calif., about April of 1960. This facility is designed to produce over 360,000 pounds of liquid hydrogen per month, 300,000 pounds of which goes to NASA under option. Linde will then truck the propellant to NASA's facilities for use in various programs.

● **Gains in storability**—The new insulations presently being developed, notably Linde's SI-4, assure almost complete storability of cryogenics. Although few details on SI-4 (Super-Insulation #4) have been released by the company because of pending patent proceedings, its weight and thermal conductivity have been announced. Compared with other standard insulations, SI-4 stacks up as follows:

Santocel thermal conductivity is between room temperature and 90°K, recorded as BTU/Hour-Foot-°F. This

'Specific Impulse Is King!' . . .

reads as 120 x 10^{-5}. Perlite, another standard insulation, has a thermal conductivity of 90 x 10^{-5}. This compares with a straight vacuum, which has a rating of 78 x 10^{-5} (with highly polished surfaces).

The SI-4 insulation rates at 3 x 10^{-5} in thermal conductivity, an obvious improvement of 30 times over Perlite, and 25 times over a vacuum. It weighs about 6.8 pounds per cubic foot, compared with the 8-pound-per-cubic-foot weight of Perlite. The figures established by Linde laboratories have been verified by the National Bureau of Standards.

Evaporation losses have also been considerably reduced by SI-4, and in the case of liquid hydrogen protected by the material, amount to 9.3% per year. Normal tankage using Perlite would lose about 200% per year. A LOX tank protected by SI-4 could be expected to lose 2½% to 3% per year through boil-off. The difference is due to the lower boiling point of hydrogen.

The cost of the SI-4 depends not only on production and availability, but also on the technique of application, which is very important. It would however, be a premium product, somewhat more expensive than Perlite. It would unquestionably pay its own way where the colder cryogenics are concerned, such as hydrogen or helium, but the low cost at which liquid oxygen and nitrogen are distributed make it questionable whether the premium cost would be justified in a ground installation. In an airborne vehicle, however, SI-4 has distinct advantages because of its light weight.

• **Limits of fluorine**—Linde feels that with the high specific impulse of a fluorine/hydrogen system combined with the storability of such cold fluids now possible, there is no great barrier to their use in space vehicles. However, when asked if they thought fluorine would ever be able to compete economically with liquid oxygen, company officials thought not. Agreeing with Rocketdyne spokesmen, they said fluorine would probably be used where specific impulse is the prime factor, but that it is very unlikely that fluorine would get down to the neighborhood of LOX in price-per-pound.

Until the advent of systems with higher specific impulses, there seems an excellent possibility that a cryogenic fluorine/hydrogen system will be the workhorse of our space programs where large payloads are used.

• **Comparisons**—The future of cryogenics in space flight as compared with other propulsion systems has been studied by Rocketdyne, which came up with some interesting results. Starting from a common point, that is, takeoff from a 300-mile orbit around the earth at a gross weight of 25,000 pounds, each vehicle or system was to complete a simulated mission to Mars. Payload delivered to Mars was the determining factor of usefulness.

The solid-propellant system delivered a gross payload of 1600 pounds, exclusive of any propulsion system or related items. Such a vehicle would be available in the early 1960's and a "fairly optimistic" solid propellant was assumed. In addition, higher motor-case strengths were assumed than those of other systems, and more staging was used.

In spite of this, says Rocketdyne, both the storable systems (hydrazine/nitrogen tetroxide bi-propellant liquid rocket) and the hybrid system (liquid chlorine - trifluoride/solid lithium - hydride) came out considerably higher in payload capability—about 2800 pounds, compared with the 1600 pounds for the solids. The pure liquid system (liquid fluorine/hydrogen) outperformed all the previous systems with a gross payload capability of 4000 pounds.

• **King Cryogenic**—"Regardless of complications," said Rocketdyne's Kraemer, "we found that higher specific impulse would always pay for itself . . . you might say 'Specific Impulse is King!' "

This criteria therefore establishes cryogenic liquids as the most efficient system for a number of years to come. Even with the advent of nuclear and ion rockets in the late 1960's or early 1970's, there will be a need for efficient large chemical boosters to get these low-thrust or radioactive rockets off the ground and away from earth.

The fluorine/hydrogen system will be available in the early 1960's, as will the large solid-propellant system, and other large cryogenic-chemical systems will be on hand even sooner. Advanced nuclear systems expected to be ready for flight by 1970 will bring the payload capability up to 6300 pounds, from the 4000-pound-capability obtainable with the F_2/H_2 system (still using the basic premise of a 25,000-pound-gross-weight vehicle leaving a 300-mile orbit). These advanced nuclear systems have a design I_s of 1080 seconds.

The future of one particular cr genic propellant—liquid oxygen— been questioned because of the po bility that liquid fluorine or oz might completely displace it. The u mate theoretical cryogenic combi tion is ozone/hydrogen, but ozone not yet reached the state of devel ment that allows its use as a stand propellant.

The ultimate practical combinati therefore, is fluorine/hydrogen, witl specific impulse of 398 seconds (th retical maximum specific impulse, lb-sec/lb. frozen equilibrium). Liq oxygen/hydrogen holds a spot ab ten seconds behind at 388 secon With the extremely low cost of L (less than a penny per pound) and high availability, it is an excellent for use in many vehicles where extreme performance of fluorine is mandatory.

• **Trend toward simplicity**—Spec equipment for handling LOX is of greater complexity (and in some ca less) than equipment for other cr genics. Rocket engines show a c tinuing trend toward simplification . witness the engine used in *Th Jupiter*: components reduced from in 1955 to 5 by 1960.

The turbopump problem is s to be greatly exaggerated, with b **Aerojet-General Corporation** and Ro etdyne defending it against advoca of pressurized systems. The reliabi of tubopumps in cryogenic systems much better than generally believ both companies say, and they emp size that the added structural weight a pressurized propellant tank is a mu greater penalty than the questiona gain from elimination of the turb pump system.

In upper stages that operate extreme altitudes, it is possible—a sometimes desirable—to almost co pletely eliminate moving parts, but it claimed there is no valid reason removal of turbopumps from boos stages. Even with the near-absolu zero temperatures of liquid hydrog (−423°F) there should be no probl of reliability with pumps and valves the equipment is properly designed.

• **Pleasing figures**—The cost propellants is a major factor in t large booster systems now in the desi stage. With the $900/pound price t on the cesium propellant of an i rocket in mind, it is nice to note t 10¢/pound cost of LOX/RP1, or t storable combinations at 70¢/pou or even the solid propellants that r up to $3/pound. These figures take a tremendous significance when o considers the three million pounds propellant that will be used in just t first stage of the *Nova* vehicle of

ion-pounds thrust, for example. For these reasons, economy, performance, availability and relative simplicity of handling, LOX takes a back seat to almost no other propellant. Where the utmost I_{sp} is needed, or where density is a consideration, Fluorine will be used. (It is about one-and-a-half again as dense as LOX.) When economy is the prime factor, LOX/Hydrogen will hold its own. As noted previously, the insulation problem with cryogenics varies with the environment, and appears to be an almost minor problem.

Interplanetary travel possibilities with LOX and other cryogenics varies with the area to be covered. In terrestrial space and closer to the Sun (Venus, Mercury areas) there is a telling definition of the storability of propellants, and the scale tends to shift toward those propellants with a fairly high boiling point. Therefore, in the region of earth and the Sun, cryogenics are not going to show up to their best advantage in long-term storability, but it is just a question of a few days or, on the moon, there is no real problem with cryogenics.

The feasibility, of course, depends on the length of time required before return to earth. The lunar temperatures during the night would aid in the storage of cryogenics while daytime temperatures would hinder storage. Once a vehicle leaves earth's environment, however, the scale pretty nearly evens out among cryogenics, storables and solids, because of the insulation needed for all of them.

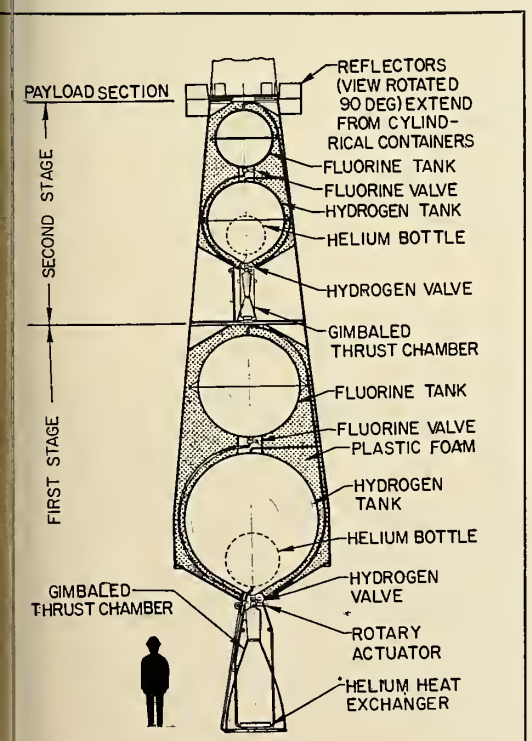
• **Backing and filling**—Evidence has been seen lately that various planning agencies like the theoretical performance of a new propellant combination and try to work it into a program. Once a closer look is taken, however, at things like costs, availability, handling characteristics, etc., a slow backward movement is begun that results in a final choice like LOX/RP1 to fill the requirement. Even though faith in the storables is expected to be borne out by increases in specific impulse to 400 seconds at high altitudes, the cryogenics are likely to be at 460 seconds by the same time.

It has "disturbed" some liquid-propellant experts to see that the government has established research funds for the advancement of solid-propellant chemistry, but has not established any funds for development of storable liquid propellants. The potential of these non-cryogenic liquids has been demonstrated on a small scale, they note, and all that remains to be done is to develop them for full-scale operation.

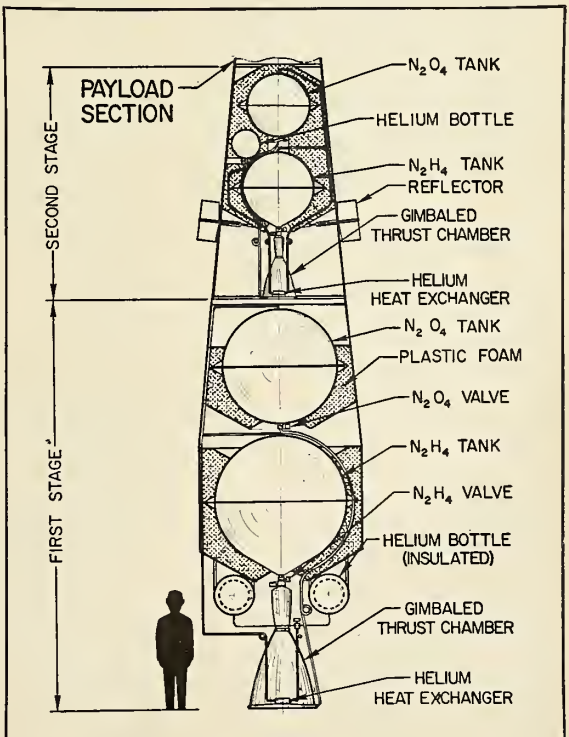
Combustion-wise, there is a greater efficiency in cryogenics than in other propellants. Smoother and more stable combustion results from cryogenically-liquified gases; the best being two cryogenics, next best is a cryogenic and a non-cryogenic liquid, then two non-cryogenic liquids, and so on down into the more stable states. The more easily vaporized the gas, the easier it is to achieve and maintain a smooth, stable combustion.

So, although ozone/hydrogen is ultimate, it is not practical and fluorine/hydrogen takes over. But this is expensive and requires special handling, and so reverts to economical, available, high performance LOX/Hydrogen, which has no radioactivity, toxicity or other highly undesirable characteristics.

In the final analysis, therefore, we find that large payloads will be necessary in order to carry out significant space missions, but that they can be put into orbit most efficiently by a cryogenic combination of fuels—the specific choice depending on a number of factors. This situation will probably remain unchanged until at least 1970.



LORINE/HYDROGEN propulsion system depicted by ketdyne. Spokesmen see it as the space program workhorse.



STORABLE PROPELLANT space propulsion system, also as pictured by Rocketdyne. Near-complete storability is at hand.

Nike-Zeus Decision Is Looming

Slated to cost $1.5 to 2 billion in FY '61 alone, the nation's only anti-missile missile under development could be cut back

by James Baar

. . . Thunderer Zeus, who all dominion hath.—The Odyssey

WASHINGTON—*Nike-Zeus*—the nation's only anti-missile missile under development—faces a life or death crisis within the next six months.

Billions of dollars and the future strategic posture of the United States ride on the outcome.

In simplest terms, the Eisenhower Administration in its final days must answer this two-part question:

Shall the **Western Electric** *Zeus* system be put into production so that it can become operational on schedule in 1963?

Or:

Shall the billions that it will cost be spent elsewhere—if at all?

There is also a third possible choice: The Administration can temporize.

The price tag on this question for FY 1961 alone is about $1.5 to 2 billion. The total price for *Zeus*—all payable within the next few years—is almost anywhere from about $5 billion up. It depends on how much defense you want to buy.

To appreciate the awesomeness and complexity of the problem you should begin by bearing in mind three basic facts:

• The United States today does not have any defense against an attack by Russian ICBM's.

• *Zeus*, for better or worse, is the only foreseeable defense that the United States can have against ICBM's for at least the next eight to 10 years.

• Russia is expected to have enough ICBM's for a major attack beginning about 1962. And that capability is expected to mount rapidly thereafter.

• **Family resemblance**—Now, let's look at *Zeus*, itself.

Basically, it is a huge direct decendant of the Western Electric *Nike* family of anti-aircraft missiles—the *Ajax* and *Hercules*. It was designed from the same general concepts: command guidance, acquisition radar, ground battery computers. And it bears a strikingly similar appearance. However, the advances have been tremendous.

Zeus has three solid-propellant stages. The **Thiokol** booster engine, which has a 450-thousand pound thrust, delivers its power in about four and a half seconds. The **Grand Central Rocket** second-stage engine is powered by what the Army describes as "special high-energy propellants." It has a newly-developed plastic nozzle made by **Douglas Aircraft.**

Both the first and second-stage engines have been static fired successfully. The first-stage engine was first fired at Redstone Arsenal last August; the second-stage engine at Beaumont, Calif., this spring.

The *Zeus* system has huge radars and computers designed to find and track oncoming warheads and direct missiles to the right areas for interception within minutes. In the final seconds of flight, a precise tracker guides the *Zeus* to its target.

Major system components are scheduled to be tested later this year at the White Sands Test Range.

• **Funding history**—The Army, Western Electric and **Bell Telephone Laboratory** began studies on the system in the mid-1950's. In Jan of 1958 the Pentagon directed Army to proceed with the progra an urgent basis and scratched the s what similar **Convair** *Wizard* that being developed for the Air F However, the Pentagon directed Air Force to proceed with rapid d opment of BMEWS—the ballistic sile early warning system.

So far, well over a half-million lars has been spent on *Zeus*. than 80 companies are engaged i development in 17 states from York to California.

This brings us down to the pr slugging match over money for in the FY 1960 budget.

Originally, the Army recomme putting $1,003,000,000 in the b for *Zeus*. This included about million for R&D and more than million for tooling and other pr tion facilities as well as some for *Zeus* bases.

Later the Army reduced its request to $626 million—$300 m for R&D, the rest for production ties. But this figure also was una table to the budget-minded Adm tration. Only $300 million for R& mained in the Army budget by the it reached Congress.

The net effect of this would been a sizeable delay in the *Zeus* table. As one Army source put it: production money is needed for lead time items. When you pr dinner, the roast takes just so lo cook. If you delay putting it i oven, the whole meal is delayed

• **Change of mind**—The Adm tration explaination was that it did not feel *Zeus* was advanced en for production. However, as the

Part One of a two-part series on anti-missile missiles.

n-fighting in congressional committee passed, the Administration re- ed itself. It included an extra $137 ion for *Zeus* production facilities he so-called "master plan" for anti- raft defense.

The $137 million is conceded gen- ly to be just barely enough to keep *s* on schedule. It also leaves the nistration with the painful decis- to be made all over again in the ing months as the nation heads a presidential election year. Only time the sums involved are billions ead of millions.

At the very core of the problem is question of just how good *Zeus* rmy experts will tell you fervently: y good. A number of other Penta- experts will tell you: Yes—and no. h in a sense are correct. It's a mat- of premise: What do you want an -missile missile to do?

Of course, you want it to knock n ICBM's. But how many? And re? And at what cost?

• **Half a loaf**—Ideally the answers simple. You want an AICBM that knock down all ICBM's fired at in anger—even when the sky is ded with possibly dozens of war- ds and scores of decoys. All of this vity is to take place outside the osphere where explosives of multi- aton warheads will do relatively e damage. And the whole show ld cost about $1.98.

This isn't *Zeus*. Nor is it anything known to be feasible at this time.

The Army contends—and most ob- ive experts agree—that *Zeus* will able to provide adequate spot de- e of vital targets.

This means that if a dozen or so heads or warheads and decoys are led at a particular target—say a . ICBM base—*Zeus* will be capable preventing the target from being royed.

Very good. However, here comes rub. In the case of a city like New York or Chicago, *Zeus* might also make a perfect score. But some of the interceptions might take place not far overhead causing widespread fires. And if *Zeus* were to bat down nine out of 10 ICBM's, one five megaton warhead on Chicago would be enough.

Finally, *Zeus* will be able to do some discriminating between warheads and decoys. And the Army contends the system is sufficiently flexible so that even if Russia becomes capable of filling the sky with warheads and decoys, *Zeus* will become capable of dealing with the problem. However, this contention is open to argument outside the Army.

Obviously all of this adds up to a weapon that is not the ideal anti-missile missile. But the Army contends that to reject it on those grounds is like starving to death because the only food in the house is ham sandwiches and you want pressed duck.

• **Strong points**—Moreover, these arguments weigh heavily in *Zeus'* favor:

• No matter how powerful a deterrent force the United States can build, the nation is powerless to prevent an ICBM attack once a war begins unless it has some anti-missile missile system.

• At a very minimum, *Zeus* would provide a guarantee that a significant part of America's retaliatory force could not be destroyed on the ground by a surprise attack.

• The very existence of *Zeus* increases the cost of an attack for Russia and raises one more doubt as to whether one could succeed.

• Finally, if the United States were to scratch *Zeus* and put its cost into offensive weapons such as more ICBM's, how much better off would the United States be if Russia developed an AICBM like *Zeus*?

"Put it this way," one Army spokesman said. "No defense is perfect. If the enemy wants to get through badly enough, he always can by paying the price of admission. What we're doing with *Zeus* is boosting the price of admission."

• **Trouble ahead**—It is difficult for many to conclude other than that the *Zeus* program should be pushed ahead on schedule. However, powerful opposition to it is certain. The root of much of this will be the money problem.

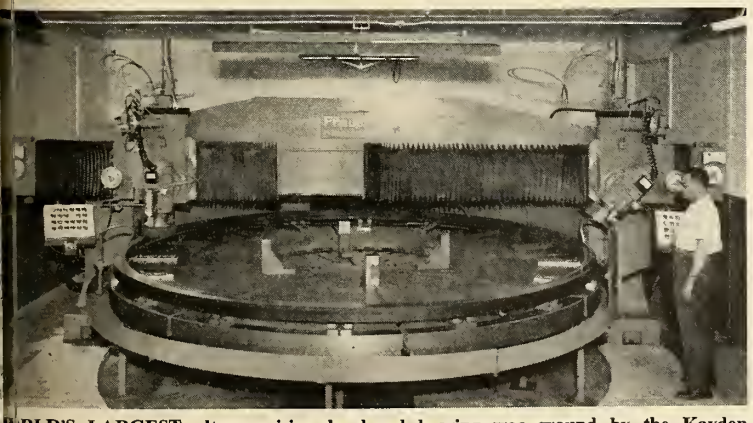
Given no worsening in the Cold War between now and January, the Administration will be even more eager than it was this year, as the presidential campaigns get underway, to call for a balanced budget.

This can mean only one thing: A defense budget frozen somewhere around the present $40 billion. Nearly $2 billion for *Zeus* will be hard to find, indeed.

Therefore, the Administration may be greatly tempted to marshal opposition against *Zeus* to try to kill it. Or, since it would be easier, postpone costly production and thereby put off having an operational AICBM until 1964—two years after Russia is expected to be in a position to, in the words of Defense Secretary Neil McElroy, "cream the country."



TESTING OF the Thiokol booster engine used in *Nike-Zeus*. The solid-propellant engine delivers 450,000 pounds of thrust in about four and a half seconds.



RLD'S LARGEST ultra-precision hardened bearing was ground by the Kayden ineering Corp. for production of giant radars needed for the *Nike-Zeus* system.

NASA Wants Small Business To Get Its Share

Civilian agency has good record in letting contracts to small firms and wants more on its buying list

by Paul Means

WASHINGTON—A new man at NASA intends to make it his business to see that small business gets its share.

But first he needs to know the names of small firms having the interest and ability to perform NASA contracts and subcontracts.

Jacob M. Roey, recently appointed Small Business Adviser, will start by screening a list of small businesses (those with under 500 employees) supplied by the Small Business Administration.

This is only the beginning. As Roey points out, "there are hundreds of small research organizations with competent staffs that have come into being almost overnight. It is our job to locate them and catalogue their interests and capabilities."

He asks any small business interested in having its name added to his list to contact him at NASA's Washington headquarters.

Roey views his job as one of education and information. He informs NASA procurement officers and large contractors of small businesses, singly or in teams, capable of performing certain contracts. He also informs small businesses of upcoming NASA contracts for which they might be capable of being contractor or subcontractor.

• **High batting average**—NASA's record of letting contracts to small businesses during their first six months of operation has been very good. The last quarterly report from NASA's Ames Laboratory shows over twice as many procurements going to small businesses as to large, and almost twice as many dollars.

Most of the Ames Laboratory procurements were for supplies and services, an area in which small businesses have greater capabilities. But the record indicates NASA's desire to give small business all the work they can handle.

NASA contractors also have a good record of subcontracting to small business. E. W. Brackett, NASA Procurement Director, points out that the **Rocketdyne Division** of **North American Aviation,** which has the NASA contract to produce the *Nova* million and a half pound thrust single chamber engine, placed 79.4% of its total subcontract work by volume with small business firms in 1958. Total dollars showed $40 million going to small business subcontractors and less than $28 million to large business subcontractors.

Roey's job, then, is to systemize the process, so that NASA and prime contractors know what small businesses are able to perform specific jobs, and so that the small businesses know what jobs are available.

• **General aims**—Though he is still drafting a policy statement outlining the goals of his job, Roey says the general programs he intends to institute are the following:

1. To compile a well-indexed file of small businesses.

2. To screen proposed NASA contracts to determine what portions could be performed by small businesses.

3. To invite small businesses to participate as members of the audience when details of NASA-proposed contracts are explained to potential bidders.

4. To give big business contractors names of interested small firms with subcontracting potentials.

5. To urge big business contractors to set up their own files of potential small business subcontractors.

6. to urge small businesses to pool their resources so that they can jointly bid on larger NASA contracts.

• **Some targets**—The evils in the contracting process detrimental to small businesses which Roey hopes to overcome include:

1. The natural tendency on the part of some procurement officers and technical staffs to award contracts to large firms of proven reliability.

2. The practice on the part of so large contractors to set up a stable subcontractors who then get most the subcontracts without competiti from the outside.

The area in which small firms ceive a lot of NASA contracts p sently is supply and services. But t area which Roey feels holds a gr future for small business is resear and development.

The Congress recently went on r ord as favoring the letting of contra to small business in this field. Unli the military program, NASA nee R&D work on many small systems a components which small busines could handle.

• **Made to order**—The very natu of the space program indicates th many opportunities exist for small bu nesses in this field.

One shot, custom-made spa probes lend themselves ideally to sm business development, since volur production line capabilities which fe small businesses possess are not neede Payloads on top of space probes a satellites vary from shot to shot NASA scientists attempt to increa their knowledge about the univers Much NASA payload contracting as the company to extend the state of t art in a specific field, and individu theoretical ability counts.

On the large space projects, such *Mercury, Vega, Centaur, Saturn,* a *Nova,* no one company is big enou to do the entire job. In these case small electronic, engineering, researc construction, and many other types firms become valuable junior partne on a competing team for the contra and after the contract is won.

Many small handmade items, tr mendously important in relation their size, can best be done in a sm intimate shop, where decisions can b made orally across the shop floor rath than routed through the chief engine up to the executive vice president.

Another reason small business should get their share of NASA co tracts is that the space administratio does not intend to adopt the systen concept of procurement, used to son extent in DOD. In the systems co cept, all contracts for a complete pr gram, including support equipmen training aids, spare parts, and oth items are placed with one contracto In such cases, small business can ser as subcontractors, but are shutout principal contractors.

Brackett states that NASA will u such a system only in crash progran where "time is of the essence;" th the usual procedure will be to "procu various items, or segments, separatel from different contractors, and int grate and assemble them ourselves

Pressing the Search for 'Whiskers'

Five to 10 years may bring usable materials with six times the strength of steel

by Jay Holmes

WASHINGTON—Metal "whiskers," a ndache for handlers of electronic ipment, may some day be a boon makers of missile structures, in ich high tensile strength is vital.

Some of these tiny metal fibers, ich grow out of bits of metal under vy electron bombardment, have a ength up to six times that of the ngest modern steel. The problem ore researchers is to form the whis-s into a material that can be fab-ated.

The strongest whiskers, which can e a tensile strength as high as 00,000 pounds per square inch, have meters of less than a 10,000th of an h. Their strength compares with a ximum of 350,000 psi for modern els.

Metal whiskers were discovered a rt time after World War II when gineers sought the cause of mys-ious short-circuits that developed in ctronic equipment after long use. en they took the black boxes apart, investigators found tiny wiry nds jutting from areas of metal faces under heavy electron flux. e strands are formed when atoms l out the metal and deposit them-ves in a regular crystal structure, metimes in the form of a spiral.

Why are whiskers so strong? A re pertinent question would be why n't most metals as strong as whis-s. For physicists have calculated—m the difference between electrosta-repulsion and bonding energy of tal atoms—that the tensile strength a perfect crystal theoretically should on the order of several million unds per square inch. The difference ween this figure and the much lower asured strengths of ordinary crystals thered physicists for many years. e discovery of whiskers' high strength nfirmed the theory. The weakness ordinary metal is due to imperfec-ns in the crystal structure.

The National Aeronautics and ace Administration is sponsoring tal-whisker research at California's **Propulsion Laboratory** and at the wis Research Center in Cleveland. rk is also under way at several in-strial laboratories, including those of **General Electric Co., Bell Telephone** and **Union Carbide Metals Corp.**

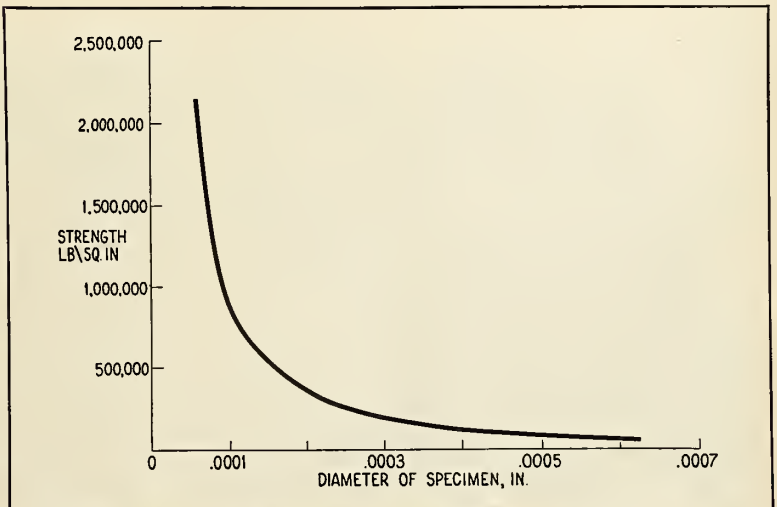
● **Five years at least**—Dr. Harold Hessing of NASA's Washington headquarters told M/R it might be possible to make usable materials from metal whiskers in 5 to 10 years. "I would say five years at a minimum," he said.

A great difficulty, Hessing explained, is that only one metal whisker in 10 has unusually great tensile strength. So far, he said, no one has devised a simple test of whiskers' strength other than to pull each one individually. "If we can pull it up to a certain load, then we know we've got one of the good whiskers," Hessing commented.

Joining the whiskers is another problem. Bonding material must be ductile and able to carry a shear load. Hessing said it may be possible to devise a method similar to one under NASA study in Cleveland for bonding wires together. The wires, immersed in molten copper, are forced through a funnel-shaped piece of metal. After the wires are forced together and the copper freezes a material of very high strength is formed. NASA scientists at Cleveland have made a package of ordinary steel piano wires ¼ inch in diameter with strength of 320,000 psi, compared with 150,000 psi for unpacked piano wire. There is no reason why such packaged wire cannot be made indefinitely long, Hessing said. The effect of the copper surface on the metal crystals is less than had been feared, he added.

● **Search for strength**—Tungsten is commonly used in experiments with whiskers because it is one of the strongest of the pure metals. Pure tungsten is stronger than pure iron. Steel, of course, is stronger than both but no one has offered any plan for growing iron whiskers with just the right amount of impurity to make high-grade steel. The accompanying graph shows maximum strengths of pure iron whiskers plotted against diameter. The curve for tungsten would have the same shape and would be a little above that for iron. A graph for tungsten wires bonded as in the NASA experiments at Cleveland would be a little below.

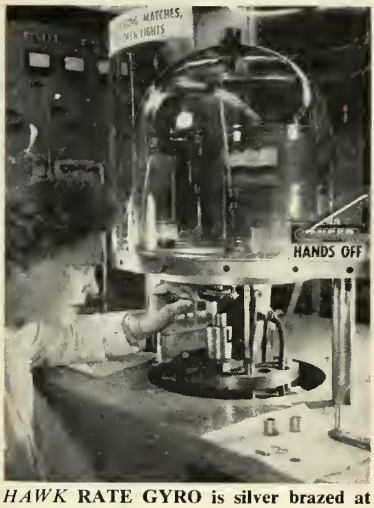
While some scientists are trying to grow longer and thicker whiskers, others are trying to eliminate or reduce them to eliminate short-circuits in electronic equipment. Several investigators report that alloys form fewer whiskers than pure metals. Nickel and tin are popular ingredients of such alloys.



MAXIMUM STRENGTHS of pure iron whiskers. Tungsten curve would be higher.

Hawk and *Lacrosse* Join Armory

Both highly mobile missiles will be deployed overseas in the next year to U.S. and NATO forces



HAWK **RATE GYRO is silver brazed at 1300°F in two minutes under controls.**

WASHINGTON—The Army this month added two powerful new missiles to its armory—the **Raytheon** *Hawk* and the **Martin** *Lacrosse*.

The first home of the *Hawk* is Ft. Bliss, Tex., where the 5th *Hawk* Missile Battalion of the 57th Artillery has been organized. The 300-man unit will train future *Hawk* missilemen for deployment in the United States and overseas.

Two *Lacrosse* units—the 5th Missile Battalion, 41st Artillery, and the 5th Missile Battalion, 42nd Artillery—have been organized at Ft. Sill, Tex. Each has about 170 officers and men.

The Mach 2.8 *Hawk* is designed specifically for intercepting enemy planes and air-breathing missiles flying from tree-top to medium altitudes in an attempt to dodge radar. It complements point defense provided by the **Western Electric** *Nike-Ajax* and *Ni* *Hercules*. Its range is about 22 mi

The *Hawk* has two stages—b powered by solid-propellent mot developed by **Aerojet** and **Thiokol.** T warhead is a high explosive. Raythe homing guidance in the missile dire it to its target.

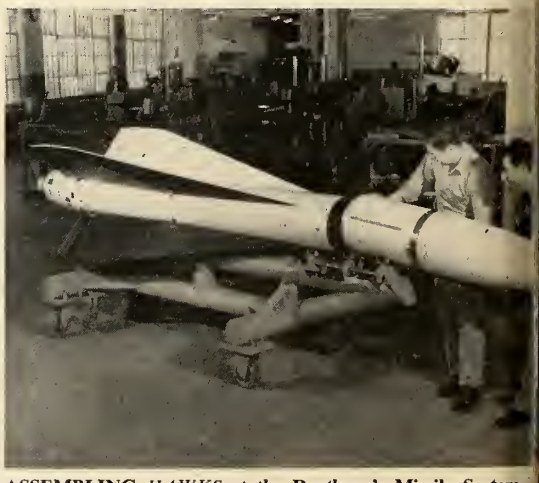
The 1250-pound *Hawks* are hig mobile. They can be rapidly tra ported either by road or by helicop and aircraft. *Hawk* launchers ca three missiles which can be fired rapid succession.

The Mach 2 *Lacrosse*—a nucle tipped artillery missile—also is hig mobile. The entire system can mounted on a standard two-and-a-h ton Army truck. The system also c easily be airlifted.

The 19.5-foot missile has a rar



THREE *HAWKS* **ready to go are mounted on mobile launcher at White Sands Test Range. They can be fired in rapid succession.**



ASSEMBLING *HAWKS* **at the Raytheon's Missile System sion, Andover, Mass.** *Hawks* **may soon be manufactured in Eu**



LACROSSE, **the Army's new surface-to-surface tactical missile, is mounted and ready for launching from standard 2½-ton truck.**

about 20 miles. Its warhead can be ded with a variety of explosives and ped charges. It can pack a nuclear rhead or a variety of conventional losives or shaped charges.

Lacrosse is powered by a solid mo- developed by Thiokol. Its guidance terminal and provides a high degree accuracy, making it possible to hit all targets such as bunker entrances.

Millions of dollars worth of *Lasses* and *Hawks* are scheduled to deployed overseas during the next ar both in the hands of U.S. Army its and NATO troops. Marine units o will be equipped with *Hawks.*

Five NATO nations are moving ward production of *Hawks* in Europe their own forces through an agree- nt with Raytheon.

The *Hawk* and *Lacrosse* are among first of the new highly mobile fast-reacting tactical weapons being developed for the Atomic-age Army. Among those still under development: the **Martin** *Pershing, Davy Crockett,* **Aeroneutronics Systems** *Shillelagh* and **Convair** *Red Eye.*

The 500-to-700-mile *Pershing* will succeed the liquid **Chrysler** *Redstone.*

Red Eye is a tube-launched guided missile for use against low-flying aircraft by troops in the field. It is equipped with an infrared homing system.

Shillelagh is a lightweight surface-to-surface missile designed for use against armor, troops and field fortifications. It is expected to be operational by mid-1960.

Davy Crockett is a light nuclear-tipped rocket designed to be fired by one or two men in the field. It is being developed as a family of missiles.



BLAST OFF for a *Lacrosse.* **It can carry a warhead an estimated 20 miles.**



READY TO GO from its mobile launcher, *Lacrosse's* **terminal guidance enables it to strike enemy positions with pin-point accuracy.**

What's New in Fuzing and Arming

Remarkable achievements have been made in a field that is shrouded in secrecy and remains largely government-controlled in the hands of a small group

by Hal Gettings

WASHINGTON—The primary function of a missile is to deliver a warhead to a target. Consequently, the warhead—with its arming and fuzing system—is a major subsystem of a missile. All the other subsystems operate only to enable the warhead to perform its function. The design and manufacture of an arming and fuzing system thus becomes a large and important part of a missile program, demanding the utmost in efficient design and reliability.

How do you make an explosive device so safe that it's practically impossible to detonate it accidentally—even if the missile carrying it blows up on the launch pad, or the jet bomber carrying it crashes on takeoff? How do you guard against a technician inadvertently putting a voltage on a fuzing circuit? And, after making it this safe, how do you get the thing to detonate without fail at exactly the time and place it's supposed to?

These are some of the problems that face the designers of arming and fuzing systems for both nuclear and conventional missile warheads. That they have solved these problems, at least to a remarkable degree, is evidenced by the fact that we have never had a premature nuclear warhead explosion—even when the weapon was involved in a bomber crash.

The safety factor is considered at least 1000 times more important than any other aspect of reliability. Designers actually shoot for a minimum of 100% reliability so far as safety is concerned.

Detonation reliability must then become a little less than 100% perfect. Design goal is aimed at what is sometimes called the "wooden bomb" concept. This means that the warhead must be capable of being dropped, stored for long periods under changing conditions, mishandled—in short, subjected to practically any sort of maltreatment—and then be ready to go on a minute's notice.

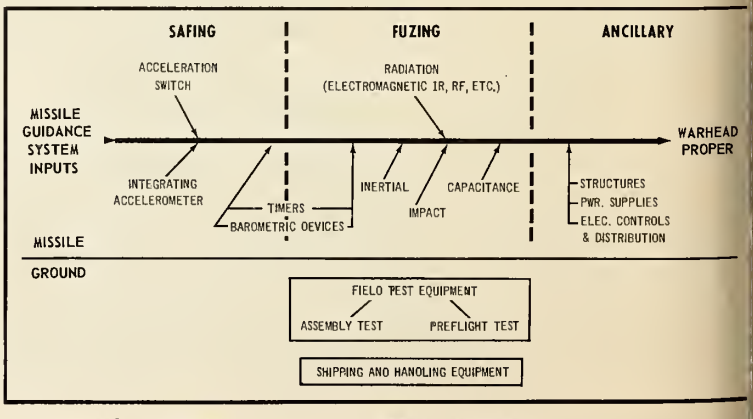
• **Shroud of secrecy**—A great deal of secrecy surrounds arming and fuzing systems—some no doubt justified, and some perhaps not. Of course, an argument for tight security is the fact that knowledge of the characteristics of a system can lead to second-order deduction of facts about the warhead itself. Knowing the sensitivity range of a proximity fuze, for instance, one can tell much about the size and capability of the nuclear payload. More important, knowing details of the system would allow an enemy to prematurely detonate the warhead.

Several manufacturers have stat privately that some of the governme agencies involved are chiefly interest in keeping fuzing systems in the ca gory of government-furnished equi ment—so that they may either pr duce the system or handle the subco tracting.

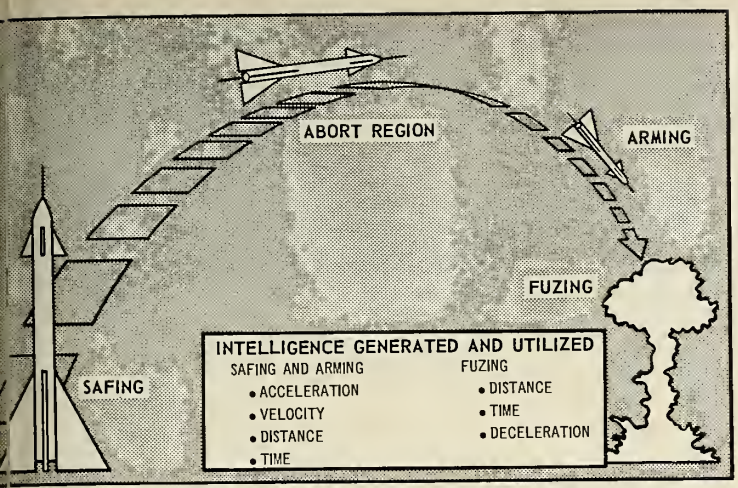
Whether this charge is true or n is a moot question. It is a fact, ho ever, that there is no central clearin house for industry information. It conceivable under such circumstanc that the state-of-the-art cannot a vance at a rate comparable to that related fields.

Accepting the need for tight s curity in this area, some sort of centr agency for coordination of past d velopments and of work in progre would help to provide answers f those with a need-to-know.

The arming and fuzing industry



INPUTS and components of a typical fusing and arming system.



UNCTIONS OF TYPICAL MISSILE SAFING, ARMING AND FUZING SYSTEM
ARMING is defined as handling and launching safety for own personnel facilities and story; the abort region is the area where the bird may be self-destructed without enation of warhead; arming prepares warhead for fuzing signal.

hole is in the hands of a small rp. In addition to the restrictions n limitations mentioned, there is r one customer—the military—for h business, and developments do not e to profitable commercial products.

• **Growth of participation**—Arming r fuzing of a nuclear warhead was le entirely by the Atomic Energy Commission until, in 1953, they agreed o transfer some of the responsibility o the armed forces. **General Electric** w the first industrial contractor to rak the barrier and produce a com-ple system from design through hard-w e production—for the *Lacrosse* nsile. GE is currently working on—o has completed—nuclear ordnance o jects for eight major missiles.

Bulova's Research and Develop-nt Labs have been in the business fo a long time and are currently w king on their 17th system. They re ntly were awarded a multimillion-do ar contract for the Army's *Persh-in* missile.

Besides GE and Bulova, there are pe haps three other companies with a m or interest in this field: **Minneapo-li Honeywell, Maxson,** and **Avco-Cros-le** Others involved to a lesser extent in ude **Bendix, Philco, Farnsworth, C lins, Emerson, Eastman, Melpar, W stinghouse,** and **General Mills.** T re are at least 30 major component su pliers.

Several government agencies are in the picture to a greater or lesser d ree. Army's Diamond Ordnance F e Lab worked in the field for many y rs. They were in at the beginning o the proximity fuze development in 1941, and have maintained their w k in this and related fields until they probably now have the most complete in-house capability of any agency. DOFL has also done considerable work in electronic miniaturization for fuze circuitry and other accessory areas.

The Navy, too, was concerned with proximity fuze development in its early stages. Naval Ordnance Labs at Corona, Calif., and White Oak, Md., as well as Ordnance Test Station, Inyokern, are today involved with arming and fuzing development.

Other government agencies involved include AEC, Air Research and Development Command and Air Force Special Weapons Command.

Picatinny Arsenal has prime responsibility for all Army missile warheads. Their Special Weapons Ammunition Command acts as specifier, buyer, and technical consultant to system contractors. They may also procure components or subassemblies for the prime. Picatinny's Atomics Lab conducts periodic symposia on arming and fuzing for industry contractors.

• **Tricky requirements**—Due to security restrictions, the problems and design criteria for A and F systems can be discussed only in principle. Several major problems confront the designer: extreme reliabilities, high accuracies, extreme environments, and tactical utility.

The double-barrelled reliability problem puts the designer on the horns of a ticklish dilemma: the safer he makes the fuze, the harder it becomes to make it operate at the proper time. This factor is overcome, to an extent, by use of redundancy in the firing circuits. An oversimplified example would be a circuit such as shown in the diagram. Switches A, B, and C would have to be closed to complete the circuit; the failure of any one would make the system inoperable. If parallel switches were added, then the likelihood of failure is reduced (assuming 100% reliability of the switches themselves). Redundancy has its limits, however, since space and weight are at a premium.

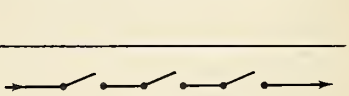
The high accuracies required in an arming and fuzing system are another problem source. The warhead must explode at a precise point in altitude or proximity to the target. It therefore must be sophisticated (almost intelligent), sensitive, and fast. Such complexity further adds to the reliability problem.

This complex and sensitive device must ride a missile through a wide range of extreme environments. It must maintain its integrity through the shock of initial blast-off, a gamut of temperature extremes, acceleration and deceleration, atmospheric re-entry (in some cases), and other shock and vibration.

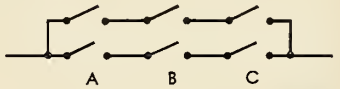
Tactical utility requires a unit that can be stored for long periods, quickly assembled, easily tested and immediately available. It must be capable of all this in the hands of field-level personnel with training roughly equivalent to that given an ordinary field artillery crew.

The so-called "adaption kit" allows missiles to have a dual capability. Battlefield generals, fleet or air force commanders can choose between either conventional or nuclear warheads—and the missile can be so armed at a split-second command.

• **Complications**—The most simple fuzing system, of course, is the basic "hammer and nail" type—a pistol firing pin, for example. Starting with this concept, a system steadily grows more complicated. A "safety" is added to prevent premature firing . . . and further equipment is then needed to bypass or remove the safety at the proper time—for instance, a propeller must revolve



SIMPLE set of series switches are closed to allow fuzing signal to go to warhead.



PARALLELING second set of switches provides alternate path for B signal (redundancy).

a certain number of times or the projectile must rotate fast enough to throw out the safety. Then we can add acceleration inputs, barometric devices, radiation (or other electromagnetic) transducers, or any amount of complicated gear to make our system more sophisticated and safe—and potentially less reliable. It is one of the most complex devices in a missile.

The basic elements and optional control inputs of a typical arming and fuzing system are shown in the diagram. The choice of the various inputs, would, of course, depend on target characteristics, location, altitude, and any number of other factors. The more of these considered necessary, the more sophisticated the system.

A system's components include timers, accelerometers, integrators, gear trains, power packages, amplifiers, a maze of switches and electronics, logic panels, and unique sensing elements—all acting on programmed and sensed inputs to set in motion a chain of events leading to the final "moment of truth." All components must be of a precision and quality not required in other areas. Although designed to be used only once, they must be ready at all times to perform their assigned function with no question as to readiness and reliability.

Little is heard—or can be told—of the actual techniques and mechanisms developed to enable a missile warhead to do its job. Their importance must be judged not by the publicity they receive but by their extremely important part in successful missile systems.

Hoffman Acquires New Data Processing Machine

MENLO PARK, CALIF.—Capable of performing 480,000 decision-making operations per minute and storing up to 6 x 10^8 characters of information, a new data processing machine recently was purchased by Hoffman Laboratories Div. of **Hoffman Electronics Corp.**

First of its kind to be built, the $800,000 computer, called a Datatron 220, is a digital system with full magnetic-core memory.

To be employed in the performance of the U.S. Air Force electronic reconnaissance system, "Tall Tom," the giant computer was built by **Electro Data Division** of Burroughs Corp. Hoffman is directing the team of seven companies involved in the program for the USAF Aerial Reconnaissance Laboratory.

The system was dedicated formally here at **Stanford Research Institute,** during a recent meeting of the Tall Tom management policy board.

reviews

STANDARD SAMPLES FOR GASES-IN-METALS, U.S. Department of Commerce, National Bureau of Standards, Summary Technical Report.

Eight bars of ferrous materials whose oxygen and nitrogen content have been precisely determined comprise a new type of standard sample now available from the National Bureau of Standards.

In providing these reference materials for the calibration of commercial apparatus used to measure the gas content of metals, the Bureau has inaugurated a program of standard samples for gases-in-metals covering a variety of metallurgical products.

RESEARCH ON FIELD EMISSION CATHODES, E. E. Martin and H. W. Pitman, Linfield Research Institute for WADC, 69 pp., $1.75, available from OTS, U.S. Department of Commerce, Washington 25, D.C.

This program was undertaken in two phases, one of which led to improvement of stability of the field emission cathode and the other involving study of the electrochemical behavior of refractory metals used to make field emitters.

In the first part, methods were developed for greatly improving stability of the cathodes by avoiding changes in surface electric field and work function. Experimental testing of fixed voltage operation of a cold tungsten emitter was extended beyond 3000 hours. In other cases current drift rates less than 5% per 100 hours of operation over several hundred hours were observed at currents of the order of 10^{-4} amperes.

Improvement during repetitive, microsecond, pulsed operation at pulse currents up to 0.1 ampere was demonstrated. Techniques included careful vacuum practice, envelope material nearly impervious to atmospheric gases, and thoroughly degassed refractory metal shaped to minimize encroachment of secondary electrons on tube envelopes.

In the study of the electrochemical behavior of refractory metals, formation and dissolution of oxide layers appeared to have a major influence on surface smoothness and emitter geometry. Developed were an automatically controlled method of emitter shaping and a technique for removing material uniformly from small parts such as small cathode structures. The effect of variation of polishing cell parameters such as temperature, voltage and electrolyte concentration was also investigated.

HIGH TEMPERATURE MATERIALS, Edited by R. F. Hehemann and G. Mervin Ault, John Wiley & Sons, Inc., New York, 544 pp, $17.50.

This book is based on papers presented at a conference sponsored by the High Temperature Alloys Commitee, Institute of Metals Division, Metallurgical Society, American Institute of M... Metallurgical and Petroleum Engi... It delves into all classes of material ... use at temperatures over 1500°F ... many of the related problem areas. ... illustrated and indexed, the book inc... research paper reports on such sul... as refractory metals, dispersion harde... gas metal interaction and oxidatio... sistance. Contributors to the volume ... top men in the field from governm... industry, research institutes and uni... ties.

MAN IN SPACE, Edited by Lt. Col. Ker... F. Gantz, USAF, Duell, Sloan and Pe... New York, 303 pp, $4.00.

Every facet of the problems invo... in man's survival outside the atmosp... is covered by pioneering research g... in the bio-medical aspects of space fl... Human factors from the general to ... specific problems as weightlessness, ... ditioning, escape, time dilation, and ... man performance under space condi... are analyzed on the basis of past ex... iments and projected into future m... Papers presented include contribu... from Col. John P. Stapp on biodynar... Dr. Hubertus Strughold, "father" of s... medicine and M/R contributor, on ... factors; Lt. Col. David G. Simons on ... altitude experiments; Dr. Hans G. ... mann on the engineering environm... and Dr. Siegfried J. Gerathewold ... weightlessness. Some of the Pentag... top strategists go into the military asp... of manned space operations and the ... for long-range planning. The appe... includes a 14-page glossary of term ... reading list of astronautic books, ... graphical notes on the authors and a ... tailed rundown on Project *Mercury*, ... nation's first manned space vehicle pro...

AIR RESEARCH AND DEVELOPM... COMMAND TECHNICAL SYMPOSI... JULY 1958, WADC, U.S. Air Force; 502 ... $7, available from OTS, U.S. Departmen... Commerce, Washington 25, D.C.

Technical papers and discussions of ... Air Research and Development Comm... symposium on materials for space vehi... and propulsion systems, held in J... 1958, in Dallas, have been published.

Attending the symposium were ... resentatives of the major Air Force ... search and development establishme... including ARDC, Office of Scientific ... search, Air Materiel Command, C... bridge Research Center, and the Wri... and Rome Air Development Centers.

Among papers presented on structu... materials were those dealing with alu... num, magnesium, beryllium, steels, su... alloys, adhesives, graphites, plastics, ... surface treatments.

Reports presented on electronic ... terials included such topics as synth... and application, energy transforming ... terials, insulation and dielectric materi... magnetic materials, and transistors.

Other papers were presented on ... terials research, materials application ... processes, and propulsion materials.

Automatic Checkout Systems Compared

Curtiss-Wright's DEMON and Nortronics' NORSCAN are representatives of the fully transistorized development trends in the checkout field

by Charles D. LaFond

WASHINGTON—For those who have followed the rapid development of automatic checkout, the evolution to solid-state systems was logical and mandatory to achieve the desired very-high-speed and data-handling capabilities.

Last week's issue of M/R summarized the results of an industry survey of checkout systems. It was evident that solid-state systems are well past the dream stage.

To better understand just how much has been accomplished with these newer checkout systems, a close-up of two systems is presented: the **Curtiss-Wright** DEMON and the **Nortronics** NORSCAN—both fully transistorized, modularly constructed, completely self-checking, and extremely flexible in application. Although the two are similar in overall design, each has certain unique attributes. It is important to note that there are other similar systems, but DEMON and NORSCAN appear to be representative of the development trends in tomorrow's automatic checkout industry.

• **Design goal**—Both DEMON and NORSCAN were designed to achieve the principal goal: a broad system capability (1) not limited to any existing weapon system, (2) incorporating sufficient functional groups to accommodate many future weapons systems, and (3) adaptable to all levels of testing. In other words, the system design is to be such that the inherent capability might permit module deletion, but not require addition, when adapted to a particular weapon system checkout.

• **Limitations**—The one limitation foreseen by both manufacturers in their respective systems is the ability of the system applications engineer responsible for determining the programming for each checkout program.

Curtiss-Wright DEMON

DEMON was formally introduced at the Benesia Arsenal in Benesia, Calif., in March of this year. It also has been in continuous use at the Santa Barbara Division of Curtiss-Wright Corporation since December, 1958.

In a current demonstration setup, DEMON is shown (Fig. 1) checking a *Nike-Ajax* missile system; however, this application utilizes something less than 5% of its total in-being system capability. There are no existing weapons systems today that would require or use the total capability of DEMON, according to Curtiss-Wright.

Company engineers believe that had DEMON been available when the *Nike-Ajax* was introduced operationally, considerable savings in time and dollars would have resulted. For example, utilization of that portion of DEMON which is now being used to check the *Nike* missile would cut by more than half the number of personnel required for tests. The skill level of those persons remaining would be several grades lower than previously required. One skilled operator still would be required for each repair crew, mainly to assure the physical quality of the repair.

Another important consideration, they believe, would be a considerable decrease in time and experience required at the Ordnance Guided Missile School, Huntsville, Ala., where Army missile maintenance crews are trained. As an example of the slash in test time required, DEMON now takes less than one minute to locate a faulty component in the missile power supply—as contrasted with several hours on a manual basis. Further, upon location of the fault, detailed visual repair information could be made immediately available to the operator.

• **Major subsystems**—Referring to Fig. 1, the DEMON system consists of a Flexowriter and the three adjacent equipment racks. The fourth rack contains various stimulus generators used in checking the *Nike,* including an analog-tape stimulas generator. The missile shown was supplied as Government-furnished equipment (GFE) by the Department of Army (certain pieces of test equipment have been removed from the missile depicted for security reasons).

The following is a brief description of each of the major DEMON subsystems as shown in Fig. 2:

• Input-output—Handled by a Model FPC Friden Flexowriter, modified slightly to meet system requirements. Standard 8-channel tape is used. Information can be fed into the system by either punched tape or direct "typing" of coded signals into the file memory. System output is also handled by the Flexowriter. Output signals result in punched tape. This is fed into the receiving mechanism and automatically typed, thus permanently recording the data.

• File memory—Consists of magnetic tape and handling mechanism (paper tape can and has been used), which provides storage of programmed information necessary to perform the following: (1) switching to apply

Editor's Note: The reference to the use of a "trend index" by Curtiss-Wright in Part I of this series last week was in error. The Nortronics "confidence index" is the only such trend-type comparison standard that M/R has found employed in any checkout system.

stimuli to injection points; (2) delivery of appropriate max. and min. values for each test for comparison with measured values; (3) execution of address functions based on go-no go response; (4) delivery of any of the test-block stored contents into the system.

• Buffer memory—Provides time-scale changing from the 12,500-character/sec. rate of the file memory to the random rate with which the stored information normally is utilized without significantly delaying acquisition of the information contents when needed.

• Decoder matrix—Accepts stored instructions from the buffer memory, and translates the instructions into an executed pulse delivered at the address specified by each instruction.

• Encoders—Convert all quantities (voltage, frequency, elapsed time) to be measured into binary-coded decimal form. Measurements are performed by comparing numerical data representing the function to be measured with numerical limits programmed by the control system.

• Search control—Supervises the movement of the magnetic-tape file memory, in response to signals arising elsewhere, to prepare for or actually to transfer one test block between file memory and buffer memory.

• Comparator—Evaluates encoded test results with respect to programmed tolerance units. Using simple logic circuitry (subtraction method) the comparison is accomplished in bi coded decimal form. A voltage-s detector is used as an "ON-OFF" c parator and to detect simple switcl functions.

• Clock—Used in the testing (in effect, the controlling) of l complex systems. A synchronous c trol logic was chosen in the interes safety and economy in preference a nonsynchronous technique. clock controls transfer of informa between all internal subsystems for all input-output operations.

• **Features**—A summary of principal features will best illustr the capabilities of DEMON.

Storage capacity is greater than 1 x 10^6 bits. The system also include "table lookup" for simultaneous eva ation of dependent variables (from functional subsystems) over a gi range. Buffer capacity is 1792 bits.

Programming is digitally control by magnetic tape (patch boards not employed). To minimize physi test equipment, the system utili magnetic tape for an analog in stimulus to the system under test.

Servo-stimulus control is provic for all high-frequency test signals t cannot be programmed on the ana tape. The output of the signal genera is precisely controlled through the of error feedback circuits which co pare the signal generator output agai the desired output, independent knob position. Thus signals are ref enced to the standard against whi the system responses are measured.

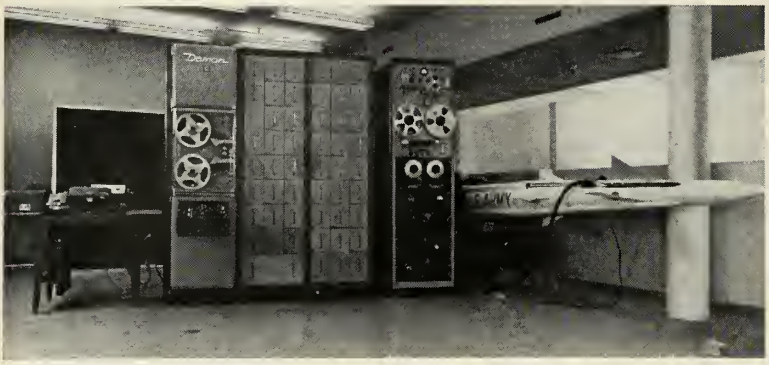
A time sharing system is so signed that it can time share the ce tral control subsystem for a number maintenance work stations simultar ously.

Readout for the test results is pr vided in terms of distance from g distance from no-go, or distance fro any arbitrary given point.

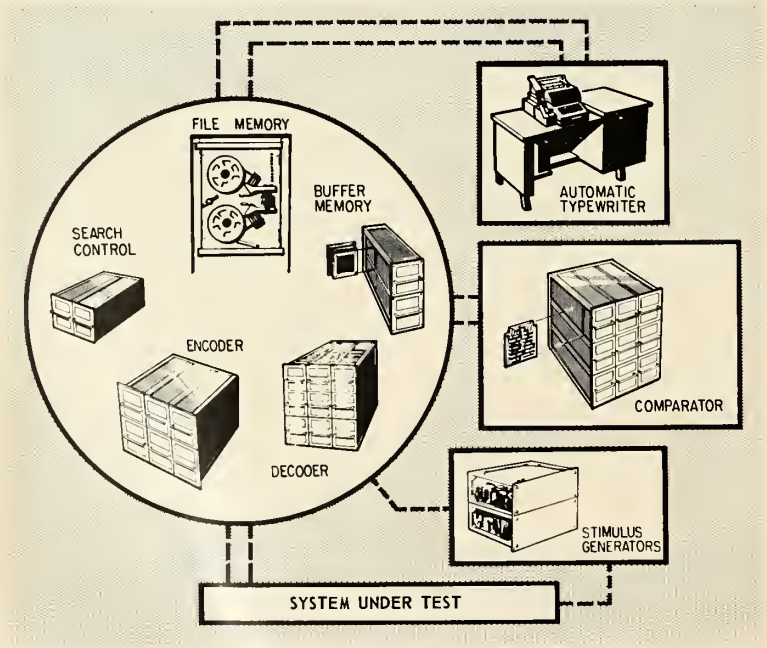
The present DEMON Flexiwrit will print out any information desire from complete test data to select failure data. This is recorded punched tape, and if desired can transmitted via teleprinter to stimula a logical supply system and thus i sure that a proper balance of stor is maintained.

A new visual readout system, en ploying a view screen, is being deve oped by Curtiss-Wright. The system w be driven by the DEMON control sy tem and will display actual photograp of the malfunctioning area of the sy tem under test, the procedure to followed in repair (or replacement and the next step to be taken by t operator after repair.

No operational failures have be experienced in the DEMON, accordir



CURTISS-WRIGHT'S DEMON checks out a *Nike-Ajax*. DEMON—along with Nortronics' NORSCAN—represent solid state technology for automatic checkout. (Fig. 1)



SUBSYSTEMS of DEMON. Fully transistorized, system is modularly constructed, completely self-checking, and extremely flexible in application. (Fig. 2)

ca company spokesman. All circuits e been designed for maximum in- endence of component tolerance, ch permits the use of 10% com- ents (resistors, capacitors, etc.) ughout the system.

Nortronics NORSCAN

Nortronics, a division of the Nor- p Corporation in Hawthorne, Calif., recently completed its first proto- e of NORSCAN, acronym for Nor- ics System Computing Analyzer e Fig. 3). But, according to a com- y spokesman, the system is founded thoroughly developed and proven cepts.

Principal memory device in NORS- N is its magnetic drum, having a acity of over ½ million informa- bits.

A major innovation in the Nor- ics system is the employment of confidence index" (discussed in de- in M/R, June 29). The index is ded from 99 to 0 and provides a ans against which test readings can compared. This furnishes an ac- ate indication of how good a go ding really is. Either analog or dig- signals may be measured against s standard.

When a time base is added, a rate change is generated. From this rate, predicted time-to-failure (due to nponent drift) is established. This e can be compared with a fixed time rval to determine a "drift index." dicted times-to-failure greater than equal to the fixed time interval re- in a maximum rating of 99; those than the fixed time figure are ex- ssed as ratios with values from 0 99. (The fixed time interval is based the predicted mean time to failure.)

• **Principal units and features**—(Refer to the simplified block diagram in Fig. 4.)

• Stimuli generator—All forcing functions are generated within the stimuli generator. These may be electronic, pneumatic, optical, mechanical, or thermal. Provisions are made for flexibility in time, amplitude, and phase. Control of function amplitudes and sequence is accomplished by the processor that specifies which signals should be fed to the switching matrix and then into the system.

• Switching matrix—Solid-state devices are used in the switching matrix for switching electronic signals. The matrix is capable of making 10,000 measurements/sec. This can be programmed to read 100 signals on 100 wires in 1 sec., or 10 signals on 1000 wires in 1 sec., or any combination thereof. It also contains basic switching blocks for switching mechanical or pneumatic signals and presents an electrical impedance of one megohm (or greater) to the system under test.

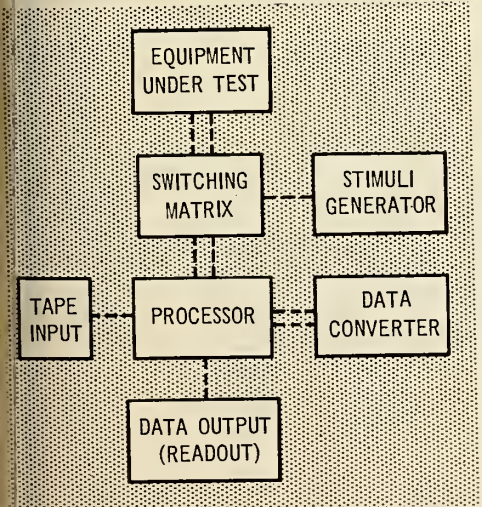
The processor controls the operation by determining which signals shall be switched to the proper wire at the proper time. Outputs from the system under test are sent through the switching matrix. If the outputs are digital signals, they go directly to the processor. If the outputs are analog signals, they are fed to the data converter.

• Data converter—The data converter performs an analog-to-digital conversion with an accuracy of 0.01% and a conversion speed of 25 microsec. The converter contains signal transducers for converting pneumatic or mechanical signals to electrical digital signals. It also has impedance matching devices and contains elements for making necessary scaling changes.

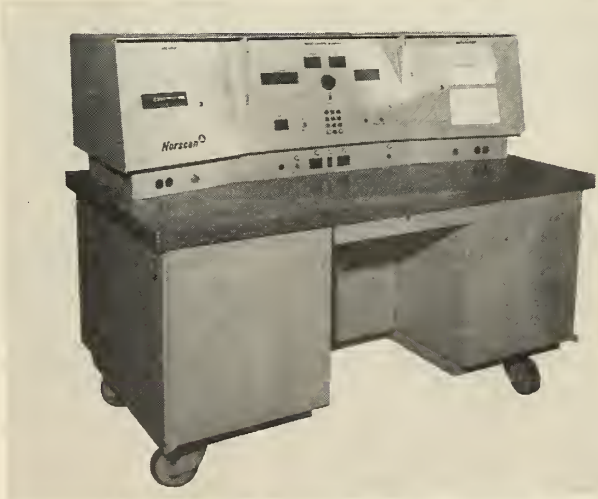
• Processor—The processor is an internally programmed digital computer, with a magnetic drum as its principal memory unit. The processor also contains an arithmetic unit, display controllers, displays, program unit, output controller, core buffer, and magnetic tape unit. The magnetic drum memory has a storage capacity of 500,000 bits of information. The core buffer, having a capacity of 1000 bits, is used for instruction storage to allow for minimum program execution time. It is also used as a buffer between the processor and the printer, between the main drum memory and the magnetic tape unit, and between the arithmetic unit and the selection matrices, which send data to, and collect data from, the system under test.

• Tape input—A high-speed tape reader, with a capability of 400 characters per second, provides the input to the processor. Initially, the tape is used to store information on the magnetic drum with respect to test sequence and test limits. Once the information has been stored on the magnetic drum, the operator energizes the test equipment and the test procedure is programmed automatically. Should any changes be made in the system under test, a new tape is inserted, the previous information erased, and new information reflecting the system changes is placed on the magnetic drum.

• Data output—The data output is under complete control of the processor. A number of different outputs from each unit may be used. The types of output depend upon the operating usage of the test equipment. They may be visual, oral, punched tape, punched



SIMPLIFIED block diagram of Nortronics' NORSCAN f broad capabilities. (Fig. 3)



PROTOTYPE CONSOLE of NORSCAN. Magnetic drum memory device in system has one-half million information bits capability. (Fig. 4)

card, printed copy, or any combination of these. Information from the magnetic tape memory may be printed in clear text for purposes of reliability reports, record keeping, and logistic determination. Reprovisioning data is also available as an output by programming the processor to provide punched cards or punched tape whenever a malfunction occurs in the system under test. This information can then be further processed or used directly to order replacement parts.

• Magnetic tape file—To store information permanently for future reference, such as malfunction prediction through the confidence index system, all data is recorded in a magnetic tape file. The unit might be comprised of an Ampex Model 800 recorder and a series of read-write amplifiers. If, for example, 30 amplifiers were employed, 15 channels would be available. A ½-inch-wide magnetic tape can store 200 bits/inch/channel. A 2500-foot tape could accommodate 7.5 x 10^6 bits with ease. Since the magnetic tape unit also records the results of the analyzer's self-test, a complete record is obtained on the unit and is available for analysis.

Fibreglass Tower Used with UCLA Antennas

LOS ANGELES—A fibreglass tower with interchangeable antennas has gone into operation at UCLA. The 18-foot structure, utilizing fibreglass to prevent metallic distortion of radiation patterns, rests on a pillbox base and both tower and antenna can be rotated independently on vertical and horizontal axes.

The tower was built by **Blaine Electronetics** and can be operated either by controls inside the base or by laboratory controls two floors below. A transmitting antenna 60 feet away illuminates the tower antenna.

The antenna is being used for various projects in advanced teaching of electrical engineering, radar, communications and other fields. One program under way involves research into transmission of electromagnetic signals between a missile re-entering the atmosphere and the ground. This transmission is difficult because of the ionized layer surrounding a re-entry vehicle.

Leach Opens Laboratory for Solid State Research

LOS ANGELES—A new laboratory designed for flexible research into solid-state devices has been opened by the **Leach Corporation.** Located at the firm's relay division, the lab will "develop solid-state packaging with no preconceived ideas," and will endeavor to meet the rapidly changing logic of space control and communications.

According to company officials, the lab will augment other work being done at previously-established electromechanical and chemical labs, as well as the new Leach Production Reliabilty Center. The lab has been well equipped with general and specific solid-state development instrumentation to permit fast study and checkout.

The lab has already developed a new programming timer which combines subminiature crystal can relays with solid-state devices in a common circuit for use in sequence progr ming.

The solid-state package deve ment philosophy at Leach is base the belief that "even in the most r lutionary electronic fields, no new vice has ever succeeded in comple supplanting the old." Therefore, L engineers are looking to the con of combining components based on peculiar characteristics of each This design logic, they predict, wil the outgrowth of research in s state packaging.

Recruiting Heavy at Military Electronics Me

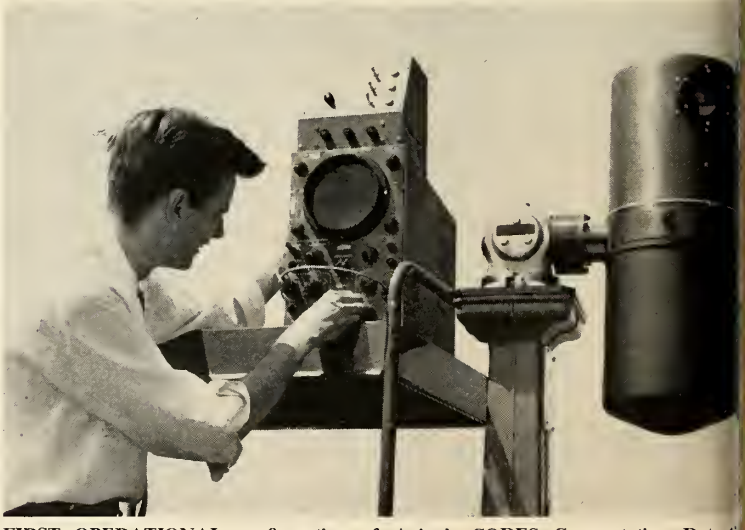
WASHINGTON—A "highly successful" third annual National Convention on Military Electronics here last week pointed up the importance of missiles in the military electronics industry. Almost all the technical sessions were devoted, at least in part, to missiles applications of electronics systems and components.

The convention, sponsored by the IRE Professional Group on Military Electronics, was attended by nearly 400 engineers—almost twice last year's figure. Some 80 exhibitors showed their latest developments in the field. Although nothing outstandingly new was to be seen at the exhibits, several items such as a pocket-sized computer and the free world's largest radar set attracted considerable attention.

The exhibit that drew the largest crowds was **Martin's** moon-satellite ball machine. Walter Mitty-type as designers could crank guidance thrust data into the machine launch a steel-ball satellite which co orbit or land on the moon if t calculations were correct.

Engineer recruiting was especi heavy. At least 25 major compa had representatives at the meeting the competition for qualified peo was the fiercest since before the stret out. One recruiter estimated that th were about 10 jobs available for ev eight men interested—a demand ab double that of last year.

Two **General Electric** engineer R. S. Grisetti and E. B. Mullen— ceived the annual M. Barry Carl Award for their paper on base guidance systems.



FIRST OPERATIONAL configuration of Avion's CODES Commutating Detecti System was exhibited at the 1959 Military Electronics Show in Washington. The mu channel, highly sensitive, infrared receiver (first described by M/R, April 20, 19 employs single-channel electronics by commutating the stored outputs of 30 detec cells and uses a single amplifier. It was developed for Air Force Cambridge Resea Center to study satellite-detection feasibility using IR techniques.

Missiles and Rockets Editorial Index

Readers are invited to save the o wing six-month index covering M R issues of Jan. 5, 1959 through u 29, 1959. This index is a reference u e to major news and technical r les published in M/R during the ir half of the year.

ASTRIONICS

Atennas

AVCO PROJECT; Radar reflector said to h ly cut weight, cost, by M/R Staff, 3/23/59, p. .

Checkout

PUSH FOR AUTOMATIC CHECKOUT; Fully r storized systems are rapidly being developed e is operational, by Charles D. LaFond, M/R ciate Editor, 6/29/59, p. 39.

Communications

CESSFUL AME IS UNVEILED; Page Communi- ns' gear tested in North Atlantic is expected nd more use on ionoscatter circuits and offers ntial for increased channel capacity, by les D. LaFond, M/R Associate Editor, 6/22/59, .3.

MMUNICATIONS SATELLITES: A LARGELY LECTED FORCE FOR PEACE; Long-proposed e relay system, now technically and economi- feasible, still gets little non-military atten- by Hal Gettings, M/R Associate Editor, /59, p. 38.

THE EDGE OF INTERSTELLAR SPACE; In 1962 A will fire minimal payload rocket and in next years will perfect communications for re- ng its data, by Hal Gettings, M/R Associate or, 4/13/59, p. 19.

NOISE TEMPERATURES IN PARAMETRIC LIFIER; by M/R Staff, 3/9/59, p. 44.

KHEED DELIVERS 9-LB. RUGGED TV SYS- TO ABMA; by M/R Staff, 2/16/59, p. 24.

Components

F REPORTS ISSUED ON CAPACITORS, TRAN- ORS; by M/R Staff, 2/9/59, p. 79.

USES 'WOOFERS' TO TEST COMPONENTS; M/R Staff, 1/12/59, p. 31.

Computers

R TO RESEARCH PHOTOCHROMIC MEMORY; M/R Staff, 5/29/59, p. 32.

HLGREN DEVELOPS COMPUTER; Used for ris, machine will handle half-million bits of rmation each second, by M/R Staff, 4/27/59, 29.

Data Processing

ICO DESCRIBED AS A NEAR-UNIVERSAL T FACILITY; Programmed tester developed by tronics automatically checks out complex mili- hardware; company says it will sharply cut s, by Charles D. LaFond, M/R Associate or, 3/30/59, p. 29.

W, COMPACT UNIT CONVERTS DATA IN- GHT; by M/R Staff, 2/2/59, p. 31.

General

SCOW BRIEFS; by Dr. Albert Parry, Con- uting Editor M/R, 6/22/59, p. 40.

ST COAST INDUSTRY; by Fred Hunter, M/R ociate Editor, 6/1/59, p. 48.

CTRONIC OUTPUT TO DOUBLE BY 1965; at's the future for electronics in MSE? by liam E. Howard, M/R Associate Editor, 5/25/59, 25.

GE'S NEW SLAVE MECHANIC HAS 'FINGERS'; 'Handyman'—result of four-year development—will go to work in radioactive areas, by M/R Staff, 4/20/59, p. 40.

HIGHLIGHTS OF IRE CONVENTION; Transistor output to pass $350 million by 1963; sales to near $300 million, by Charles LaFond, M/R Associate Editor, 3/30/59, p. 14.

INTEGRATED ELECTRONICS FOR SMALL MISSILES; Prime consideration in design and manufacture is that the missile be considered as a round of ammunition, by Gordon E. Sylvester, 3/2/59, p. 21.

CONTINUED GROWTH IN MILITARY ELECTRONICS; Armed Services seeking those companies with electronics capabilities to serve as missile, astronautics prime contractors, by Raymond M. Nolan, M/R Associate Editor, 2/9/59, p. 26.

FUTURE OF ELECTRONICS: GROWTH WITH ASTRONAUTICS; EIA President David R. Hull gives a probing look at missile electronics today and predicts tomorrow's uses, 2/9/59, p. 28.

THE AGE OF THE ELECTRON; Guest Editorial, by Dr. Ernst Weber, 2/9/59, p. 7.

ELECTRONICS BUYING SHOWS QUARTERLY INCREASE; by M/R staff, 2/2/59, p. 31.

AMPHENOL AND BORG FIRMS MERGE ELECTRONICS OUTPUT; by M/R Staff, 1/19/59, p. 27.

1958 ELECTRONIC SALES HIT RECORD $7.7 BILLION; by M/R Staff, 1/12/59, p. 27.

TWO NEW REPORTS ISSUED ON ELECTRONICS; by M/R Staff, 1/5/59, p. 29.

Infrared

UNIT COOLS IR GEAR TO AS LOW AS 60° K; by M/R Staff, 5/25/59, p. 32.

AVION DEVELOPS NEW IR SEARCH SYSTEM; CODES, built around commutating infrared detector, will be modified for satellite tracking, by Charles D. LaFond, M/R Associate Editor, 4/20/59, p. 32.

TWO APPROACHES FOR COOLING IR DETECTORS; by M/R Staff, 2/16/59, p. 23.

SERVO CORP. MANUFACTURES 12-INCH IR DOME; by M/R Staff, 2/16/59, p. 24.

Guidance

MIDCOURSE GUIDANCE IS NECESSITY FOR INTERPLANETARY TRAVEL; Venus flight would require orbit about the sun and eventual capture by planet, by L. T. Seaman, 2/9/59, p. 40.

SPACE NAVIGATION POSES NEW REQUIREMENTS; Automatic, self-contained inertial systems will be required to provide precise velocity vector control, by Frederick Stevens, 2/9/59, p. 37.

INTERPLANETARY GUIDANCE FOR MAN IN SPACE; Existing components will be accurate enough for unmanned probes with possible radio control for cutoff and staging. But next generation of manned vehicles will impose a different set of requirements headed by reliability, by Lawrence S. Brown, 2/9/59, p. 67.

THE HOW AND THE WHY OF INERTIAL GUIDANCE; While basic principles have been known for many years, solution of some of the problems peculiar to ballistic missiles is only now becoming a reality, by F. K. Mueller, 2/9/59, p. 49.

SIMPLIFIED GUIDANCE PROPOSED; by M/R Staff, 1/12/59, p. 27.

LEAR DESIGNS GUIDANCE FOR MANNED SATELLITE; Broad features appear feasible in system for integrating accelerometers and retrofitting 'Bootstrap' gyros, by M/R Staff, 1/5/59, p. 26.

Gyros

FREE ROTOR GYROSCOPE DEVELOPED BY AUTONETICS; by M/R Staff, 5/11/59, p. 21.

ROLL REFERENCE GYRO STARTED BY SPIRAL SPRING; by M/R Staff, 3/9/59, p. 44.

NEW APPROACH FOR LIQUID FLOATED GYROS; Norden Division of United Aircraft gets patent for unheated gyro that mechanically compensates for temperature variations, by M/R Staff, 2/16/59, p. 18.

GYRO DRIFT DEMANDING NEW MEASUREMENT TECHNIQUES; by Ralph Hookway, 1/19/59, p. 22.

SPERRY DEVELOPS NEW FLOTATION FLUID; by M/R Staff, 1/12/59, p. 27.

Measurement

NEEDED: NEW VELOCITY MEASUREMENT UNIT FOR SPACE; Is the Optik—based on speed of light—the answer for the confusion in scientific terms? by Maj. William C. Mannix, USAF, 4/27/59, p. 21.

LET'S CONSIDER THE OPTIK; editorial, by Clarke Newlon, M/R Executive Editor, 4/27/59, p. 7.

GYRO DRIFT DEMANDING NEW MEASUREMENT TECHNIQUES; by M/R Staff, 1/19/59, p. 22.

Miniaturization

GE OFFERS NEW MICROMODULAR CONCEPT; Company claims eraser-size device named TIMM utilizes heat losses and lends itself to stacking for varied uses, by M/R Staff, 5/25/59, p. 28.

MINIATURIZATION—A SWELLING TIDE; Chain reaction of new breakthroughs could lead to microscopically small parts before trend runs its course, by Heyward E. Canney, Jr., M/R Contributing Editor, 6/8/59, p. 39.

Optics

GIANT MIRROR CREATED FOR NSF'S NEW OBSERVATORY; Corning's reflector largest built in 25 years, was made by 'sagging' and must cool for seven months, by Donald E. Perry, M/R Managing Editor, 2/23/59, p. 23.

THEODOLITES DETERMINE AZIMUTH FOR JUPITER; Optical-electronic combination provides method for automatic alignment and monitoring of inertial guidance systems, by M/R Staff, 2/2/59, p. 29.

Plasma

PLASMA ENGINE DELIVERS NEARLY 2-LBS.; Republic's experimental 'magnetic pinch' engine produces over 4000-lbs. at peak with 1700 sec. Ist, by M/R Staff, 6/8/59, p. 34.

ARGMA'S PLASMA JET TEST FACILITY IN OPERATION; Prototype model for aerodynamic heating tests reaches 50,000° fusing argon gas with 13,000 fps flow rate, by M/R Staff, 3/23/59, p. 39.

Power Sources

MINIATURE BATTERIES HAVE HEAVY MISSILE USE; Yardney's latest Silvercel may make possible more pre-flight tests for reliability. Early model saw service in Viking; many employed in today's birds, by Donald E. Perry, M/R Managing Editor, 2/23/59, p. 28.

Production

NEW BLOCK GROUP STRESSES MODULAR CONCEPT; by M/R Staff, 3/9/59, p. 43.

INTEGRATED ELECTRONICS FOR SMALL MISSILES; by M/R Staff, 3/2/59, p. 21.

Radar

RADAR DEFENDED AT AFCEA; by M/R Staff, 6/1/59, p. 40.

Telemetry

RECORDER SIZE AND WEIGHT CUT; Ampex AR-200 weighs one-third as much and is half the size of previous magnetic tape recorders, by Charles D. LaFond, M/R Associate Editor, 6/15/59, p. 35.

NEW BLOCK GROUP STRESSES MODULAR CONCEPT; K-Block modules produced by ASCOP can be used in various telemetering systems as well as data multicoding, by Donald E. Perry, M/R Managing Editor, 3/9/59, p. 43.

NEW COMPACT UNIT CONVERTS DATA IN FLIGHT; by M/R Staff, 2/2/59, p. 31.

EGLIN TELEMETERING CONTRACT IS FOR $500,000; by M/R Staff, 1/19/59, p. 25.

Thermo-Electricity

PROSPECTS FOR THERMO-ELECTRICITY; Heavy investment in research gives hope for long-lived power units for space application, by Hal Gettings, M/R Associate Editor, 6/22/59, p. 29.

Tracking

RADAR IS STRONGLY DEFENDED AT AFCEA CONVENTION; by Hal Gettings, M/R Associate Editor, 6/15/59, p. 40.

NASA'S PROJECT MERCURY RANGE TO COST $12 MILLION PLUS; Worldide tracking system with unprecedented reliability must be operating within year, by Paul Means and Hal Gettings, M/R Associate Editors, 4/18/59, p. 26.

AVION DEVELOPS NEW IR SEARCH SYSTEM; by M/R Staff, 4/20/59, p. 32.

SIMPLIFIED TRACKING GEAR PROVIDES MUCH DATA; Independent Sohio station uses interferometer principle to track satellites—even Lunik—and records on two-channel direct-writing oscillograph, by Donald E. Pierce, 3/16/59, p. 29.

RADIO SEXTANT CAN TRACK SUN, MOON CONTINOUSLY; by M/R Staff, 3/9/59, p. 44.

NASA PLANS INCLUDE EAST-WEST MINITRACK FENCE; Other goals are two additional parabolic dishes for continuous deep-space tracking, and developing safe tracking and communications for man in space, by Paul Means, M/R Associate Editor, 3/2/59, p. 13.

U.S. AGENCIES SILENT ON LUNIK TRACKING; by Frank McGuire, M/R Associate Editor, 2/2/59, p. 21.

THEODOLITES DETERMINE AZIMUTH FOR JUPITER; by M/R Staff, 2/2/59, p. 29.

TEMCO DEVELOPS TV SURVEILLANCE SYSTEM; by M/R Staff, 1/12/59, p. 31.

Transistors-Tubes Semiconductors

MINIATURIZATION—A SWELLING TIDE; by M/R Staff, 6/8/59, p. 39.

SIMPLE SOLION MAY FILL LOW FREQUENCY GAP; by Charles D. LaFond, M/R Associate Editor, 6/1/59, p. 39.

TUBES AND TRANSISTORS: WHERE DO WE STAND? M/R survey shows that if anyone wins 'battle' it'll be to benefit of entire industry, by Hal Gettings, M/R Associate Editor, 6/1/59, p. 41.

RCA DEMONSTRATES SOLAR CELL USING GALLIUM ARSENIDE; Company also shows new 'tunnel' diode and rectifier, calls development of vital importance, by M/R Staff, 5/11/59, p. 16.

NEW WAY TO 'GROW' GERMANIUM; by M/R Staff, 5/4/59, p. 26.

HOW NBS RESEARCHES SEMICONDUCTORS; Studies include crystal growth, electrical and optical measurements, carrier lifetime, nuclear magnetic resonance, and theory, by Charles D. LaFond, M/R Associate Editor, 4/27/59, p. 31.

RCA DEMONSTRATES THIMBLE-SIZE TUBES; by M/R Staff, 4/6/59, p. 48.

TRANSISTORS VS. TUBES; . . . are arbitrary military design specifications jeopardizing U.S. security? by Donald E. Perry, M/R Managing Editor, 3/16/59, p. 21.

PHOTO-DUO-DIODE SHUTS OFF CURRENT IN DARKNESS; by M/R Staff, 3/9/59, p. 44.

TUBE SAID TO RUN YEARS ON WEAK SOLAR POWER; by M/R Staff, 2/2/59, p. 31.

ASTROPHYSICS

Astronomy

SPACE OBSERVATORY IN THREE YEARS? NASA is spending $3.5 million to solve the remaining problems and bring a revolution in astronomy; 1.5 million pound thrust engine clusters are believed adequate, by Hal Gettings, M/R Associate Editor, 6/29/59, p. 42.

OHIO STATE TEAM MAKES LOW-COST RADIO TELESCOPE; Staff Report, 5/4/59, p. 27.

WHAT IS TOPOGRAPHY OF MOON'S OTHER SIDE? That terrain may be rougher with more craters and smaller mares, astronomer believes, by Dr. I. M. Levitt, Contributing Editor, M/R 2/16/59, p. 14.

DETECTION SEEN POSSIBLE BY STAR OCCLUSION; ACF technician proposes to AAS meeting that telescope be mounted to a space platform and stabilized by slaving it to three reference stars, M/R Staff Report, 1/12/59, p. 23.

BIG PINE TELESCOPE TO GO IN OPERATION SOON; M/R Staff Report, 1/5/59, p. 14.

General

HEAT AND METORITE IMPACT EFFECTS STUDIED; M/R Staff Report, 6/15/59, p. 22.

IONOSPHERE REPORTED BIGGER THAN SUPPOSED; M/R Staff Report, 5/11/59, p. 41.

Nucleonics

TOP SCIENTISTS FIND ARGUS OPENING NEW AVENUE TO EXPERIMENTATION; First detailed discussion of historic tests confirms theories of Christofilos, who calls for further projects, by Charles D. LaFond, M/R Associate Editor, 5/18/59, p. 37.

NUCLEAR EXPLOSIONS IN SPACE (first in a series of four articles); A scientific explanation of PROJECT ARGUS and how an electron accelerator could lead to creation of an artificial particle belt, by Prof. S. Fred Singer, M/R Contributing Editor, 3/30/59, p. 33.

NUCLEAR EXPLOSIONS IN SPACE (second of a series of four articles); Trapped radiation will be problem for manned vehicles. Close burst to ICBM could make its bomb inoperative. Defender may have to revise anti-ICBM strategies, by Prof. S. Fred Singer, M/R Contributing Editor; 4/6/59, p. 36.

NUCLEAR EXPLOSIONS IN SPACE (third of a series of four articles); High-altitude blasts seriously interfere with radio and radar. Complete knock-out of electronic defense is unlikely. Artificial release of molecules could sweep up extra ionization, by Prof. S. Fred Singer, M/R Contributing Editor, 4/13/59, p. 21.

NUCLEAR EXPLOSIONS IN SPACE (last of series of four articles); Many techniques exist for detecting trapped particles. But high-altitude bursts at some latitudes might leave no traces. Adequate inspection procedures may be difficult to establish, by Prof. S. Fred Singer, M/R Contributing Editor, 4/20/59, p. 26.

Radiation

RADIATION EFFECTS: WHAT'S BEING DONE? by Charles D. LaFond, M/R Associate Editor; 6/8/59, p. 37.

NEW DETAILS ON RADIATION; Staff Report; April 6; p. 40.

PARAFFIN WAX MAY BE BETTER FOR SHIELDING; Researchers feel hydrogen atoms in wax could absorb more neutrons than plastics, by W. C. Parle and A. M. Erskine, 3/16/59, p. 34.

RADIATION CAN BE AVOIDED; Van Allen advocates polar launchings; proposes that two radiation belts be mapped by 100-pound payload satellite, by Norman L. Baker, M/R Associate Editor, 1/5/59, p. 13.

INNER VAN ALLEN RADIATION BELT IDENTIFIED; Staff Report; 6/15/59, p. 39.

MANAGEMENT & GOVERNMENT

Air Force

AF SEES IMPROVED SYSTEM MANAGEM Weapon System Project Offices are repor getting the job done more efficiently alth there's still the problem of just when produ people should take over, by Betty Oswald, Associate Editor, 6/29/59, p. 35.

AF PUSHES RESEARCH ON DETONATION P LEM, by James Baar, M/R Associate Ed 6/15/59, p. 23.

U.S. DECIDES TO PUSH ALBM—'INVULNERA DEFENSE WEAPON; Douglas wins competition begins design study based on concepts tester Lockheed, Convair and Martin; GE said to guidance contract, by James Baar, M/R Asso Editor, 5/18/59, p. 19.

BOMARC WILL SOON MOVE INTO U.S. DEFENSE ROLE; Boeing surface-to-air missile to first base this fall, may displace Nikes, James Baar, M/R Associate Editor, 5/4/59, p.

THE DEATH OF A MISSILE; One of 40,000 fails and a 75-foot bird of space (Atlas) b up—pictures by Cornell Capa, story by Erica M/R Associate Editor, 5/4/59, p. 17.

ANDERSON PROMOTED FROM ARDC TO H AMC; Popular commander becomes a conte for chief of staff after hectic but rewarding ef to speed missiles, by James J. Haggerty, Jr., Contributing Editor, 3/9/59, p. 18.

Army

MEDARIS GIVES HIS BASIC PROCUREM PHILOSOPHY; M/R Staff, 6/29/59, p. 18.

ARMY EXPANDING BREAKOUT POLICY; Cong sees increased opportunities for small business Army taking "standardized" components a from primes and buying under competitive ding, by Erica Karr, M/R Associate Editor, 6/8 p. 13.

AOMC RECOMMENDS 'NO FUNDS' FOR MISS ABLE; Only 8 Lacrosse battalions; Prototype shing testing soon; Chrysler submits Jupiter target missile, by Donald E. Perry, M/R Man ing Editor, 3/30/59, p. 13.

ARMY IN THE SPACE BUSINESS (editori 2/2/59, p. 7.

ARPA

ARPA—A DANGEROUS COMPROMISE (editori 4/13/59, p. 11.

Budget

20 ICBM SQUADRONS IN BUDGET, M/R SI 2/2/59, p. 21.

BUDGET HOLDS $7 BILLION FOR MISSILES; $ million for space exploration; Minuteman, Ho Dog, Polaris, Nike-Zeus programs to be acce ated in $40 billion defense budget. ARPA we $455 million; NASA budget is $485 million, Clarke Newlon, M/R Executive Editor, 1/26, p. 21.

Congress

CAN CONGRESS DEFINE 'INFLUENCE'?; James Baar, M/R Associate Editor, 6/29/59, p.

CHAIRMAN SEEKS BROAD R&D POWER; R Overton Brooks feels his House group should h jurisdiction over all non-military research and velopment bills; sees this as step toward Dep ment of Science, by Erica Karr, M/R Associ Editor, 6/29/59, p. 32.

U.S. SEEKS WAYS TO CLOSE TRANSLATION G by James Baar, M/R Associate Editor, 5/25/ p. 35.

DEPARTMENT OF SCIENCE: STILL 'IFFY'; Hoov type commission recommended in Congressio hearings to decide how to centralize scattered forts in science, by Erica Karr, M/R Associ Editor, 4/27/59, p. 30.

MAHON TO DEMAND MORE ATLASES; by Jar Baar, M/R Associate Editor, 4/13/59, p. 34.

W PON SYSTEM CONCEPT FACES TRIAL; House gr p is set to quiz industry and Pentagon spokes- m in lengthy hearings airing charges of mon- o ization and profiteering, by James Baar, M/R A ciate Editor, 4/6/59, p. 15.

H SE GROUP URGES RELIABILITY PROGRAM; Jo is to recognize that reliability must be bal- and against other factors, by Betty Oswald, 4/ 9, p. 27.

U SURVIVAL IN THE ATOMIC/MISSILE AGE— T eminent lawmakers write their own widely di gent views on the Russian threat and how th U.S. should counter it. By Senator Stuart Sy gton and Rep. James G. Fulton, 3/30/59, p. 8.

PR CUREMENT OVERHAUL SOUGHT; Saltonstall bi aimed at cutting lead time and Pentagon re tape, has strong support in industry and a g some high DOD officials, by Erica Karr, M Associate Editor, 3/9/59, p. 39.

WH T WILL BE OUTCOME OF PROBE OF STL? C gress may recommend that STL sever all fi cial ties to Thompson Ramo-Wooldridge, and th a limit be placed on profits and salaries of co pany officials, M/R staff, 2/16/59, p. 13.

H SLE OVER SIZE OF RED LEAD; Five Con- g ional committees set to probe defense/space p grams, by Erica Cromley, 2/2/59, p. 13.

C NGRESS SEES URGENCY IN SPACE-MISSILE G LS, M/R Staff, 1/19/59, p. 18.

LE ISLATING FOR THE SPACE AGE (editorial), 1/ 59, p. 9.

R D REPORT SHOULD GUIDE 86TH CON- G SS; Soviet space lead estimated at 12 to 18 m ths; U.S. will require 5 years to catch up, C gress told, by Paul Means, M/R Associate Edi- to 1/19/59, p. 17.

C NGRESS SET FOR RENEGOTIATION FIGHT; I stry groups press for elimination of 17-year- o Act labeled costly and discriminatory, by E. . Halmos, M/R Contributing Editor, 1/12/59, p. 3.

O OSITION DEVELOPING TO PRESIDENT'S C NCIL; M/R Staff, 1/5/59, p. 14.

C NGRESS WILL KEEP EYE ON SPACE PRO- G M; New space committees being formed; I stry ready to battle for new renegotiation a by Erica Cromley, 1/5/59, p. 15.

Contracts

A IY EXPANDING 'BREAKOUT' POLICY; Con- is sees increased opportunities for small busi- e with Army taking 'standardized' components y from primes and buying under competitive b ling, by Erica Karr, M/R Associate Editor, 59, p. 13.

A ONG LOOK AT RENEGOTIATION (editorial), 59, p. 7.

N A PATENT RIGHTS DEBATED; Question is h much proprietary interest should space agency in over inventions performed under contract, staff, 6/1/59, p. 17.

L LINES FOR THE V-2; the need for less com- specifications (editorial), 3/23/59, p. 11.

N A, DOD HAVE WIDELY DIVERGENT PATENT H TS, 3/2/59, p. 14.

Financing

C ALLS OF MISSILE BUSINESS FINANCING; ewth can be deadly. But here's where to get tal—while you still can, an M/R staff report, /59, p. 17.

Industry

A MATTER OF THE MUNITIONS LOBBY (edi- al), 6/29/59, p. 7.

W KE UP AND LIVE; better communications by I stry essential (editorial), 6/22/59, p. 7.

E K. HOFFMAN RECEIVES M/R's GODDARD H PHY, M/R staff, 6/1/59, p. 23.

E DUCATE OUR YOUTH OR RUSSIA WILL; I stry urged to increase participation in scholar- awards (editorial), 4/20/59, p. 11.

E RGETIC CHAMPION OF THE COMPONENT R OACH, by Erica Karr, M/R Associate Edi- 4/6/59, p. 43.

HOFFMAN . . . THE POWER BEHIND ROCKET-DYNE, by Erica Karr, M/R Associate Editor, 3/23/59, p. 26.

LOCKHEED EMPHASIS IS SYSTEMS MANAGEMENT; Perfecting ability in systems management is setting pace at Lockheed Missiles and Space Division, by William O. Miller, M/R Associate Editor, 2/2/59, p. 16.

Missile Business—Outlook and Trends

DEFENSE CONTRACT PROFITS, by William E. Howard, M/R Associate Editor, 5/25/59, p. 50.

SPACE MARKET, by William E. Howard, M/R Associate Editor, 5/11/59, p. 49.

D-P's GROWTH; Daystrom-Pacific to Enter Systems Work, by Richard van Osten, M/R West Coast correspondent, 4/20/59, p. 34.

ESTIMATING MISSILE EXPENDITURES; Unfortunately there are no definitive answers; but with forward planning company resources could be directed to proper business success, by Douglas S. Evered, Missile Division, North American Aviation, Inc., 2/2/59, p. 26.

NASA

NASA PATENT RIGHTS DEBATED; Question is how much proprietary interest should space agency retain over inventions performed under contract, M/R staff, 6/1/59, p. 17.

NASA SPACE FLIGHT CENTER NAMED FOR GODDARD, 5/4/59, p. 38.

NASA MAY HAVE TO ASK FOR MORE FUNDS; Eight satellite launchings, 2 space probes and 45-50 sounding rockets may require additional funds above requested $485 million, M/R staff, 4/20/59, p. 24.

NASA EXPANDS NACA PROCUREMENT SET-UP; Procurement chief says agency is decentralizing contracting and prefers doing business with established companies, by Erica Karr, 4/6/59, p. 25.

HETS PROGRAM: SPACE COOPERATION (editorial), 3/9/59, p. 7.

SPACE 'PROGRESS' BY 1969? by Paul Means, M/R Associate Editor, 2/2/59, p. 25.

NATO

NATO MISSILE BUILD-UP AT STAKE: Outcome of East-West Conference over Russia's May 27 Berlin ultimatum will affect $1 billion in U.S. missile aid, by James Baar, M/R Associate Editor, 4/27/59, p. 13.

Navy

NAVY'S REORGANIZATION TO AFFECT RESEARCH; Rear Adm. Hayward—probably next DCNO—discusses what's needed from industry, by William O. Miller, M/R Associate Editor, 3/30/59, p. 24.

Pentagon—DOD

PRIORITY RULES ARE REVISED, by Betty Oswald, M/R Associate Editor, 6/29/59, p. 19.

THE NEW DEPUTY SECRETARY OF DEFENSE (editorial), 6/15/59, p. 9.

HOW IS DOD MOVING ON RELIABILITY? Some observers say it is in all directions but Air Force has come up with a new reliability monitoring system which should give better standards, by Betty Oswald, M/R Associate Editor, 6/1/59, p. 21.

PROPOSED—A UNIFIED STRATEGIC COMMAND (editorial), 6/1/59, p. 9.

THE NEXT DEPUTY DEFENSE SECRETARY (editorial), 5/18/59, p. 9.

CONCURRENCY—PRIME NEED IN PENTAGON (editorial), 5/11/59, p. 7.

WEAPON SYSTEM CONCEPT FACES TRIAL; House Group is set to quiz industry and Pentagon spokesmen in lengthy hearings airing charges of monopolization and profiteering, by James Baar, M/R Associate Editor, 4/6/59, p. 15.

QUARLES BEST TO REPLACE McELROY (editorial), 3/30/59, p. 7.

SOME VIEWS OF DOD RESEARCH CHIEF YORK; Pentagon's first R&E director gives priority to weapon system on basis of importance of its mission and encourages industry to do more research on its own, by Paul Means, M/R Associate Editor, 3/23/59, p. 21.

PROCUREMENT OVERHAUL SOUGHT; Saltonstall bill, aimed at cutting lead time and Pentagon red tape, has strong support in industry and among some high DOD officials, by Erica Karr, M/R Associate Editor, 3/9/59, p. 39.

THE NEW LINE-UP IN SPACE (editorial), 2/23/59, p. 9.

DOD CHIEFS BACK BUDGET: REGRET CUTS; Sentiment heavy in Congress for restoring many budgetary cuts, M/R staff, 2/9/59, p. 21.

NEITHER LIFE NOR DEFENSE ENDS AT 40 (editorial), 1/26/59, p. 11.

THE CASE OF DR. YORK AND MR. JOHNSON (editorial), 1/12/59, p. 57.

IDA'S 'BRAIN FACTORY' GUIDES WEAPON CHOICES; Five universities work with Pentagon to provide staff for secret projects, by E. E. Halmos, Jr., M/R Contributing Editor; 1/5/59, p. 20.

Procurement

MEDARIS GIVES HIS BASIC PROCUREMENT PHILOSOPHY, M/R Staff, 6/29/59, p. 18.

NASA EXPANDS NACA PROCUREMENT SET-UP: Procurement chief says agency is decentralizing contracting and prefers doing business with established companies, by Erica Karr, M/R Associate Editor, 4/6/59, p. 25.

PROCUREMENT OVERHAUL SOUGHT; Saltonstall bill, aimed at cutting lead time and Pentagon red tape, has strong support in industry and among some high DOD officials, by Erica Karr, 3/9/59, p. 39.

Renegotiation

A LONG LOOK AT RENEGOTIATION (editorial), 6/8/59, p. 7.

CONGRESS SET FOR RENEGOTIATION FIGHT; Industry groups press for elimination of 17-year-old Act labeled costly and discriminatory, by E. E. Halmos, M/R Contributing Editor, 1/12/59, p. 13.

Research

AF PUSHES RESEARCH ON DETONATION PROBLEM, by James Baar, M/R Associate Editor, 6/15/59, p. 23.

Russia

RED THREAT FROM ANTARTICA; U.S. and other nations are worried about Russian bases build-up and submarine missile launching potential, by James Baar, M/R Associate Editor, 6/1/59, p. 15.

SOVIET AFFAIRS; USSR plans scientific information center, by Dr. Albert Parry, M/R Contributing Editor, 6/1/59, p. 47.

SOVIET AFFAIRS; Soviet press evaluates U.S. missilery, 4/20/59, p. 48.

WHEN RUSSIA PUTS MEN IN SPACE (editorial), 4/6/59, p. 6.

SOVIET AFFAIRS; Russians claim space lead, by Dr. Albert Parry, M/R Contributing Editor, 1/12/59, p. 38.

WORLD MUST SOLVE BRAND NEW PROBLEM OF MOON RIGHTS; Authorities seeking answers find few precedents to work with and most consider U.N. control the most feasible, by Donald Cox, M/R Contributing Editor, 3/23/59, p. 24.

Taxes

WITH GOVERNMENT RECONSIDERING FAST TAX WRITE-OFFS, WILL 1959 BE 'BOOST' OR 'BUST' YEAR FOR SPACE RESEARCH? by William E. Howard, M/R Associate Editor, 4/20/59, p. 19.

Weapon Systems & WS Management

AF SEES IMPROVED SYSTEM MANAGEMENT; Weapon System Project Offices are reportedly getting the job done more efficiently although there's still the problem of just when production people should take over, by Betty Oswald, M/R Associate Editor, 6/29/59, p. 35.

HOW DO WE MAKE WEAPON SYSTEM INTEGRATION WORK? AF has established Project Offices with broad authority for overall management of all phases, by Betty Oswald, 6/15/59, p. 24.

STRATEGIC READY RESERVE STUDIED; Contractual personnel would maintain and operate complex weapon systems even in tactical use under proposed plans, by Donald E. Perry, M/R Managing Editor, 5/4/59, p. 13.

'FATHER' OF DYNA-SOAR AWAITS AF DECISION, by Erica Karr, M/R Associate Editor, 5/4/59, p. 29.

SMALL ALBM MAY GO ON F-10S; Republic's Mach 2 fighter may be built in Europe under NATO nations' share plan, by Clarke Newlon, M/R Executive Editor, 4/27/59, p. 14.

RELIABILITY IS OUR MOST IMPORTANT HEADACHE (editorial), 2/16/59, p. 7.

MATERIALS

Ceramics

MISSILE NEEDS POSE CHALLENGES FOR CERAMICS; Industry expects demand within decade for materials that will take temperatures up to 4000°F in missiles, by R. T. Inglis and D. L. Krout, Jr., 3/9/59, p. 34.

Connection (welding, etc.)

WELDING REDSTONE; Extreme care exercised at Reynolds plant precludes faulty welds, by M/R Staff, 6/8/59, p. 29.

Environmental Effects

SPACECRAFT MATERIALS PROBED BY SYMPOSIUM; by Frank McGuire, M/R Associate Editor, 5/25/59, p. 56.

IR ANALYZERS MONITOR GIANT WIND TUNNEL; by M/R Staff, 5/11/59, p. 41.

SOVIET AUTHOR WRITES ON THERMAL MATERIALS; by M/R Staff, 3/2/59, p. 29.

Explosive Forming

INDUSTRY PUTTING INCREASED EMPHASIS ON HEF PROCESSES; But the physical and metallurgical problems still remain largely unanswered with techniques being debated, by Frank McGuire, M/R Associate Editor, 5/6/59, p. 28.

Metals

BERYLLIUM STRUCTURE MADE; by M/R Staff, 6/8/59, p. 41.

NAA'S NOVEL APPROACH TO STAINLESS STEEL HONEYCOMB PANELS; Company sees "new era" in vehicle construction; process includes original heat-treating cycle, by Frank McGuire, M/R Associate Editor, 5/11/59, p. 23.

LOW COST BRAZED STEEL HONEYCOMB STRUCTURES; Martin's new hardened alloy solves problem of uneven filleting in brazing and allows opening of tolerances, by Clarence A. Boyce, Jr., Martin Co., 5/4/59, p. 33.

METALS CONGRESS DISCUSSES PROBLEM SOLUTIONS; Great strides reported in such fields as increasing metal strength and test methods, 3/23/59, p. 29.

'BREAKTHROUGH' IN TUNGSTEN FABRICATION; Fansteel research opens new applications for missile electronics, propulsion and structures, by Donald E. Perry, M/R Managing Editor, 3/23/59, p. 22.

Outlook

WHAT'S COMING IN MATERIALS RESEARCH? A leader in the field says costly and less glamorous production research has been neglected but novel techniques are being developed for fabrication and screening of new materials, by Arthur R. Lytle, Union Carbide, 4/6/59, p. 30.

HERE'S 1959 OUTLOOK FOR MISSILE MATERIALS; Metals will remain the mainstay, but competition from plastics will mean more teaming with ceramics, by Alfred J. Zaehringer, Associate Editor, M/R, 1/26/59, p. 24.

Plastics

SINGER'S CAST EPOXY RESIN MIRRORS REQUIRE NO COSTLY HAND WORK; Polishing and finishing eliminated in plastic replica process. Mirrors withstand 20,000g in shock tests, by M/R Staff, 3/2/59, p. 16.

MISSILES, SATELLITES & RESEARCH VEHICLES

Foreign Astronautics

REPORT FROM WEST GERMANY; Reds have "hundreds" of 700-mile missiles facing Western Europe; Germany would make Hawks under license; French atomic complaints, by Clarke Newlon, M/R Executive Editor, 6/29/59, p. 45.

BRITISH ASTRONAUTICS; More successful Seaslug trials; Rolls-Royce building Rocketdyne motors; Thunderbird comes into service with Army, by G.V.E. Thompson, M/R British Correspondent, 6/29/59, p. 28.

ON DISPLAY AT PARIS AIR SHOW; The Continent's biggest Space Age exhibition, by Jean-Marie Riche, M/R French Correspondent, 6/29/59, p. 24.

BRITISH ASTRONAUTICS; Government evasive on how much will be spent for space flight program; planetary probes and manned flight ruled out already, by G.V.E. Thompson, M/R British Correspondent, 6/8/59, p. 30.

SWISS FIRM TURNS OUT MOST MISSILES IN ITALY; Contraves AG developing into big supplier with its RSD-58 and RSC-57 missiles, by Anthony Vandyk, M/R Geneva Correspondent, 6/1/59, p. 22.

FRENCH ASTRONAUTICS; Air-to-Air and Ground-to-Air Missiles, M/R Paris Correspondent, 5/11/59, p. 19.

BRITISH ASTRONAUTICS; Progress on 24-channel time multiplex system; No decision yet on a British spaceflight programme; Blue Steel readied for test at Woomera, by G. V. E. Thompson, M/R British Correspondent, 5/11/59, p. 17.

FRENCH ASTRONAUTICS; S.E.P.R. test facilities are believed to be best on Continent; firm builds and tests both solid and liquid-fueled engines, by Jean-Marie Riche, M/R French Correspondent, 4/13/59, p. 28.

U.S. BUYING SS 10-11 FOR FORCES IN EUROPE, by Frank G. McGuire, M/R Associate Editor, 3/2/59, p. 32.

BLACK KNIGHT ENGINE DESCRIBED; by Anthony Vandyk, M/R Geneva Correspondent, 2/2/59, p. 24.

SEDOV COMPARES WEIGHTS OF U.S./SOVIET ROCKETS; M/R Staff, 2/2/59, p. 19.

EUROPEAN GROUP STUDIES BUILDING U.S. MISSILES; M/R Staff, 2/2/59, p. 21.

Research Vehicles

AEROJET'S NEW SOUNDING ROCKETS; Company is already taking orders for Astrobee series reportedly costing less than Aerobee but offering improved ease of handling, thrust alignment and attitude accuracy, by Frank G. McGuire, M/R Assistant Editor, 6/15/59, p. 25.

SCOUTING THE FRINGE OF SPACE; X-15 manned research vehicle rehearses for first flight, by Erica Karr, M/R Associate Editor, 6/1/59, p. 31.

NASA REPORTS SUCCESSFUL S-STAGE SOUNDING ROCKET, M/R staff, 4/13/59, p. 38.

X-15 DROP SOON; Guidance to be tested in early phase, 2/16/59, p. 26.

Satellites

VANGUARD ORBIT TRY FAILS AS REGULATOR BREAKS DOWN, M/R staff, 6/29/59, p. 33.

NASA SPACE LAB PLANS OUTLINED; ARS r... ing also hears debate on the long-term val... Project Mercury holding facility' and report ... ramjet, ion engine and APU developments ... Frank G. McGuire, M/R Associate Editor, 6/2... p. 24.

U.S. MAY SEEK PACT TO SILENCE OUTW... SATELLITES; Delegation at Geneva meeting ... also propose radio frequencies to be reservec... space use only, by Paul Means, M/R Asso... Editor, 6/1/59, p. 24.

ABMA RECEIVES FIRST OF SATURN ENGI... Jupiter test stand being modified to accommo... cluster of Rocketdyne H-1 liquid engines, ... staff, 5/25/59, p. 36.

ADAM MAKES COMEBACK IN MERCURY,... Paul Means, M/R Associate Editor, 5/4/59, p. ...

DISCOVERER, YES; VANGUARD, NO! Polar s... lite capsule is believed to have reentered; r... netometer try invalidated by second stage tro... 4/20/59, p. 22.

EXPLORER V WILL CARRY HIGHLY COMI... PAYLOAD; by Paul Means, M/R Associate Ed... 3/27/59, p. 20.

DISCOVERER I ORBIT DUBIOUS; Intermittent ... nals may be caused by satellite's tumbling ... solar heat reviving cold batteries, M/R s... 3/9/59, p. 20.

PIONEER DEVIATES IN TRAJECTORY; But ... stage Jupiter fired perfectly with less than ... second lift-off delay by ABMA team, by ... Means, M/R Associate Editor, 3/9/59, p. 20.

WEATHER SATELLITE WILL HAVE THREE C... ERAS; Later meteorolgical experiments will ... responsibility of Weather Bureau Section, by F... G. McGuire, M/R Associate Editor, 3/2/59, p...

REDS SAY LUNIK MADE 'COMET,' by Frank ... McGuire, M/R Associate Editor, 2/23/59, p. 3...

SCOUT COULD ORBIT 150 LBS, M/R staff, 2/16... p. 13.

U.S. RESEARCH AIMS AT SPACE LAB, by Cl... Newlon, M/R Executive Editor, 2/2/59, p. 12.

RE-ENTRY NAVIGATION: 'BREAKTHROUGH' ... NOT REQUIRED, by Raymond M. Nolan, ... Associate Editor, 1/26/59, p. 29.

LOCKHEED SPACE STATION INTERESTING ... AGENCIES; Satellite Laboratory could be in... eration in 10 years; Cost estimate put at $... billion, by Norman L. Baker, M/R Associate Ed... 1/19/59, p. 19.

STANDARD NAVIGATION AIDS COULD GU... SPACE TRAVEL; M/R staff, 1/19/59, p. 27.

LUNIK BECOMES SOLAR SYSTEM'S Tenth "Plan... Indications are Russians may have hoped to ... moon; exploit demonstrates know-how in velo... guidance, by Norman L. Baker, M/R Assoc... Editor, 1/12/59, p. 21.

USSR LUNAR PROBES WILL ORBIT CLOSE ... SURFACE. By Lt. Cmdr. John A. Fahey, U.S. N... Intelligence School, 1/12/59, p. 22.

MISSILE SUPPORT

Electronics

ELECTRONIC OUTPUT TO DOUBLE BY 1... What's the future for electronics in MSE? ... William E. Howard, M/R Associate Editor, 5/25... p. 25.

General

THE GOLDEN FIELD OF MISSILE SUPPORT (... torial), by Clarke Newlon, M/R Executive Edi... 5/4/59, p. 6.

ARS MEETING STRESSES GROUND SUPP... EQUIPMENT; Pre-launch problems, data hand... and missile performance comes up in techn... papers delivered by specialists, by William ... Miller, M/R Associate Editor, 3/30/59, p. 16.

Launching Facilities

HOW TO HANDLE 24-MEG THRUST; Special ... istics will be needed for 1.5 million pounds-... boosters, by Chauncey J. Hamlin Jr., North Am... ican Aviation, 6/29/59, p. 16.

FBM SUB PROVIDES NEW MARKET; With 45 mi-launching boats possible, lion's share of om $4.5 billion should go for support equipment, by onald E. Perry, M/R Managing Editor, /8/ , p. 31.

MIN TEMAN RAIL CONCEPT PUSHED; 200 missile trai appear possible which should open up a who new field of missile support equipment run g into multi-million dollar program, by Wil lian E. Howard, M/R Associate Editor, 6/1/59, p.

U.S SEEKS MANUS LAUNCH SITE; ARPA has eng ering plan to spend millions on tying island into PMR; NA5A may help in development of site hen selected, by William E. Howard, M/R Ass ate Editor, 5/18/59, p. 21.

BIL ONS FOR ICBM LAUNCHING FACILITIES; Air orce wants $343 million in FY '60 alone to har Atlas and Titan bases . . . advent of Mineman will swell outlay, by William E. How d, M/R Associate Editor, 5/11/59, p. 13.

CA OPERATING AT ONE-FIFTH CAPACITY, by M/ Staff, 5/4/59, p. 36.

PM INVESTMENT TO REACH $250 MILLION IN 196 Extra $75 million probably will be funded n xt two years for base construction, by Robert Mo , 4/13/59, p. 36.

A RD LOOK AT SPACE LOGISTICS; AF-spon or conference told it may be 5-10 years before ma an be kept alive in space; planners banking on etter component reliability, by William O. Mil , M/R Associate Editor, 4/6/59, p. 17.

ATI BASES TO BE HARDENED; Titan and Atlas will both be continued, Pentagon tells Congress, but omarc sites are cut sharply, by James Baar, M/ Associate Editor, 3/30/59, p. 15.

WOLD RAPIDLY ADDING MORE MISSILE LA ES; United States is negotiating in hopes of operation in man-in-space plans. Existing an s very from relatively small facilities to those ex ding thousands of miles. Small nations are par ipating at a fast-growing rate, by William O. iller, M/R Associate Editor, 3/9/59, p. 15.

Production Facilities

PI FORGE FORMS STEEL ONE INCH THICK, y I/R Staff, 3/23/59, p. 31.

HE ROBOT IS BIG STEP IN NUMERICAL CON RO; Automatically programmed tool developed t IT translates jargon and guides cutting, by an J. Haggerty, Jr., M/R Contributing Editor, /59, p. 33.

HO IRBM PRODUCTION; by Fred S. Hunter, M/ Associate Editor, 2/16/59, p. 15.

UI ER IRBM PRODUCTION; by Alfred J. Zaeh ne , M/R Associate Editor, 2/16/59, p. 18.

Research Facilities

IC BIG A MISSILE SUPPORT FILE? AF list il tart with some 2500 data sheets but opinions iff on how much longer it will get, by William oward, M/R Associate Editor, 6/22/59, p. 13.

F CATALOGUING SUPPORT ITEMS; Massive ol e due July 1 should save millions in waste l development of redundant equipment and od standardize handling and checking-out ea by William E. Howard, M/R Associate di , 6/15/59, p. 21.

Society

FEAM SEEKS SAFER MISSILE FLIGHTS; GM8 ro is handicapped by sparse data but hopes to velop a central report procedure, by Richard arOsten, M/R Associate Editor, 4/27/59, p. 28.

HT WILL BE NEEDED IN MSE—WHEN MAN NRS THE MISSILE, by Hal Gettings, M/R ssiate Editor, 4/20/59, p. 20.

Budget Facilities

DU COMPANIES PRODUCING VERSATILE R ES; Bendix, Republic and Marquardt joined rs in designing ground-launched Hilo, pro d a bomber-like radar image. Bell worked t Bendix in developing Penny, air-launched to erm at high altitude and supersonic speeds, Frank G. McGuire, M/R Associate Editor, 59, p. 21.

Test and Checkout

ATLAS PARTS TEST STAND PRODUCED BY ROCKETDYNE; by M/R Staff, 6/8/59, p. 32.

A MAMMOTH GANTRY FOR SATURN; Structure will cost $9.5 million with test tower, opening new dimension in missile support equipment, by M/R Staff, 6/8/59, p. 33.

VIBRATION TESTING OF NEW MISSILES SAVES MONEY AND TIME; Trend is toward more accurate reproduction of effects of dynamic forces, using such equipment as Ling's spectral density analyzer system, by Cameron G. Pierce, 4/27/59, p. 17.

VANGUARD TESTING: BACKBONE OF PRESENT BALLISTIC MISSILE ART; Checkout 'primer' developed by Martin gives pattern for industry to follow, by William E. Howard, M/R Associate Editor, 4/6/59, p. 20.

TITAN'S TESTING TIME MAY BE ONE HALF ATLAS'; SAC personnel to join Martin's streamlined test division in September; static firings may be eliminated at Cape, by Donald E. Perry, M/R Managing Editor, 3/16/59, p. 22.

COOK LABS DO MASS COMPONENTS TESTING; Inland testing engineers screen up to 100,000 parts simultaneously without damaging those that are acceptable, by M/R Staff, 2/23/59, p. 24.

BOMARC ENGINES ARE TESTED AT MARQUARDT LAB; Huge facility stores fifty tons of air for supersonic testing at altitudes near 200,000 feet, by Raymond M. Nolan, M/R Associate Editor, 1/12/59, p. 15.

Test Ranges

A CRISIS IN RANGE INSTRUMENTATION; AFMTC commander says more funds and effort must be expended to cure the rapidly widening time bottleneck, by Maj. Gen. Donald N. Yates, 6/29/59, p. 20.

Tracking

NEW AMPLIFIERS EXTEND MISSILE TRACKING RANGE; by M/R staff, 3/23/59, p. 41.

3000-MILE RADAR MAY BE ON TRACKING SHIP; by Peer Fossen, M/R Associate Editor, 2/2/59, p. 32.

Transportation

GOODYEAR'S APPROACH FOR ATLAS MSE; by M/R Staff, 4/20/59, p. 23.

NYC TESTS MISSILE TRANSPORT; by Frank G. McGuire, M/R Associate Editor, 2/2/59, p. 19.

PROPULSION

Controls

THROTTLEABLE ENGINE PROLONGS AIRCRAFT LIFE; Rocketdyne's AR series with up to 6000-lb thrust is ready for use although Navy has cancelled program, by Frank G. McGuire, M/R Associate Editor, 4/27/59, p. 23.

COMPLICATION FOR SOLIDS: THRUST-DIRECTION CONTROL; Ballistic missiles will require thrust vector control, thrust termination, thrust modulation, by Norman L. Baker, 2/9/59, p. 23.

Cryogenics

PROPULSION ENGINEERING; New plant turns out 'purest hydrogen ever made', by M/R staff, 6/8/59, p. 45.

FLUORINE ENGINES MAY ARRIVE WITHIN FIVE YEARS; Dramatic increase in rocket capability will come when compatible materials are developed. Fuel supply considered more than adequate, by Paul Means, M/R Associate Editor, 5/11/59, p. 42.

VACUUM JACKETING CUTS FUEL LOSSES; CEC reports its jacketed lines reduce boil-off by half, compared to those insulated with other materials, M/R staff correspondent, 4/6/59, p. 22.

Hybrids

PROPULSION ENGINEERING; Advantages of hybrid nuclear-chemical rocket engines, M/R staff, 5/18/59, p. 52.

Liquid

PROPULSION ENGINEERING; Ammonium nitrate as oxidizer, M/R Staff, 4/27/59, p. 49.

BRITISH ASTRONAUTICS: British firm starts manufacture of hightest hydrogen peroxide, by G. V. E. Thompson and K. W. Gatland, M/R Contributing Editors, 4/6/59, p. 19.

PROPULSION ENGINEERING; Boron fuels, M/R Staff, 3/16/59, p. 40.

ARMOUR ENTERS EMPIRICAL ROCKET APPLICATIONS, M/R staff, 3/2/59, p. 18.

FUELS VAPORIZATION STUDY CONTRACT AWARDED BY NSF, M/R staff, 2/23/59, p. 56.

PROPULSION ENGINEERING; Pre-packaged liquid propellant announced by Navy, by Alfred J. Zaerhringer, M/R Associate Editor, 2/9/59, p. 106.

1-1.5 MEG ENGINE MAY BE OPERATIONAL IN SIX YEARS, M/R staff, 2/2/59, p. 20.

Nuclear

PROPULSION ENGINEERING; Vary thrust for optimum nuclear rocket performance, M/R Staff, 6/1/59, p. 45.

AEC IS RECOVERING VALUABLE CERIUM 144, M/R staff, 4/13/59, p. 38.

PROPULSION ENGINEERING; Aerojet's head questions nuclear rocket's practicality, M/R staff, 4/6/59, p. 47.

THE NEGLECTED ATOMIC PROPULSION PROGRAM (editorial), 3/2/59, p. 7.

GE SCIENTISTS DESCRIBE NUCLEAR POWER PACKAGE, M/R staff, 1/5/59, p. 30.

Outlook

INDUSTRY TELLS CONGRESS: DO MORE BASIC RESEARCH NOW, by William E. Howard, M/R Associate Editor, 3/30/59, p. 20.

CHEMICAL INDUSTRY EXPANDS FOR ASTRONAUTICS, by Alfred J. Zaehringer, M/R Contributing Editor, 2/2/59, p. 28.

Plasma

PLASMA ENGINE DELIVERS NEARLY 2 LBS; M/R staff, 6/8/59, p. 34.

Solids

PROPULSION ENGINEERING; Basic studies on plastics will give propulsion engineers more solid propellant data, M/R Staff, 6/22/59, p. 45.

COMPLICATION FOR SOLIDS: THRUST-DIRECTION CONTROL; Ballistic missiles will require thrust vector control, thrust termination, thrust modulation, by Norman L. Baker, M/R Associate Editor, 2/9/59, p. 23.

SPACE MEDICINE

Animal Experiments

PIONEERING MONKEYS AND MICE; Two monkeys come back strong from Jupiter flight, though one dies later; Discoverer III tests will be U.S.'s most elaborate effort, by James Baar, 6/8/59, p. 28.

SPECIAL PROBLEMS OF THE MONKEY-IN-SPACE, by Dr. Earl T. Carter, Ohio State University, 5/11/59, p. 30.

Human Engineering

ADAPTING MAN TO HIS LIFE IN SPACE, by James Baar, M/R Associate Editor, 6/29/59, p. 22.

SPACE FEEDING: BIG $$ MARKET; Air Force contracting with industries on four lines of space food with bulk of work being handled through Quartermaster Food and Container Institute, by James Baar, M/R Associate Editor, 6/15/59, p. 28.

SPACE MEDICINE PROBLEMS PROBED BY AMA, by Frank G. McGuire, M/R Associate Editor, 5/11/59, p. 22.

CONVAIR INVESTIGATES ENVIRONMENTAL TOLERANCES, M/R staff, 2/9/59, p. 63.

Space Capsules

AN EXCLUSIVE INTERVIEW WITH THE AF SPACE MEDICINE CHIEF; Dr. Hubertus Strughold looks beyond Project Mercury to time when space flights may last months, 3/30/59, p. 22.

McDONNELL GETS MERCURY AWARD; by Clarke Newlon, M/R Executive Editor, 1/19/59, p. 18.

STRUCTURES

Astrodynamics

DRAG BRAKE PROPOSED FOR M-I-S, M/R Staff, 6/22/59, p. 18.

Components

THE CASE FOR COMPONENTS RESEARCH, by Charles D. LaFond, M/R Associate Editor, 4/6/59, p. 22.

Design

NOTCH SENSITIVITY WALL WILL CRACK, M/R Staff, 6/22/59, p. 15.

DETAILS OF ATLAS CONSTRUCTION DISCLOSED, M/R Staff, 6/1/59, p. 26.

Nose Cones

BIRTH OF A TITAN NOSE CONE, M/R Staff, 5/11/59, p. 32.

SPRAYING TECHNIQUE MAY CUT RADOME COST, by Richard Van Osten, M/R Associate Editor, 3/16/59, p. 37.

THE CASE FOR ABLATION, by Henry G. Lew, Sinclair M. Scala and George W. Sutton, 6/8/59, p. 19.

THE CASE FOR HEAT SINK, by Dr. J. D. Stewart, 6/8/59, p. 16.

Test

WEAPONS TESTING BOOMS AT AF'S ARNOLD CENTER, M/R Staff, 3/9/59, p. 31.

ARGMA'S PLASMA JET TEST FACILITY IN OPERATION; Prototype model for aerodynamic heating tests reaches 50,000° fusing argon gas with 13,000 fps flow rate, by M/R Staff, 3/23/59, p. 39.

THE DEATH OF A MISSILE; One of 40,000 parts fails and a 75-foot bird of space (Atlas) blows up—pictures by Cornell Capa, story by Erica Karr, M/R Associate Editor, 5/4/59, p. 17.

VIBRATION TESTING OF NEW MISSILES SAVES MONEY AND TIME; Trend is toward more accurate reproduction of effects of dynamic forces, using such equipment as Ling's spectral density analyzer system, by Cameron G. Pierce, 4/27/59, p. 17.

VANGUARD TESTING: BACKBONE OF PRESENT BALLISTIC MISSILE ART; Checkout 'primer' developed by Martin gives pattern for industry to follow, by William E. Howard, M/R Associate Editor, 4/6/59, p. 20.

TITAN'S TESTING TIME MAY BE ONE HALF ATLAS'; SAC personnel to join Martin's streamlined test division in September; static firings may be eliminated at Cape, by Donald E. Perry, M/R Managing Editor, 3/16/59, p. 22.

COOK LABS DO MASS COMPONENTS TESTING; Inland testing engineers screen up to 100,000 parts simultaneously without damaging those that are acceptable, by M/R Staff, 2/23/59, p. 24.

BOMARC ENGINES ARE TESTED AT MARQUARDT LAB; Huge facility stores fifty tons of air for supersonic testing at altitudes near 200,000 feet, by Raymond M. Nolan, M/R Associate Editor, 1/12/59, p. 15.

missile business . . .

By WILLIAM E. HOWARD

Multi-million dollar savings . . .

are envisioned through proposed electronic data processing of DOD's worldwide logistics operation. High speed equipment would be utilized to keep up-to-the-minute records of the thousands of parts and design changes in missile/aircraft and other weapon systems. AIA reports the plan will be submitted to DOD next month. It was devised by a Military/Industry Logistics Data Development Unit (MILDDU) after a 10-month study determined that a single data exchange system could be designed using a standardized punch card record length as the base for development.

Meantime, just such a "push-button" . . .

delivery system has been developed at Warner Robins Air Materiel Area, Robins AFB, Ga., to support *Mace* installations. **Goodyear Aircraft,** which recently received a $302,000 *Mace* warehousing order from Warner Robins and has the complete support contract for the **Martin**-built missile as well as its guidance system, says the new electronic logistic system is called MAST (missile automatic supply technique). Designed to eliminate slow-moving paperwork, MAST absorbs data on component usage over a global network in seconds. The data is code-punched at supply depots and transmitted to Warner Robins.

Inventories are instantly computed . . .

at headquarters and orders issued to warehouse points or manufacturers to ship required parts and supplies. The concept amounts to a supply sergeant's dream come true. No forms. Just punch a button and wait for the stuff to arrive on the next plane.

Goodyear says the MAST system has been thoroughly tested and presently is being put into operation to control *Mace* logistics primarily at launching and supply depots of the Tactical Air Command in Europe. Squadrons of the 800-mile range *Mace* are now replacing the shorter range *Matador.*

An automatic production and inventory . . .

control system is helping keep kinks out of operations at the **Rocketdyne Division of North American Aviation.** The company says the newly-installed Mechanized Production Control (MPC) system gives management a daily report on all rocket engine manufacturing activities. Moreover, it "immediately calls out corrective action for all behind-schedule parts or components."

Rocketdyne Factory Manager Ross Clark . . .

says with MPC company business is administered at considerably less cost and with greater accuracy. Here's the way it works: employing automatic tabulating machines, MPC established schedules on all production activities, starting with engineering drawings. Then, automatically, engineers are notified when to release the drawings, the purchase department is notified when to buy parts or material, and production departments are informed when they will receive the parts and given a completion date. All activities leading to engine fabrication are pre-scheduled and all components and parts are detailed on a master list.

"Move cards" keep track of progress on parts and components as they move through production departments. Information from these cards is fed into electronic accounting machines, which then compile reports listing the production status of all parts.

Benefits of the system, says Clark . . .

include reduction of production lead time, reduction of work that is behind schedule and the maintaining of accurate up-to-the-minute inventories. He says MPC is, indeed, one of the company's "most important new programs."

ppointment of **Samuel W. Stewart** as director of engineering and research at the Gabriel Electronics Division was announced. Stewart was formerly head of the Microwave Engineering Department at the Sperry Gyroscope Co., where he was in



TEWART

ge of research-through-production of icrowave components, antennas and an- ent systems.

verett B. Boise, former supervisor of pplications engineering, production types, as been elevated to manager of applica- io engineering, receiving tubes, for E Hytron. Boise is a graduate of Rens- el r Polytechnic Institute and has served s n engineer with the RCA patent de- artment license division, and as chief o mercial engineer for National Union Ra o Corp.

Tasker Instruments Corp. recently ai ed **David J. Green,** vice president for Ad nced Systems Development to direct x ratory programs into advanced R&D o epts and systems design. Green comes o Tasker from the System Development Co., formerly a division of the Rand Co., where he was head of Corporate Ad nce Planning and served as a mem- e of the management committee.

Dr. David M. Heinz has been named s nior scientist at Hoffman Electronics Co.'s new Science Center in Santa Ba ara, Calif. He will concentrate on er conductor materials and in the field f general chemistry. Dr. Heinz was o erly a physicist in the materials and pr esses unit of General Electric's In- tr ent Department, and a research as- o te in the GE Research Department's Ge al Physics Research Laboratory.

Dr. Robert E. Samuelson has been appointed to the newly created post of assistant general manager for research and development at Motorola's Western Military Electronics Center in Phoenix. With Motorola since 1950, Dr. Samuelson has been successively



AMUELSON

se r project leader, chief engineer and en neering manager of the Military El tronics Center in Phoenix.

Dynatronics, Inc., Orlando, Fla., has pr oted former vice president and chief en neer **George F. Anderson** to vice president and general manager. The firm is engaged in R&D and production of space communication, data handling and specialized test equipment.

Epsco, Inc.'s new subsidiary, Monitor Systems Inc., will be headed by **Harry H. Rosen.** Rosen is former manager of Data Processing and Computation in G.E.'s Missile and Space Vehicle Department. MSI expects eventually to employ several hundred engineering, production, and management personnel from the Philadelphia area.

William R. White, acting general manager, takes over as president of U.S. Semiconductor Products, a division of Topp Industries, Inc. **Dr. Friedrich Schwarz,** who has headed the company since its beginning two years ago, has been elected chairman of the board of directors. In addition to his new assignment, Schwarz will be active in the research and development programs of other Topp divisions—U.S. Science and Micro-Path.

Other officers in the company will include **Robert Rutherford,** vice president and director of engineering, and **Gayle Hodges,** secretary-treasurer. Reorganization of the U.S. Semcor management team came one week after finalization of its acquisition by Topp.



PHILLIPS

Alvin B. Phillips has been appointed chief engineer of Motorola's Mesa transistor product line. Phillips is a former marketing product planner with General Electric's Semiconductor Products Department.

Carl E. Calohan was appointed advertising and sales promotion manager of Giannini Controls Corp., succeeding **Richard L. Lawrence,** who resigned to accept a similar position with Hughes Semiconductor Products.

Glen P. Bieging has been named manager of marketing for General Electric Co.'s Missile and Space Vehicle Department. He was manager of market research and product planning for the G.E. Heavy Military Electronic Department in Syracuse.

Allan F. Donovan, vice president and director of Advanced Systems Planning at Space Technology Laboratories, Inc., has been named a delegate to a panel of technical experts which will advise the U.S. Committee on Nuclear Testing. He will counsel the Committee on the possibilities of using space vehicles to carry out undetected nuclear tests in outer space. Donovan joins the eight other members of the panel headed by **Dr. Wolfgang K. H. Panofsky,** of Stanford University, in Geneva to begin discussions with similar groups of British and Russian experts.

Hal V. Miller was named liaison engineer at Packard Bell Electronics Corp.'s Technical Products Div.

New manager of the Space Technology Laboratories Field Office at Warren AFB, Cheyenne, Wyo., is **W. H. Edwards.** He has been with STL since September, 1955, and played a prominent part in the firm's *Atlas* ICBM work.

ANALYTICAL ENGINEERS

career opportunities with an expanding facility in New England . . .

Requirements: BS in Mechanical Engineering or AE degree, 2-5 years experience in one or more of the following: 1) small turbo-machinery (compressor, turbines, fans) 2) lightweight heat exchangers 3) thermodynamic cycle analysis 4) air conditioning, air and vapor cycle refrigeration.

Duties: Work includes both applied theoretical and experimental analysis starting with initial design and continuing through prototype. Involves performance computation defining configurations of components and complete systems to meet specifications. Opportunity to utilize IBM 704 and 705 for complex methods of analysis.

Join a technical group whose facilities and background knowledge are unrivalled in the industry. Your talents will be employed in the development of advanced concepts, and also in internal consulting work on problems encountered by the Design and Development Engineering Groups.

Very pleasant urban or suburban living conditions . . . opportunity for tuition-paid post graduate study . . . generous relocation allowance.

This Division of United Aircraft is now actively engaged in product diversification and development of jet aircraft equipment, ground support equipment and missile components.

Reply to Mr. A. J. Fehlber
Technicol Employment Supervisor

HAMILTON STANDARD
Div. of
UNITED AIRCRAFT CORPORATION
431 Bradley Field Rd.
Windsor Locks, Conn.

Panels Reportedly Solve Radar Van Heat Problems

FULLERTON, CALIF.—Ground systems engineers at **Hughes Aircraft Company** report that they have devised a low-velocity air diffusion panel to solve the ticklish heat problem in close quarters of new mobile radar vans designed to detect enemy missiles.

In designing and producing "3-D" radar mobile control vans, Hughes was faced with the problem of cooling both the myriad electronic equipment and the seven operators in the compact vehicles, it was reported by Wayne Stauch, Hughes mechanical engineer.

In addition to the fact that the van ceiling is only three inches above the head of the average operator, the problem was compounded by the limitation of diffusion space to a narrow central "corridor," Stauch said.

Finding that standard high velocity air diffusion was unsatisfactory from both a draft and noise standpoint, project engineers found a solution after testing the comparatively new concept of low-velocity diffusion.

The air diffusers used consist of panels with a perforated distribution plate which, by means of a pressure displacement valve, slows down the speed of the cool air and diffuses it evenly throughout the air conditioned area. The air is brought to the panels from the cooling source through the plenum above the van ceiling.

Stauch points out that depending upon the size of the van, up to three pairs of valves are used. The air flow can be regulated by a valve adjustment.

The special ventilation product used to solve the problem, Stauch reports, was the Multi-Vent panel, produced by the **Pyle-National Company,** Chicago, developers of the low velocity diffusion method.

Originally designed by Pyle-National to solve similar problems in railroad passenger cars, the technique has in recent years been used for air conditioning office buildings, computer rooms, and general commercial and institutional applications.

The product is also beginning to receive attention, he said, for mobile homes, office trailers, submarines, ocean going passenger vessels, and other uses where space limitation is a problem.

Solids Seen as Good Source for AP

SAN DIEGO—Solid propellants can be a versatile efficient source of power for many space flight purposes besides rocket propulsion.

Two Washington, D.C., scientists told the recent American Rocket Society meeting here that gas turbines fueled by solid propellants can drive electrical generators, mechanical and exhaust systems and perform several other functions.

Melvin Cohen, of the Hicks Corp., and Lt. Com. Edward J. Sheeh the Navy Ordnance Bureau, said power can be used in a missile electronic and guidance systems, dynamic and flight control sys and separation and termination de

Missile designers have many so of power available. Four of the common are batteries, bottled pressed gas, liquid-propellant gas erators and solid-propellant gas g ators. Cohen and Sheehy outlined advantages and disadvantages:

Batteries—Use limited by exce weight and size as against power put.

Bottled gas—Heavy inert ponents necessitated by high gas sures; excessive space requirement cause of low density.

Liquid-propellant generators— ter than batteries or bottled gas many purposes but more com bulkier and less reliable than solid pellant generators.

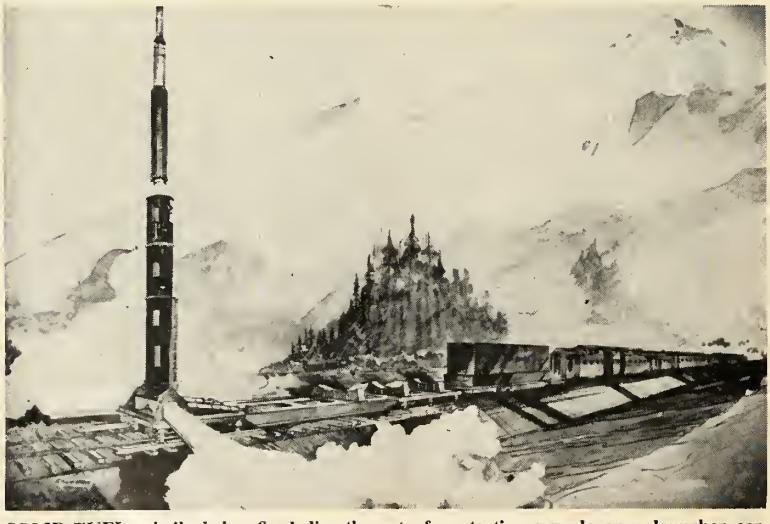
The solid-propellant generator one major limitation. It is inher a "one-shot" operation. It is not tical to turn a solid propellant off on again, although some work is done in smothering the fire before charge is completely burned up.

• **In an emergency**—Cohen the solid-propellant turbine prot never would compete with solar teries for such long-term low- power uses as light, heat and needs aboard a manned space But he said such a turbine woul valuable for emergency use while ing repairs on regular power sou He compared this to the auxi power supply in a hospital basen for use in case the city supply i terrupted.

In the laboratory, experim units have supplied gas-turbine p for periods of time on the order o to 20 minutes, Cohen reported. noted that this is nearly the maxi duration of an ICBM flight. The b ing is prolonged on essentially same principle as in a cigarette- packing the propellant in a long, row cylinder. It may be curled, ever, for convenience.

Several missiles already use s fuel gas turbines, Cohen declared. their use is growing rapidly. One missile has a turbine of this type can run an electrical generating tem from 60 to 90 seconds, more enough time to last the one-mi flight. A second turbine runs hydr equipment for about the same pe of time. Cohen declined to identify missile beyond saying it is in the class (*Talos, Terrier* and *Tartar*). added that such devices are also in in one British missile and in a h speed Navy torpedo.

Launching from Railroad



SOLID-FUEL missile being fired directly out of protective capsule on a launcher car, preliminary designs for which have been made jointly by Bethlehem Steel Co. and Paul Hardeman, Inc. Flame at the bottom is deflected by outstretched shields in this artist's conception. Hydraulic jacks, carried under car, push steel beams down over ties to stabilize the car. (See M/R, June 1, page 19).

contract awards

MISCELLANEOUS

Cnell Aeronautical Laboratory, Inc., for ne creation and preliminary design an- yses of general support missile systems. ward by The Allison Div. of General otors Corp. GM and CAL will collaborate n the project (amount not disclosed).

ARMY

onca Manufacturing Corp., Middletown, hio, has received a "very substantial" nount for the production of base shel- rs for the *Jupiter* missile program mount not disclosed).

,000,000—Raytheon Co., Andover, Mass., r continued production of the *Hawk* r defense missile. Sixty-one million for issiles, eighty-four million for ground uipment and sixteen million for en- neering services.

754,785—Chrysler Corp., for work on the edstone 200-mile range missile.

833,870—Sperry Rand Corp., for research nd development work on the *Sergeant* issile.

320,690—Sperry Rand Corp., for ground nd test equipment for the *Sergeant* ystem.

32,408—Blaw-Knox Company, Pittsburgh, a., for construction of *Atlas* ICBM unching stands and operations build- gs at Fairchild AFB, near Spokane, ash.

97,788—California Institute of Tech- ology, Pasadena, for research and devel- pment work to be performed at the Jet ropulsion Laboratory.

000—Bowen-McLaughlin - York, Inc., ork, Pa., for vehicle engineering services r the T88 series, medium recovery ve- icle, including three pilot models.

020—Western Electric Co., Inc., N.Y., r *Nike* spare parts and components (ten ntracts).

0,213—Western Electric Co., Inc., N.Y., r *Nike* spare parts and components welve contracts).

9,169—Rheem Manufacturing Co., Dow- ey, Calif., for missile warhead design nd development.

9,297—Douglas Aircraft Co., Inc., Santa onica, Calif., for *Nike* repair parts and unching area items.

9,632—Consolidated Electrodynamics Corp., asadena, for recording oscillographs.

6,000—North American Aviation, Inc., ocketdyne Div., Canoga Park, Calif., for ocket engines.

3,712—Ordnance Specialties, Inc., El onte, Calif., for a powder actuated eefing line cutter.

000—Thompson Ramo Wooldridge, Inc., os Angeles, for telemetering system de- elopment.

166—Tele-Dynamics Inc., Philadelphia, r services consisting of the manufacture f telemetry transmitting systems, com- onents, assemblies and sub-assemblies, nd the modification and testing thereof.

167—Kin-Tel, Div. of COHU Electronics, an Diego, for amplifiers.

372—Hallamore Electronics Co., Ana- eim, Calif., for cameras and accessories.

838—Helge Olsen Inc., East Orange, N.J., r pyrotechnic area, facilities and utili- es, additional altitude test chamber at icatinny Arsen, Dover, N.J.

935—RIAS, Div. of Martin Co., Balti- nore, for research and development on he effects of surface films on the me- hanical properties of metals.

065—Resdel Engineering Corp., Pasadena, alif., for receivers and oscillators.

NAVY

000,000—Autonetics Div. of North Ameri- an Aviation, Inc., for electronic arma- ent control systems for the Republic of Vest Germany (subcontract from Lock- eed Aircraft Corp.).

$2,000,000—Convair Div. of General Dynamics Corp., San Diego, for design and manufacture of a radar for navigation-bombing, system (subcontract from Autonetics Div. of North American Aviation, Inc.).

$1,500,000—Melpar, Inc., for production of target detecting devices for the *Talos* surface-to-air missile.

$1,241,057—Federal Pacific Electric Co., Newark, N.J., for missile and *Asroc* fire control switchboards.

$980,000—Summers Gyroscope Co., Santa Monica, Calif., for high performance gyros to be used in the *Terrier* and *Tartar* missiles (subcontract from Convair Div. of General Dynamics).

$760,000—Westinghouse Electric Corp., Baltimore, for production of electric propulsion motors to be used in the anti-submarine torpedo, the Mark 37.

$182,500—Telemeter Magnetics, Inc., Los Angeles, for research and development of magnetic core memory.

$166,347—General Electric Co., Syracuse, N.Y., for research on defense against ballistic missiles.

$143,007—Aeronutronic Systems, Inc., Glendale, Calif., for research on defense against ballistic missiles.

$128,079—Convair Div. of General Dynamics Corp., San Diego, for research on ballistic missile defense.

$121,061—Allied Research Associates, Inc., Boston, for research on defense against ballistic missiles.

$117,783—Hnghes Aircraft Co., Culver City, Calif., for research on defense against ballistic missiles.

$96,225—University of Chicago, for research on defense against ballistic missiles.

$25,041—Winzen Research, Inc., Minneapolis, for research on defense against ballistic missiles.

$25,000—Armour Research Foundation of Illinois Institute of Technology, Chicago, for research on high powered transducers.

AIR FORCE

$722,413—General Petroleum Corp., Los Angeles, for 6,453,000 gallons of rocket fuel.

$623,201—Litton Industries, Electron Tube Div., San Carlos, Calif., for miscellaneous electron tubes.

$500,000—United Electrodynamics, Pasadena, Calif., for an FM/AM telemetry system used in research and development flight tests of the *Minuteman* missile (subcontract from Boeing Aircraft Corp.).

$395,404—Tidewater Oil Co., Los Angeles, for 2,524,000 gallons of rocket fuel.

$315.557—Bell Oil and Gas Co., Tulsa, for 1,757,000 gallons of rocket fuel.

$175,393—Photo-Sonic, Inc., Burbank, Calif., for 18 35-mm high-speed motion picture cameras.

$131,313—Tung-Sol Electric Inc., Newark, N.J., for miscellaneous electron tubes.

$136,710—Eitel-McCullough, Inc., San Bruno, Calif., for miscellaneous electron tubes.

$70,304—Allen B. Dumont Labs, Inc., Clifton, N.J., for miscellaneous electron tubes.

$48,000—Waste King Corp., Los Angeles, for research and development of a prototype quantity of pilot static tubes capable of withstanding exposure to temperatures up to 1400°C for 15 minutes to be used on aircraft and missiles flying at speeds up to Mach 5.

$44,929—Olin Mathieson Chemical Corp., Chemicals Div., Baltimore, for 7125 lbs. of monomethyl hydrazine for testing and evaluation in support of weapons system 138a.

$35,543—Curtiss Wright Corp., Electronics Div., Calstadt, N.J., for drone control and radar tracting systems simulator used in conjunction with a modified M-4 tracting radar.

$27,486—Ampex Corp., Newton, Mass., for recorder, reproducer, magnetic tape, seven channel.

$27,441—Kenick Manufacturing Co., L.I., N.Y., for rocket assembly used on F84 and F84F1 aircraft.

NASA

$500,000—The Siegler Corp., Hallamore Electronics Co. Div., for airborne computers and associated test equipment for the *Vega* outer space rocket (subcontract from Jet Propulsion Laboratory).

The civilian space agency awarded the following contracts during the month of May, in addition to those which appeared last week.

$110,000—National Science Foundation, for support of the Space Science Board of the National Academy of Sciences.

$60,000—University of Florida, for study of general instability of cylindrical shells, aimed at aiding both rocket and space vehicle designers.

$60,000—University of Wisconsin, for design studies of an ultraviolet telescope system to go into a future orbiting space observatory. The telescope would examine the radiation emitted by stars.

$50,000—Army Ordnance, for part of 20 *Nike-Asp* sounding rockets to be fired from Fort Churchill, Canada, and Wallops Space Flight Station in ionospheric sampling experiments.

reviews

CTR-371 COMPUTERS, 1937-58, Available from OTS, U.S. Department of Commerce, Washington 25, D.C.

A catalog of technical reports, listing all reports in the field of computers, has been published by the Office of Technical Services, U.S. Department of Commerce.

It identifies reports on digital, analog, photographic, mathematical, navigational computers and others. Many of the reports resulted from research conducted for the Army, Navy, Air Force, Atomic Energy Commission, and other agencies of the U.S. Government. Others are German documents captured during World War II.

METAL-CERAMIC LAMINATES, R. K. Francis, R. Brown, E. P. McNamara and J. R. Tinklepaugh, Alfred University for WADC. 78 pp, available from OST, U.S. Department of Commerce, Washington 25, D.C.

Using brazing and hot-pressing techniques, metal-ceramic laminates can be fabricated when the thermal expansion of the ceramic is equal to or slightly less than that of the metal. Fosterite-stainless steel 430, molybdenum-alumina, and Kovar-alumina liminates were fabricated by brazing techniques; laminates of molybdenum and a 40% alumina-60% mullite ceramic were hot pressed.

Thermal expansion and thermal conductivity studies demonstrated that mixtures of mullite and alumina can be used to provide a varying range of thermal expansion. Measured conductivities of the stainless steel laminates were much higher than calculated results. A comparative apparatus for measuring thermal conductivity was constructed and found accurate to plus or minus two per cent in the temperature range 100 to 1000°C.

YOU'RE ON THE INSIDE...



You make your point before the conference begins when you advertise in Armed Forces Management. It's the *only* magazine offering across the board coverage of *all* the military services in the $45 Billion Market. Armed Forces Management reaches 17,000 military and civilian executives in administrative, executive, procurement and evaluation positions. And you reach the *right* man in the *right* spot. AFM is addressed to job titles, not names, (majors through 5-star generals/admirals and civilian executives with Civil Service rating of GS-13 or above). This enables you to sell military purchasing influences month after month regardless of personnel rotation. *For a complimentary copy of the detailed Armed Services Marketing Manual, write Marketing Director, Armed Forces Management.*

AF m ARMED FORCES management

AMERICAN AVIATION PUBLICATIONS, INC.
1001 VERMONT AVENUE, N. W. WASHINGTON 5, D. C.

propulsion engineering

You must be a defense contractor . . .
to use the new rubber and asbestos insulation that **Astrodyne** has developed for solid propellant motors. The company developed the insulation primarily for Navy use. It greatly extends the motor life and, in effect, adds to burning time. It's cheaper and lighter than reinforced plastics now in wide use. Typical test result: Insulation held exterior of motor case to 200°F for 3.5 min., under propellant flame of 5500°F.

Tantalum producers are skeptical . . .
about the drastic price cut made by **Union Carbide Metals,** according to the magazine *Chemical Week*. Carbide cut the tantalum price from $60/lb. down to $35/lb. early this month. There was a lot of talk about a new future for the metal—wider experimentation and development would now be possible. However, *Chemical Week* says Carbide's competitors are commenting that "Carbide has been selling close to the $35/lb. level for some time." Carbide replies, according to the magazine, that the higher price always was considered a "list price" subject to negotiation on large orders, frequently whittled down to near $35, where small orders have gone at near the $60 price.

Nuclear propulsion is a step closer . . .
to reality for aircraft, manned satellites and space ships, thanks to **Goodyear's** castable nuclear shielding material announced at mid-month. The synthetic rubber-powdered boron material shields crew members from neutrons. It features a new rubber molecule high in hydrogen content, as well as mixed-in boron. The hydrogen slows down the neutrons, the boron captures them.

Until now, polyethylene slabs have been used for lightweight shielding. However, the slabs are difficult to work with since they are too rigid to conform to many shapes. The Goodyear product is fully castable—pour it into any shape, it fills the entire volume and sets at about room temperature. Goodyear scientists believe the shield is the lightest and most effective neutron shielding material yet developed.

In spite of its high hydrogen content, the material can withstand temperatures from −60°F to 200°F. It absorbs radiation without damage. Goodyear says it's "reasonably priced."

Note: The material is not the full answer to missile and aircraft nuclear shielding problems. Lead still must be used to shield against gamma radiation. The Goodyear material, however, replaces the concrete and water neutron shields used in earth-bound installations.

Forced draft air heater . . .
for testing missile components at **Wyle Laboratories,** Norco, Calif., delivers 20 million BTU/hr. at 1500°F. The unit, built by **Hirt Combustion Engineers,** can deliver extremely high flows of gaseous oxygen or nitrogen, 35 lbs/sec at 200 psi. Purpose: Test missile components at actual operating temperatures and flows. This is one of the largest units of its type ever built, according to the builders, who say there is no practical limit to the size of future units.

High temperature reactions . . .
are studied by a new technique developed at **Bell Telephone Laboratories.** In describing the general technique in *Chemical & Engineering News*, Bell Telephone's Lloyd Nelson says it "may be helpful in attacking such problems as . . . prolonging the life of a missile nose cone, or developing protective clothing against nuclear blasts." Here's a capsule description: Fine particles or filaments of absorbing materials are suspended in a transparent medium and exposed to a high-speed, high-intensity flash of light. The particles hit a very high temperature and then cool again almost instantaneously. Chief advantage: The speed of the reaction does not allow time for side reactions —researchers can follow the main reaction without interference.

research.
design...
development

TELEMETRY

Boeing's expanding work on Minuteman, the Air Force's solid-propellant ICBM and other extremely advanced weapon system programs, has created exceptionally rewarding, long-range openings in the field of telemetry techniques, systems, sub-systems and equipment.

These are challenging opportunities for years-ahead work in the design, testing and evaluation of telemetry systems and components, as well as the development of new applications and techniques in areas such as:

- **Test Equipment**
- **Specialized Transistors and Signal Conditioners**
- **Pulse Code Modulation, Pulse Duration Modulation and FM/FM**
- **Missile Telemetry**
- **Flight Test Data**
- **Special Circuitry and Equipment**

Assignments are available at virtually all experience levels, and with educational backgrounds ranging from B.S. to post-Ph.D. At Boeing you'll be with an industry leader in the development of advanced weapon systems.

Drop a note *today*, to:

Mr. Stanley M. Little
P. O. Box 3822 - MRA
Boeing Airplane Company
Seattle 24, Washington



BOEING
...environment for dynamic career growth

EMPLOYMENT
■ ENGINEERS—SCIENTISTS ■

Work on
TOTAL SOLUTIONS
to Major Defense Problems

at General Electric's Defense Systems Department

You'll find greater opportunities in Systems Engineering in an organization whose charter has a breadth and scope seldom met in industry:

...to find total solutions to specific large scale defense problems requiring the integration of diverse fields of knowledge and equipments. These problems will be of sufficient magnitude and duration to justify the allocation by General Electric of considerable numbers of highly qualified scientists and engineers to contribute *systems program management* and *systems engineering support*—on programs such as:

ATLAS • DYNA-SOAR • SENTRY
...and other highly classified systems which cannot be listed here.

Immediate Opportunities for:

Systems Program Engineers
Systems Management Engineers
Guidance Equation Engineers
Data Processing Engineers
Electronic Systems Management Engrs.
Operation Analysts
Systems Logistics Engineers
Engineering Psychologists

Forward your confidential resume at an early date. Whereas growth potential here is evident—both for DSD and the engineers who join us—the positions filled during these early months will carry significant "ground-floor" benefits.

Write fully to Mr. E. A. Smith
Dept. 7-G.



DEFENSE SYSTEMS DEPARTMENT
A Department of the Defense Electronics Division
GENERAL ELECTRIC
300 South Geddes Street
Syracuse, New York

soviet affairs . . .

By DR. ALBERT PARRY

An alloy of iridium and aluminum . . .

as a tremendous boon to rocketry is discussed in the Moscow *Yunyi Tekhnik*. For a long time, despite all the experiments which were attempted, such an alloy could not be achieved, the Soviet magazine says. The reason for continued failure was plain: Aluminum melts at 660°C, while the melting point of iridium 2400°C.

But a new method . . .

accomplishing the needed alloy was at last found. The Russian journal calls the discovery "the meteorite-metallurgical technique." This consists of "shooting" at melted aluminum a charge of extraordinarily tiny particles of iridium emerging at a tremendous speed from a special electrical instrument.

"Not being in a molten state," the description in *Yunyi Tekhnik* continues, "iridium nonetheless fuses with the molten aluminum into an alloy. This alloy possesses the light weight of aluminum and the high mechanical and heat-resisting solidity of iridium, thanks to which it becomes an ideal material for the making of most important parts of airplanes and rockets." But to what extent this method and the resulting alloy are now being used in the Soviet Union, the Russian item does not say.

On broader implications . . .

of this subject, "Heat-Resisting Alloys" is the title of a special lengthy article in *Sovetskaya Aviatsia* by Professor N. Skliarov. He discusses the arrangements now being made by the Soviet government to expand and improve Russia's production of heat-resisting alloys in the Seven-Year Plan just begun (1959-65). Rather dismissing aluminum, magnesium, and other low heat-resisters, Professor Skliarov suggests that Soviet experimenters are now paying close attention to such "more infusible metals" as chrome, niobium, tantalum—and "the highest-melting metal—wolfram."

Yet Professor Skliarov also speaks of "extraordinary difficulties" hampering "the utilization of these metals." The *Sovetskaya Aviatsia* writer, who holds the degree of doctor of the technical sciences, says that these metals can be cast only in a vacuum, "in special arc furnaces from which air is barred." He reveals that the Seven-Year Plan is emphasizing the introduction and improvement of the arc-furnace method of casting various metals needed in aviation and rocketry.

Powder metallurgy is another field . . .

looming large in the Seven-Year Plan, according to Doctor Skliarov. "High heat-resisting materials," he writes, "can be obtained not alone as cast metal alloys but also by pressing and baking ready-made parts from mixtures of powdered metals with highly infusible compounds which melt at 3000°C and at yet higher temperatures."

The value of powder metallurgy, he continues, is in the fact that methods of this metallurgy help in the manufacture of such synthetic materials as "combinations of metals with their infusible oxides." He gives this example: The oxide of aluminum melts at 2500°C, and this oxide permits experimenters to create a material twice as heat-resisting as can be had from ordinary aluminum alloys.

Powdered or pulverulent metals . . .

can aid in the making of porous materials. The latter, as Doctor Skliarov points out, "combine solidity with their heat-resistance thanks to their cooling by a liquid flowing through the pores." The result is that experimenters obtain "most divergent combinations of materials with good heat-insulating qualities, a high thermal capacity, and the ability to absorb a great quantity of heat coming from outside."

That is why the Seven-Year Plan devotes so much attention to this part of Soviet technology and industry. Playing a significant role in today's technology, the heat-resisting materials "will have a yet greater importance in the technology of the future," the Soviet scientist concludes.

--when and where

JULY

t Annual Basic Statistical Quality In-sute, University of Connecticut, Sorrs, July 12-24.

di Technical Commission for Aero-natics and Los Angeles Section of t- Institute of Radio Engineers, Third nnial Joint Meeting, Ambassador otel, Los Angeles, July 16-17.

e American Rocket Society, Propel-l ts and Combustion Committee, ropellants, Thermodynamics and ndling Conference," Ohio Union, io State University, Columbus, y 20-21.

al Annual Institute on Missile Tech-rlogy, Chief of Research and Devel-cment, U.S. Army, University of nnecticut, Storrs, July 26-Aug. 7.

e Denver Research Institute of the liversity of Denver, 6th Annual mposium on Computers and Data ocessing, Stanley Hotel, Estes Park, lo., July 30-31.

AUGUST

tition of Investigation of Biological ences, Sponsor: Air Force Office of entific Research, Aeromedical Div., World Health Organization, Monte-video, Uruguay, Aug. 2-7.

Association of the U.S. Army, Annual Meeting, Sheraton-Park Hotel, Wash-ington, D.C., Aug. 3-5.

American Astronautical Society, Second Annual Western Regional Meeting, Ambassador Hotel, Los Angeles, Aug. 4-5.

Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

Institute of Radio Engineers, Western Electronic Show & Convention, Cow Palace, San Francisco, Aug. 18-21.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Sym-posium on Anti-Submarine Warfare, (classified), San Diego, Calif., Aug. 24-26.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Mis-sile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, Uni-versity of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkeley, Calif., Sept. 2-4.

Air Force Association and Panorama: Send Reservations to AFA Housing Bureau, P. O. Box 1511, Miami Beach, Sept. 3-6.

Standards Engineering Society, Boston Section, Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, Confer-ence and Exhibit, Chicago, Sept. 21-25.

Industrial Nuclear Technology Conference, Sponsored by Armour Research Foun-dation of Illinois Institute of Tech-nology and Nucleonics Magazine and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

American Rocket Society, Solid Propel-lants Conference, Princeton University, Princeton, N.J., Sept. 24-25.

Institute of Radio Engineers, 1959 Na-tional Symposium on Telemetering, Civil Auditorium, San Francisco, Sept. 28-30.

OCTOBER

Society of Automotive Engineers, National Aeronautics Meeting, Aircraft Manu-facturers Forum and Aircraft, Engi-neering Display, The Ambassador Hotel, Los Angeles, Oct. 5-10.

Electronics Industries Association Confer-ence, University of Pennsylvania, Uni-versity Park, Oct. 6-7.

Stanford Research Institute, First High Temperature Symposium, Asilomar Conference Grounds, Monterey Pen-insula, Calif., Oct. 6-9.

National Electronics Conference, Spon-sored by American Institute of Elec-trical Engineers, Illinois Institute of Technology, Institute of Radio Engi-neers, Northwestern University and University of Illinois, Hotel Sherman, Chicago, Oct. 12-14.

Armour Research Foundation, 15th An-nual National Conference, Hotel Sher-man, Chicago, Oct. 26-30.

Institute of Radio Engineers, Professional Group on Electron Devices, Shoreham Hotel, Washington, D.C., Oct. 29-30.

NOVEMBER

41st National Metal Exposition and Con-gress, International Amphitheatre, Chi-cago, Ill., Nov. 2-6.

Mid-America Electronics Conference, 11th Annual Meeting, Kansas City Muni-cipal Auditorium and Hotel Muehle-bach, Kansas City, Nov. 3-5.

Fifth International Automation Exposi-tion and Congress, New York City, Nov. 16-20.

The Institute of Radio Engineers, 1959 Northeast Electronics Research and Engineering Meeting, Boston Common-wealth Armory, Boston, Nov. 17-19.

1960

JANUARY

Institute of the Aeronautical Sciences, 28th Annual Meeting, Hotel Astor, New York, Jan. 25-28.

APRIL

American Society for Metals, 2nd South-western Metal Exposition and Con-gress, State Fair Park, Automobile Building, Dallas, Apr. 25-29.

SEPTEMBER

International Council of the Aeronautical Sciences, Second Congress, Zurich, Switzerland, Sept. 12-16.

Advertisers' Index

Aejet-General Corp., Sub-General Tire & Rubber Co. 10
Agency—D'Arcy Adv. Co.

Boeing Airplane Co. 47
Agency—Fletcher Richards, Calkins & Holden, Inc.

Grove Valve & Regulator Co. 2
Agency—L. C. Cole Co.

Kefott Co., Inc. 51
Agency—Gaynor & Ducas, Inc.

Lockheed Aircraft Corp., Missile Sys-tem Div 6
Agency—Hal Stebbins, Inc.

Minneapolis-Honeywell Regulator Co., Honeywell Div. 4
Agency—Commerce Adv.

North American Aviation, Inc., Au-tonetics Div. 8, 9
Agency—Batten, Barton, Durstine & Osborn, Inc.

Northrop Corp. 52
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

A. O. Smith Corp., Aeronautical Div. 3
Agency—Klau-Van Pietersom-Dunlap, Inc.

United Aircraft Corp., Hamilton Standard Div. 43
Agency—Chambers Wiswell Shattuck Clifford McMillen, Inc.

EMPLOYMENT SECTION

General Electric Co. 48
Agency—Deutsch & Shea, Inc.

CLASSIFIED

For approved storage and transportation of high explosives and propellants in Los Angeles area contact:
W. A. Murphy, Inc.
436 North Arden Drive
El Monte, California
CUmberland 3-8048

Memo from the Assistant Publisher

This is the first in a series of memos to you, the reader, keeping you informed about what we're doing and planning here at Missiles and Rockets.

Just as a starter, let's take a look at M/R's title, "The Magazine of World Astronautics." There are variations . . . such as "Technical/News Weekly of the Missile/Space Industry" . . . more comprehensive, but somewhat awkward. We believe our present definition, concise and to the point, is adequate.

Then consider the market. There are many industries combining to make up this Missile/Space field we talk about. Which are these industries, and who is the man . . . the engineer . . . whose efforts produce new developments in this area?

In short . . . for whom, and for what reason, is Missiles and Rockets being edited and published?

Astronautics Engineering (or missile engineering, space technology . . . call it what you will) has been defined as the applied science whereby simultaneous extensions of the state of the art in aeronautical, electronics, chemical, metallurgical and astrophysical engineering combine to produce new developments in the field of missiles and space vehicles. Each of these industries plays an integral part in the fulfillment of man's greatest venture to date: the perfection of the art of missilery and the subsequent conquest of space.

The astronautics or missile engineer may be basically an aeronautical engineer; he may be an electronics or chemical engineer, a physicist or metallurgist (if he's young enough, he may even bear the *title* of missile engineer). But to his basic knowledge in one or more of the above sciences he's had to add capabilities in magnetohydrodynamics, space communications, digital computer logic design, celestial mechanics, reentry simulation . . . there are scores of others.

To serve this man, the astronautics engineer, his proper diet of news and technical editorial coverage of all of these sciences *as they apply to missile/space projects* . . . coverage of Astronautics Engineering . . . is the editorial purpose of Missiles and Rockets and M/R's "reason for being."

Working toward more complete fulfillment of this editorial mission, M/R has made a number of changes and improvements in its editorial product over the past several months, not the least of which has been a decided increase in the amount and caliber of technical coverage. This week there are several more changes:

Missile Electronics, a familiar M/R department since the section was first instituted in October, 1957, now becomes Astrionics, a column heading we've used from time to time for several years. As the science of Astronautics Engineering broadens, so does M/R, and the term Missile Electronics is no longer broad enough in scope to cover electronics in both missiles and space systems. Hence a new title: Astrionics.

M/R's weekly Contract Awards feature, which you tell us is an invaluable information guide, has been expanded and relocated, enabling M/R editors to include the latest available award informati each week.

In keeping with our definition of Astronauti Engineering, we invite your attention to the editori masthead on page four, revamped this week. Nar the primary fields of Astronautics Engineering: stru tures, electronics, propulsion, materials, astrophysic support equipment, and you'll find an M/R edit (sometimes two) covering each.

To get more late news into M/R each wee the editorial by Executive Editor Clarke Newlc will be moved back to this page beginning ne week; you'll find it here from then on.

So far this year, M/R has published 955 pag of editorial material devoted to the Missile/Spa market . . . more than any other magazine of a type. Beginning on page 37 of this issue, you'll fi an editorial index for the period January throu June 1959.

In addition to thorough weekly news coverage Astronautics happenings in Washington and arou the world, we've inaugurated a program to give reade a minimum of four "round-up" or "state-of-the-ar articles each week, letting you know where we've bee "where we're at," and where we're going in technic areas vital to Astronautics progresses.

Take, for example, the "Fuzing and Arming" sto on page 30. Here Astrionics Editor Hal Gettings e plores a technology of extremely high reliability paran eters, and identifies industrial and government leade in the field.

Beginning this week on page 13 is the first in three-part series by Associate Editor William E. Howa on the Missile Industry in New England . . . an ar which garners over $1 billion each year in missile co tracts and employs more than 150,000 people. Ne week Bill will get more specific and survey the Bosto area; on July 27th: a Connecticut close-up. Surveys other U.S. missile manufacturing areas will follow.

What's the outlook for aluminum? Cryogenics? A sociate Editors Paul Means and Frank McGuire te these stories on pages 18 and 21 . . . stories compile after hundreds of miles of travel on both East and We Coasts, and hundreds of man hours of editorial r search. More of this type of editorial treatment w follow next week when M/R editors discuss printe circuitry, monopropellants and the vehicle requiremen for Missile Support.

On July 20 you'll see M/R's Third Annual Enginee ing Progress Issue, featuring the famous Guided Missi Encyclopedia, expanded this year to include the late available information on British, French, Swiss ar Italian missiles in addition to those of the United Stat and Russia. Watch for this issue: It will be M/R's bi gest weekly effort to date.

Keep us posted on how we're doing: keep yo criticisms and suggestions coming. M/R is being edite for you . . . the Reader.

E. D. Muhlfeld
Assistant Publisher

PRECISION GYROS

A Proven Kearfott Capability. The increasing use of Kearfott gyros and gyro platforms in today's missile programs, underscores the company's leadership in gyro design and production. Such missile projects as the Atlas, Bomarc, Polaris, Snark, Subroc and Talos rely on Kearfott gyros or gyro platforms, as do the majority of manned aircraft now in service.

FLOATED RATE INTEGRATING GYROS. High accuracy miniature gyros specifically designed for missile use. The performance characteristics of these gyros are superior to any comparably-sized units available today. Hermetically sealed within a thermal jacket and ruggedly designed for adaptability to production methods. These gyros operate efficiently at unlimited altitudes. More precise performance characteristics can be provided in the same dimensions.



TYPICAL CHARACTERISTICS

Mass Unbalance:
Along Input Axis: 1.0°/hr maximum untrimmed
Standard Deviation (short term):
Azimuth Position: 0.05°/hr
Vertical Position: 0.03°/hr
Drift Rate Due to
Anisoelasticity: Steady Acceleration: .015°/hr./g² maximum
Vibratory Acceleration: .008°/hr./g² maximum

Damping:
Ratio of input angle to output angle is 0.2
Characteristic Time.
.0035 seconds or less.
Weight: 0.7 lbs.
Warm-up Time:
10 minutes from—60°F
Life:
1000 hours minimum

VERTICAL GYROS. Provide accurate vertical reference in the form of two 400 cps synchro signals proportional to the sine of gimbals' displacement about pitch and roll axes. Gravity-sensitive vertical reference device provides electrical signals directly to torque motors which maintain gyro spin axis perpendicular to earth's surface. Hermetically sealed, they are unaffected by sand, dust, sun, rain, salt spray, humidity or fungus conditions as specified in MIL-E-5272A.



TYPICAL CHARACTERISTICS

Repeatability to Established Vertical: To within a cone of half angle equal to 15 minutes of arc (± 8 minutes typical).
Free Drift Rate in 5 minutes Time: 2.5° maximum at room temperature. 3.75° at −54°C and + 71°C.
Erection Rate: 2.5°/Min.
Initial Erection: The gyro will erect to within ± 1° of established vertical in 60 seconds time after application of power at room temperature.
Vibration and Shock: The gyro will meet above characteristics after vibration of 0.060" total excursion cycling between 10 CPS and 55 CPS for 4.5 hours. Shock test in accordance with MIL-E-5272A Procedure 2.
Operating Life: 1000 hours minimum.

FREE GYROS. Provide extremely accurate reference in the form of electrical output signals proportional to displacements about outer axes. With 360° of freedom about outer axes (inner axis freedom depends on the unit involved), these gyros may be mounted to give output signals of either pitch, roll or yaw. Shock and vibration resistant, they are equipped with quick-starting motors for applications in high performance missiles and aircraft.



TYPICAL CHARACTERISTICS

Free Drift Rate: Within 0.5° in one minute time.
Shock: The gyro operates satisfactorily without damage after 60g shock of .015 seconds duration.
Hermetically Sealed: These instruments are hermetically sealed and are not affected by sand, dust, sunshine, rain, humidity or fungus conditions.
Operating Temperature Range: Gyros operate in ambient temperatures below −20°C to + 100°C. A maximum of 3 minutes of operation at 400°F will not damage these gyros nor impair their accuracy.
Weight: 5.5 lbs. approximately.

SPRING RESTRAINED RATE GYROS. Almost universally applicable in missile and aircraft designs demanding precise angular rate measurements in environments of extreme shock and vibration. Fluid filling provides added immunity to shock and vibration, reduces bearing friction in AC types and potentiometer wiper friction in DC types. Kearfott design advances permit 30 second warm-up, overcome fluid viscosity variations resulting from ambient temperature change. These gyros are single-degree-of-freedom, viscous damped, spring restrained, with gimbals supported by precision bearings. Compensatory damping mechanisms eliminate need for accessory heaters.



TYPICAL CHARACTERISTICS

Maximum Rate (°/sec.): 45-1000
Natural Undamped Frequency (cps) (± 10%). 16
Damping Ratio (of critical) over Temperature Range: .35 to .80
Operating Temperature Range (°F): −65 to +185
Vibration: 12 g's @ 20-2,000 cps
Shock (Motor Running): 60 g's for 6.5 milliseconds

Warmup Time (Sec.):	30
Weight (lbs.) (max):	1.5
Gyro Time Constant (Sec.):	.012

Engineers: Kearfott offers challenging opportunities in advanced component and system development



Roll Stabilized Directional Gyro



3 Gyro—4 Gimbal Gyro Reference



25 Pound Inertial Platform

Kearfott | A GENERAL PRECISION COMPANY

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation

Sales and Engineering Offices: 1500 Main Ave., Clifton, N. J
Midwest Office: 23 W. Calendar Ave., La Grange, Ill.
South Central Office: 6211 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vineda Avenue, Pasadena, Calif.

...NEWS IS HAPPENING AT NORTHROP

Demonstrating the platform of LINS – new, Lightweight Inertial Navigation System – is Dr. William F. Ballhaus, Vice President and General Manager of Nortronics.



NORTRONICS REVEALS LINS... COMPLETE PRECISION INERTIAL NAVIGATION SYSTEM!

A recent demonstration at Nortronics' Guidance Symposium revealed the most advanced precision inertial guidance system ever assembled. LINS – Lightweight Inertial Navigation System – includes platform, platform electronics, environmental control and computer. Total system weight: slightly in excess of 100 pounds. Equipment volume: less than three cubic feet.

Actual working hardware, LINS is a complete, precision system for automatic navigation applications to advanced aircraft, drones, missiles, and space vehicles. It is ready now – the latest result of Nortronics' more than twelve years of creative research and production in the field of automatic guidance and navigation systems.

If you have the need to know more – contact Nortronics today, regarding LINS for your own system requirement. Nortronics' experience offers unique and proven capabilities in tailoring the design, development and production of complete and integrated guidance systems to your requirements.

NORTRONICS

HAWTHORNE, CALIFORNIA

A Division of Northrop Corporation

JULY 13, 1959

JUL 1959
HOUSTON PUBLIC
LIBRARY
Houston, Texas



HONEST JOHN IN ITALY

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

ASA To Fight Budget Cuts 11
ston—'Hub' of Space Work ... 12
eport on Printed Circuitry 22

AN AMERICAN AVIATION PUBLICATION



STEPS IN THE RACE TO OUTER SPACE

Nuclear Rocketship

Despite the sky-high transportation costs, Lunar manufacturing should prove economically viable. With unlimited Solar power, controlled atmospheres and advanced automation, a considerable commerce could be realized in delicate instruments, rare minerals, reactor cores and other items that might be more efficiently processed or produced in the Moon's perfect vacuum.

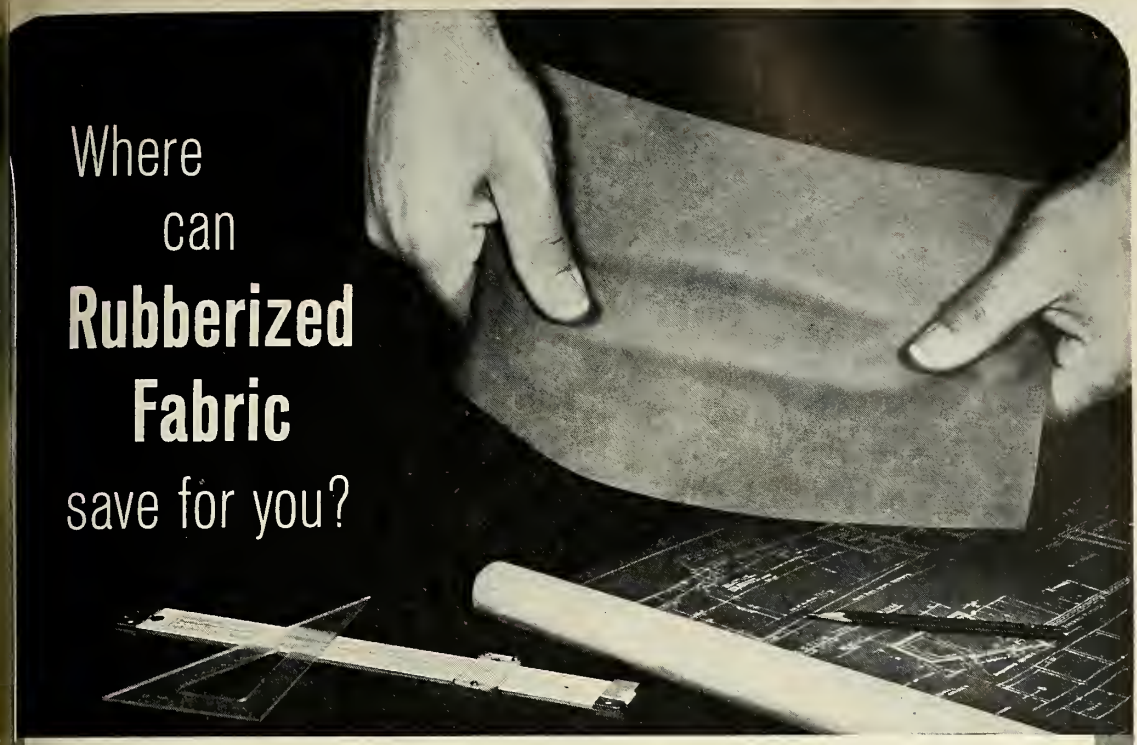
To supply the Moon colonists, and to carry their production back to Earth, special rocketships will be developed. Nuclear energy is the most promising source of propellant power. The ship shown here utilizes nuclear fission for heat and hydrogen gas as a working fuel. From pressurized tanks, the gas is fed through a heat exchanger, expanded, and expelled for the motive thrust.

When the craft leaves Earth, it carries only enough gas for a one-way trip. For, by extracting hydrogen and oxygen from Lunar rocks, Moon settlers will be able to refuel the rocketship for the return age. This will permit smaller fuel ta on the craft and larger payloads.

Inertial navigation systems will pla increasing role in the exploration of o space. ***ARMA***, now providing such tems for the Air Force ATLAS ICBM, be in the vanguard of the race to o space. ***ARMA*** . . . Garden City, N A Division of American Bosch Arma C

AMERICAN BOSCH ARMA CORPORATIO

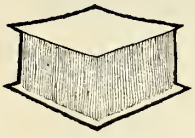
Where can **Rubberized Fabric** save for you?



Need strength, flexibility and portability in one lightweight material? Goodyear Rubberized Fabric may be your answer.

INFLATABLE, PORTABLE

Air Mat Fabric provides excellent insulation against heat, cold, vibration. Ideal for personnel shelters, portable scaffolding, shock cushioning. Beams made of this unique rubber-coated inflatable material have highest strength-to-weight ratio known.



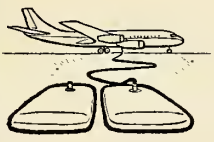
INFLATOPLANE

—another ingenious application of Air Mat Fabric. Pilot simply unfolds it, inflates it—and *flies away!* Do your plans call for a lightweight structural material that can be moved easily, occupies a bare minimum of storage space, can be erected quickly?



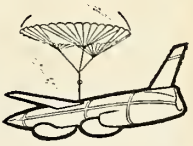
LOOK! COLLAPSIBLE FUEL TANKS

that unroll like a rug—can be set up, filled and pumping 45 minutes after delivery. Eliminates need for bulky, hard-to-handle metal drums. Designed for use wherever temporary or emergency storage of gasoline, oil, water—any bulk liquid—is required.



WANT TO BRING A MISSILE BACK?

Goodyear Recovery Bags—made of tough, rubberized fabric—fold into test missiles, inflate on way down to cushion ground impact. Saves the missile for firing another day, eliminates cost and weight of electronically operated conventional landing gear.



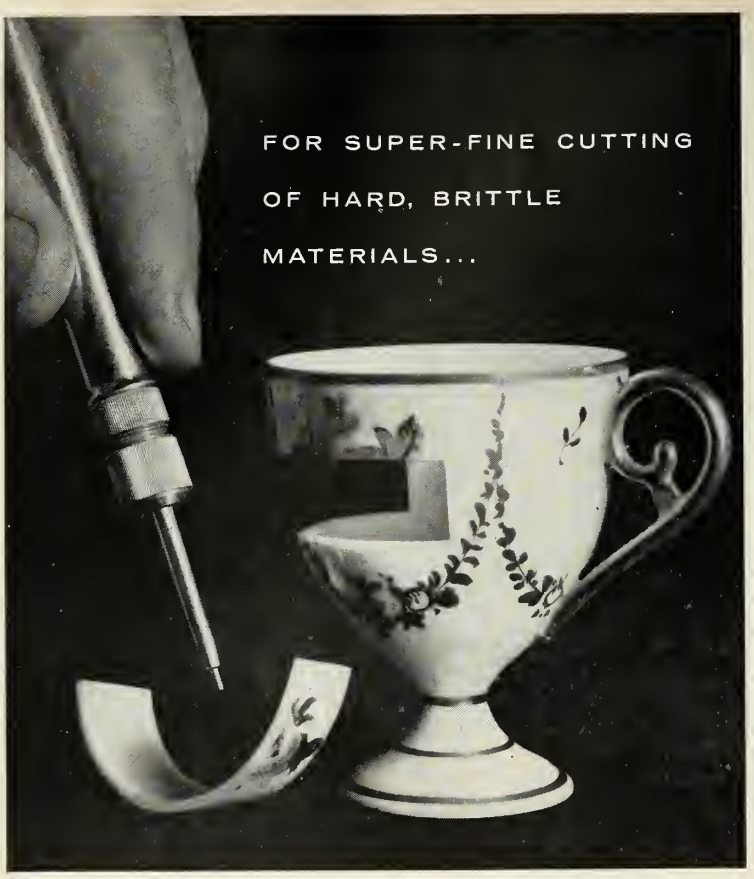
FOR DETAILED INFORMATION on rubberized fabric—and how it can save for you—write Goodyear, Aviation Products Division, Akron 16, Ohio, or Los Angeles 54, California.

AVIATION PRODUCTS BY

GOODYEAR

Inflatoplane—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

RE AIRCRAFT LAND ON GOODYEAR TIRES, WHEELS AND BRAKES THAN ON ANY OTHER KIND



THE S.S.White Industrial Airbrasive Unit

We don't recommend slicing up the family's fine Limoge China, but this does illustrate the precisely controlled cutting action of the S. S. White Airbrasive Unit. Note how clean the edge is, and how the delicate ceramic decoration is unharmed.

The secret of the Airbrasive is an accurate stream of non-toxic abrasive, gas-propelled through a small, easy-to-use nozzle. The result is a completely *cool* and *shockless* cutting or abrading of even the most fragile hard materials.

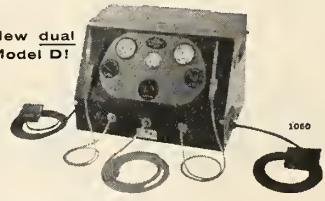
Airbrasive has amazing flexibility of operation in the lab or on an automated production line. Use the same tool to frost a large area *or* to make a cut as fine as .008"!...printed circuits...shaping and drilling of germanium and other crystals...deburring fine needles...cleaning off oxide coatings...wire-stripping potentiometers...engraving glass, minerals, ceramics. Jobs that were previously thought impossible are now being done.



Send us samples and specs on your difficult jobs and let us test them for you.

SEND FOR BULLETIN 5705A . . . complete information.

New dual Model DI



S.S.White

S. S. White Industrial Division
Dept. 20A, 10 East 40th Street, New York 16, N. Y.
Western Office: 1839 West Pico Boulevard, Los Angeles 6, California
Circle No. 1 on Subscriber Service Card.

Executive Editor .....CLARKE N
Managing Editor ....DONALD E.

NEWS STAFF
News Editor .....REED
Defense and Legislative .....BETTY JAM
West Coast .....RICHARD VAN
Copy Editor .....ERI
Editorial Assistant .....DAVID

ASTRIONICS
Guidance and Control ....CHARLES D.
Support Equipment .....HAL

ASTRONAUTICS ENGINEERING
Chemistry & Propulsion .....JAY
Astrodynamics .....PAUL

MISSILE SUPPORT
Installations and Equipment
East Coast .....WILLIAM E.
West Coast .....FRANK

BUREAUS
Los Angeles .....FRED
Paris .....JEAN-MARI
Geneva .....ANTHONY V

CONTRIBUTORS
British Astronautics .....G. V. E. TH
Propulsion .....MICHAEL
Industry .....JAMES J. HAGGE
Soviet Affairs .....DR. ALBER
Space Medicine .....DR. HUBERTUS ST
Astrophysics .....DR. I. M
Research .....HEYWARD CAN

ADVISORY BOARD
DR. WERNHER VON BRAUN . ROBERT P. F
DR. PETER CASTRUCCIO DR. ARTHUR KAN
KRAFFT EHRICKE DR. EUGEN
R. F. GOMPERTZ ALEXANDE

PRODUCTION AND ART
Art Director .....WILLIAM
Assistant Art Director .....BACIL
Production Manager .....J. F.
Ass't Production Manager .....ELS

BUSINESS STAFF
Assistant Publisher .....E. D. M
Advertising Sales Manager .....W. E.
Circulation Director .....L. L. F
Promotion Manager .....J. E.
Advtg. Service Manager ..MRS. GLADYS
New York
Eastern Advtg. Mgr. .....P. B.

ADVERTISING OFFICES
New York ..(17 East 48th St.) P. N. A A. B. S
Detroit ...(201 Stephenson Bldg.) K. J
Chicago .....(139 N. Clark St.) G. E
Los Angeles .(8929 Wilshire Blvd.) J. W C. R. M
Miami .....(208 Almeria Avenue) R. I
Toronto (12 Richmond St. E.) ALLIN AS
London .....(28 Bruce St.) NORALL
Paris .....11 Rue Co
Geneva .....10 Rue

Missiles and Rockets Volume 5 Numb

Published each Monday by American A Publications, Inc., 1001 Vermont Ave. Washington 5, D.C.

WAYNE W. PARRISH ....*President & P*
LEONARD A. EISERER *Executive Vice P & General M*
A. H. STACKPOLE .....*Vice P*
FRED HUNTER .....*Vice P*
ERIC BRAMLEY .....*Vice P*
ROBERT R. PARRISH .....*Vice P*

Printed at the Telegraph Press, Harrisb Second class postage paid at Washingto and at additional mailing offices. Co 1959, American Aviation Publications,

Subscription rates: U.S., Canada and Union Nations—1 year, $8.00; 2 years, 3 years, $14.00. Foreign—1 year, $10 years, $18.00; 3 years, $26.00. Single rate—$.75. Subscriptions are solicited from persons with identifiable comm or professional interests in missiles rockets. Subscription orders and chan address should be referred to Circu Fulfillment Mgr., M/R, 1001 Vermont Washington 5, D.C. Please allow 4 for change to become effective and e recent address label if possible.

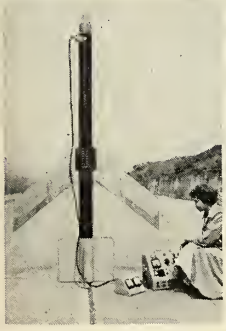
ABC AUDITED PAID CIRCULATION NBP READERSHIP Eastman RESEARCH



COVER: the *Honest John* is now in the hands of Italian NATO troops. U.S. soldiers remain in that country to operate two *Corporal* battalions (see p. 15).



BOSTON area is booming with plants like these, especially along Route 128, the "Golden Industrial Semicircle." M/R survey of dramatic growth begins on p. 12.



CHECKING electronic equipment of the new Armstrong Whitworth *Flutter Dart*, a British rocket test vehicle for investigating aircraft wing flutter (p. 18).



PRINTED circuit's original artwork is checked by a Ryan technician. An M/R survey shows big advances in technique (p. 22).

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

JULY 13 HEADLINES

NASA Braces for Fight to Restore House Budget Cuts
Space agency worries over effect on research and Project *Mercury* but has high hopes Senate will undo the slashes .. 11

Boston Works to Become the 'Hub' Of Space Research
Many millions are spent here on missile/space research and production. Second in a series of regional surveys 12

A Formula for Reliability—Put First Things First
An expert decries our misplaced emphasis on perfecting assemblies and urges priority for testing of materials 14

A Report from U.S. Missile Troops in Italy
Touring M/R Executive Editor Clarke Newlon writes from Vicenza 15

British Astronautics
Armstrong Whitworth unveils its *Flutter Dart* rocket test vehicle 18

The Air Force 'Integration' Effort in Weapon Systems
The Aeronautical Systems Center takes over management responsibility after a system is okayed for production 21

Soviets Launch and Recover Two Dogs and a Rabbit .. 45

ASTRONAUTICS ENGINEERING

ARPA Seeks 'Blue Sky' Defense Against Russian Missiles
More than $208 million has already been spent or earmarked for Project *Defender*—the search for something better than *Zeus*. Last of a two-part series 16

ASTRIONICS

Printed Circuitry Is Paying Dividends
A survey finds missile business has helped to spur rapid growth of circuits that enhance reliability, cut assembly costs and permit fast repair 22

MISSILE SUPPORT

DIGILOCK—A Big Step in Digital Telemetry
Space Electronics Corp.'s system offers digital advantages minus some of its drawbacks for missile applications 37

NEW MISSILE PRODUCTS

Linde's New 'Short-Arc' Welding Process 29

THE MISSILE WEEK

Washington Countdown 7
Industry Countdown 9
More About the Missile Week 43

DEPARTMENTS

People 42
Propulsion Engineering ...44
West Coast Industry 46
Contract Awards 47, 48
When and Where 49
Editorial 50



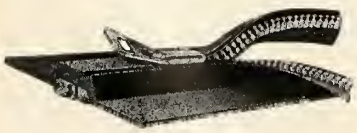
Zippered nose cone cover foils moisture, dust, abrasion

To protect the polished finish of missile nose cones from assembly to countdown, B. F. Goodrich fabricated unique zippered "all-weather" Nose Cone Covers for Avco's Research and Advanced Development Division.

Made from neoprene coated nylon fabric, this shipping cover has non-rigid neoprene ribs and spacers that keep it from riding down on the cone. Special B. F. Goodrich Pressure Sealing Zippers provide easy access and removal—yet seal positively against dust, dirt, grime, damaging impact.

B. F. Goodrich was asked to engineer this special project because of its widely-known ability to manufacture coated fabrics to any shape or size—as in aircraft baggage pa In addition, the space-saving B. F. Goodrich Zipper—u widely for air ducts, inspection ports, access doors, and aile gap seals—withstands any pressure up to the maxim strength of the zipper itself. And it, too, can be fitte complex contours.

Tricky sealing problems like this one are just part of day's work at B. F. Goodrich. Next time you have suc problem and need an answer—fast—write or call *B.F.Good Aviation Products, a division of The B.F.Goodrich Comp Dept. MR-79, Akron, Ohio.*



B.F.Goodrich ***aviation produc***

Circle No. 2 on Subscriber Service Card.

Washington Countdown

IN THE PENTAGON

A Lockheed *Polaris* . . .

is expected to be launched from a surface ship sometime within the next six weeks. The launching from a tube aboard the *Polaris* Test Ship Observation Island in the Atlantic probably will be preceded by the launching of a *Polaris* from a sea motion simulator at Cape Canaveral.

• • •

Meantime, wider use for *Polaris* . . .

is being stressed by Navy officials—apparently with an eye to hit at AF proposals to incorporate the *Polaris* system in SAC. Navy officials note *Polaris* subs will be able to perform patrol and ASW jobs while on station. Also, they plan to be able to launch *Polarises* from surface ships such as the new nuclear-powered cruiser Long Beach.

• • •

Two new Army missiles . . .

Davy Crockett and Convair's *Red Eye,* are reported being sought by the British Army. Both are light nuclear-warhead hurling weapons designed for the use of troops in the field.

• • •

A top-level Air Force committee . . .

is studying ways to tighten up the weapon system concept of management. The committee is particularly looking for ways to improve programming and possibly slow down the rotation of project officers.

• • •

Curtailment of operations . . .

at the sizable U.S. missile tracking base on Fernando Noronha Island off Brazil is reported to be in the works. Reason: Not enough data collected to justify the high cost.

• • •

Pentagon R&E Director Herbert York...

is trying to avoid some of the inter-service knife play that helped undercut onetime Missile Czar William Holaday. The ex-czar had only one military adviser representing all three services. York has appointed one military adviser from each service.

ON CAPITOL HILL

A major public airing . . .

of repeated delays in the nuclear-powered aircraft program is the goal of the Joint Atomic Energy Research Subcommittee's forthcoming hearings. The two-day open hearings—first on the ANP program since it began more than a decade ago—are expected to start about July 22. Subcommittee members are expected to charge the Administration with setting back three years the development of a nuclear-powered aircraft—a potential principal carrier of ALBM's.

• • •

The Hébert Subcommittee . . .

has called in a team of experts to compile results of its questionnaire poll of retired military and Federal civilian officials employed by defense contractors. Results are expected to begin to show up when the subcommittee calls in a parade of ex-military brass later this month.

• • •

The Martin *Mace-B* . . .

is now expected to survive the congressional ax after all. Language in the Senate version of the defense appropriations bill would permit the Air Force to get new funds for *Mace* under a general money transfer clause permitting the switching of money from other projects. The House probably will go along.

AT NASA

***Little* Joe, the poor man's *Atlas* . . .**

will be tested later this month at NASA's Wallops Island Test Center. *Little Joe,* which costs a sixth as much as an *Atlas,* is a cluster of six solid-propellant rockets capable of boosting a Project *Mercury* man-in-space capsule to a speed of about 4000-miles an hour for testing escape equipment.

AROUND TOWN

Some of the reports . . .

that are being passed as the "latest" in the nation's capital:

. . . Congressional Democrats are feeling the pinch of Democratic Advisory Committee demands for billions more for defense.

. . . The French are planning to build a huge missile range—probably in French West Africa.

. . . Some top Pentagon officers are warning that development of manned space vehicles is a life-or-death race with Russia.

A UNIQUE APPROACH TO INFRARED GUIDANCE

This precision spherometer measures a unique material developed at Hughes for infrared guidance. It can measure the curvature of the dome's surface to an accuracy of 10^{-6} meters.

The material tested is unique in that it is completely opaque in the visible region, yet transmits very well in the infrared. First application of this material to military equipment requirements was carried out at Hughes.

This project is just one of the advanced studies in all phases of radar, inertial and infrared guidance currently underway at Hughes Research & Development Laboratories.

Assignments in missile guidance now open include:

Physicists to conduct Radiation Detector Studies
E.E.'s for Experimental Circuit Design
E.E.'s for IR Systems Studies
E.E.'s for Servo Analysis and Simulation
Optical Designers

The salary structure for the above positions reflects the advan nature of the assignments. Please inquire by writing directly Dr. Allen Puckett, Assoc. Director, Hughes Systems Deve ment Laboratories.

the West's leader in advanced electronics **HUGHES** *Hughes Aircraft Company, Culver City 54, California*

© 1958, H.A.C.



Industry Countdown

All signs continue to point . . .
to **Boeing** as winner of the *Dyna-Soar* contract despite Air Force decision to delay making award. Indications are that the "further studies of various aspects of the program" announced by Air Force involve strong political pressure for greater spreading out of the big money package—particularly to firms that have suffered cutbacks in other programs.

STRUCTURES

France is cutting off . . .
production of **Sud Aviation** *4200* and *4500* ground-to-ground missiles and concentrating on development of a ground-to-ground ballistic missile. Work will be done at Sud's Cannes plant. Sud also is researching a strategic ballistic missile to be developed by SEREB.

• • •

Raytheon *Hawks* . . .
will be in large-scale production shortly. Assembly of the Army's operational anti-aircraft missile will begin late in the summer at the Red River Arsenal, Texarkana, where major components will be shipped from all over the nation. Guidance packages will come from **Raytheon's** Andover, Mass., plant; solid-fueled motors from **Aerojet-General's** Sacramento facility; frames from **Northrop Aircraft,** Anaheim; warhead from Iowa Ordnance Depot; and missile shipping containers from the **Williamson Co.,** Madison, Ind.

• • •

Production of advanced *Terriers* . . .
is under way at the **Convair**-operated Naval Industrial Reserve Ordnance Plant at Pomona, Calif. The new solid two-stage *Terriers* will be a major weapon in the Navy's missile arsenal. The new guided missile frigate Dewey will get it first.

• • •

Air Force now setting up . . .
precision calibration laboratories at many of its bases. About $6 million has been allocated for equipment and contracts have been let. Aim is for 168 of the labs ultimately. They will be utilized chiefly for maintaining accuracy of measurement for extremely close-tolerance missile components.

Under $2 million AF contract . . .
Lockheed Aircraft will build four 1400-mph F-104 jet fighters as missile target drones.

• • •

Navy interest in explosive forming . . .
of refractory metals is increasing. BuAer has awarded **Chromalloy Corp.** substantial contract to develop new techniques and practices in producing complicated shapes.

ELECTRONICS

Missile site survey unit . . .
is being formed by the Air Force at Orlando AFB to establish exact location of ICBM, IRBM and space vehicle launching. Data will be used to increase accuracy of plotting trajectories—and aid in predicting missile impact.

• • •

Funding for *Midas* and *Sentry* . . .
in Fiscal 1960 is now set. AF is putting $19.1 million into *Midas* ballistic missile early warning satellite and $4.45 million into *Sentry* recon satellite. *Midas* facilities are to be situated in remote area of the United Kingdom. **Convair** *Atlas* boosters will be used to put both systems in orbit.

PROPULSION

Avco Lycoming Division has won . . .
$6 million **Aerojet-General** contract to make second and third stage *Minuteman* motor chambers, and chambers for *Polaris.*

• • •

Theoretical studies . . .
of propellant sloshing and dynamic propellant tank deformation is part of a $1 million research assignment handed the Army Ordnance Missile Command by NASA. AOMC also will investigate celestial mechanics of missile and space vehicle trajectories and ablation effects.

• • •

More monopropellant research . . .
will be undertaken by **Stauffer Chemical.** Navy contract for $100,000 is third awarded the company by the services in high-energy field.

SPACE MEDICINE

Two-man space cabin simulator . . .
will be delivered in October to the new $10 million Air Force School of Aviation Medicine at Brooks AFB, San Antonio. School personnel are now in process of moving from old quarters across town at Randolph AFB.



AIRBORNE...NEW USAF T-38 TALON!

The T-38 Talon fills a vital requirement of the Air Training Command. It is a lightweight, low-cost aircraft in which our new generation of space age airmen can safely master the art of supersonic flight.

Pioneering a new Northrop family of economical manned aircraft for the space age, the Talon is a direct result of teamwork between Norair and suppliers. This T-38 Team that made the trainer a reality is now producing it under USAF contract at Hawthorne, California. Soon to follow is the N-156F multi-purpose fighter, American-designed for our free-world allies.

The T-38 Talon stands as the latest airborne evidence of Norair capability and production know-how. Norair's creative management further adds to the accomplishment by trimming production costs with methods that include PACE — the unique Performance And Cost Evaluation program; new and superior quality controls; and Norair-conceived, years-ahead production techniques.



NORAIR Hawthorne, California
A Division of ***NORTHROP CORPORATION***

Circle No. 3 on Subscriber Service Card.

NASA Braces To Fight Cuts

by Paul Means

VASHINGTON—Two Russian dogs ed Snowflake and Daring, and an med Russian rabbit could be A's best bet to rejuvenate Con-'s flagging interest in space re-ch.

The latest Soviet space experi- came after the House lopped 68 million from NASA's supple-al FY '59 and FY '60 budgets, just before the Senate began its erations.

Congress leaped into action after Russians orbited *Sputnik 1* in ber of 1957, claiming that the inistration had been stingy with e research money. NASA hopes the latest Russian experiment will arly shake Congress out of its ent lethargy.

• **What could happen**—If the space cy *has* to make do with $68 mil-less, it may mean that the whole A schedule for space research, in-ng Project *Mercury's* attempt to the first man in space, will have e revised.

Schedules for the big space boost-such as *Vega, Centaur, Nova,* and *rn,* will have to be lengthened so they do not run out of money. firings of *Vega,* expected in late), may have to be delayed.

he cut will also mean less space re-h, without the insurance in some of back-up shots in case the experiment fails.

• **One-two punch** — The House's t-face on money for space re-h culminated last week when the e Appropriations Committee d to cut the NASA budgets by 500,000. Committee member Rep. rt Thomas (D-Tex.) defended the by stating that NASA had more ey than it could spend wisely.

dding to space agency's woes was chnical point of order raised by H. R. Gross (R-Ia.) which elimi-d what was left of the $48,354,000 he NASA FY '59 supplemental. Gross pointed out that a recently d law forbids the House to appro-e money for NASA not "here-" authorized by the House Com-e on Sciences and Astronautics. Committee had authorized the lemental before the passage of the law (P. L. 8645) not "hereafter" as the language of the law requires.

The House then salvaged $18 million of Project *Mercury* R&D funds in the supplemental by tacking them onto FY '60 budget. Lost was $22,-725,000 for construction and equipment, bringing the total loss to the NASA budget to $68 million.

NASA officials are confident that the House space committee will either re-authorize the funds kicked out by Rep. Gross's technicality, or amend P. L. 8645 so that the words "hereafter" do not apply to their earlier authorization of this money.

• **The real danger**—What they are worried about is the $45,500,000 cut, which NASA Administrator Dr. Glennan warns will cripple efforts to establish U.S. leadership in space research.

NASA spokesmen point out that the $35,145,000 cut in R&D funding would severely cut into the funds available for the development of advanced systems, such as *Vega, Centaur, Nova,* and *Saturn.* They point out that $310 million of the $354 million NASA asked for in R&D money goes for fixed costs required to continue contractual obligations started in 1959, and to pay for operational costs of already ordered items.

To cut $35,145,000 out of the R&D budget—as the House has done—leaves NASA with only $8,305,500 for development of advanced systems. In order to re-balance the program, NASA scientists say they will have to delete scheduled space flights, slow down procurement of equipment for these flights, and delay important elements of the NASA flight program.

Such delays could have international repercussions as well as denying NASA scientists needed knowledge. The cut in Project *Mercury* R&D funds in the FY '59 supplemental by 10% will mean according to NASA spokesmen, a slowing down of the program, thereby jeopardizing the U.S.'s chance of being the first nation to place man in orbital space flight.

Other important programs, such as the meteorological and communications satellite programs, and nuclear engine research under Project *Rover,* may have to be delayed.

• **Tracking threatened** — Another cut NASA officials say the program cannot sustain is the $7,325,000 slash in the construction and equipment allocation. If the funds trimmed out by Rep. Gross's technicality are included, NASA's construction and equipment budget would be cut by $30,050,000.

Much of this money is needed for the Project *Mercury* tracking range, without which the astronauts cannot take their first ride into space. The importance of the new tracking facilities was underlined recently when NASA attempted to award the contract for construction and integration of the range by July 1.

The House cut also reduced the NASA proposed salaries and expenses budget by $3,030,000, which will deny the use of 100 new employees to the space agency. Many of the new NASA employees were to man the expanded worldwide tracking and observation installations.

• **Rock bottom**—NASA had pretty well wrung its budget dry before submitting it to Congress. In fact, some observers had felt that the NASA budget was too small, and that the space agency would have to ask for fore funds later in the year. (See M/R, April 20, page 24.) Dr. Glennan admitted as much in criticizing the House cut, stating that the Space Agency had learned that money for certain projects did not go as far as its had originally seemed it would.

NASA hopes for restorations of the House cuts rest first with the Senate Appropriations Committee, chairmanned by Sen. Carl Hayden (D-Ariz.) If the space agency gets by this hurdle, then action by the Senate as a whole and the Senate-House Conference will decide the budget's fate.

• **Friend in power**—A strong ally on the side of the space agency should be Senate Democratic Leader Lyndon Johnson of Texas, chairman of the Senate Aeronautical and Space Sciences Committee, which has already authorized the NASA budget in total, and an advocate of space research since the launching of *Sputnik 1.*

If the majority leader can swing the support of his party, then prospects are good that the NASA budget cuts will be restored. In the House, the Republicans in general favored the total NASA budget and the Democrats favored the cuts.

Boston—'Hub' of Space Research

Tracing the development of a proud city's leadership in many fields of the space race; a look at the famous 'Golden Semicircle'—second in a series of regional surveys

by William E. Howard

BOSTON—Few cities physically show the nation's explosive growth in missile/space manufacturing and research more than Boston—a culturally endowed community which long ago laid claim to being the "Hub of the Universe," and where industry today is in the process of making this extravagant boast come true.

The entire metropolitan area is rapidly emerging as the country's leading research center. Scientists in hundreds of laboratories are conceiving and putting together the sophisticated offensive and defensive weapons of tomorrow. And they are responsible for much of the brainwork going into astronautic systems which one day will enable man to explore space.

Nowhere is the magnitude of this fast-expanding activity more eye-arrestingly apparent than along a 65-mile stretch of superhighway skirting the city from north to south in a great arc. Down the length of this busy artery there already are more than 200 modern plants employing more than 30,000 persons.

This is Route 128—Boston's "Golden Industrial Semicircle." Less than 10 years ago, it did not exist. Route 128 was only a country road meandering through meadows and woods, and connecting suburbs.

Where there were pig farms only a few years ago, today "industrial parks" are springing up. Once-quiet towns are the scene of more development. Industrial brick and mortar investment alone is estimated at $140 million. The entire complex—including business and home development—is valued at more than $500 million, and the figure is increasing.

Land values have shot up from $1000 an acre to as much as $26,000—with plenty of takers. All segments of industry are represented in this booming new area. But electronics is far and away the most predominant.

• **Key to growth**—Originally, conversion of Route 128 into an expressway was conceived primarily as a way to divert traffic around Boston's congested streets. But by the time it was opened in 1951, developers were already making plans to attract new industry. Electronics manufacturers just beginning to open a vast new market were the first to see its advantages for locating efficient one-story plants—with the highway affording quick transportation and the historic old towns offering pleasant living.

Gravitation to Route 128 was slow at first. Then research took over, mushrooming the growth of the electronics industry and forcing the construction of new plant facilities. Concurrently, in the early '50's, came the development of missiles with their heavy electronic requirements.

One after the other, **Raytheon Mfg. Co., CBS Electronics, Sylvania Electric, Avco** and other well-known companies moved out to the new highway.

Paving the way for the migration were such real estate developers as the Boston firms of Cabot, Cabot & Forbes and R. M. Bradley & Co. They were the ones that launched the industrial park plan, offering in one package a ready-prepared site, well-located, and engineering facilities to design any type of plant for purchase or lease. Both firms are credited with contributing greatly to the orderly development of Route 128.

Thirteen industrial parks are either completed or in final construction stages and three more are being started. These parks are absorbing, too ever-mounting number of new spawned in the dawning of the Age.

Illustrative of what is happeni the case of **Itek Corp.** Founded two years ago by four Boston U sity engineers, Itek now has more 700 employes engaged in classifie connaissance satellite and other work. In quick order it bought plant on 128, leased 65,000 squar of the **Waltham Watch Co.** works is planning to build a laboratory 43-acre site in Lexington near "Golden Semicircle." Incidentally also has a new West Coast install

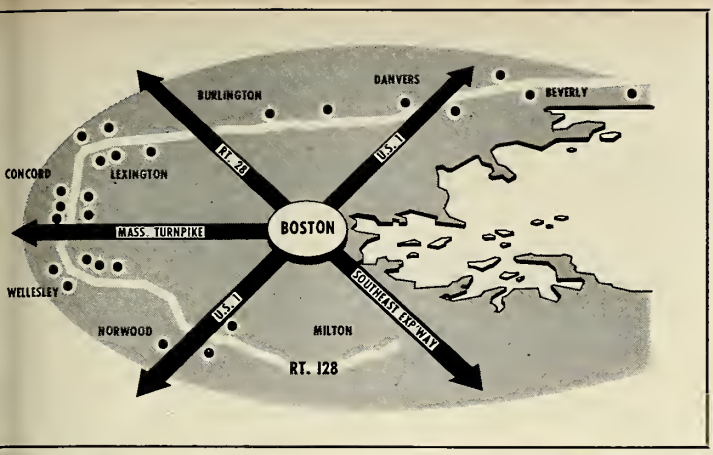
Another spectacular examp **Transitron.** Founded six years ago eight employes, it now has 3000- is the second-largest semicond producer in the nation.

In the past two years more $52 million has been poured int plants along Route 128—and opers feel there is room to doub present total. Visibly supporting optimism, the fabulous expansion keeps on accelerating.

• **Air Force millions**—Perha biggest single contributor to the ing boom—not only along 128 elsewhere in the metropolitan ar the Cambridge Research Center Air Force's Air Research and De ment Command. CRC has beer still is funneling millions of dollar research.

As of May 31, CRC had out ing 1199 contracts totalling $32 lion. Millions more in contracts duction and research—are being p into the area by the AMC, N ARPA, the Army and Navy, an vate industry as well.

• **The MIT influence**—Han



OF the Boston area shows some of the towns where many missile/space plants sprung up. More than 30,000 persons are employed along Route 128 alone.

with CRC as a font of new ideas, ledge—and industrial talent—is Massachusetts Institute of Tech- y. Scores of firms owe their exist- to MIT, through its creation of productive fields of research and sion of brains to work them. arvard and other Greater Boston utions also are producing a con- us stream of technical talent. n September, the **Mitre Corp.,** a n-profit organization which takes ame from MIT, will move into million plant at Bedford along e 128. Mitre, under a contract MIT, serves as the technical staff ie Air Defense System Integration ion working on correlating activi- f human operators with the com- electronic gear of SAGE. litre, which has H. Rowan Gaither airman of its board, expects to d to a $5 million facility and ually employ 1500 to 2000. The presently is located in Lexington, ironically, the liberty of the na- vas once entirely in the hands of human operators. On the village green 77 Minute Men armed with muskets fired on the British in 1775 in the first conflict of the Revolutionary War.

MIT made history at its Lincoln Laboratory along Route 128 by bouncing a signal off of Venus in February, 1958, when it was 28 million miles from earth, with a 90-ton radar telescope. It took a year to decipher the data, and the feat was disclosed only a few months ago.

From MIT's Instrumentation Laboratory, headed by Dr. Charles S. Draper, has come the all-inertial guidance system for *Titan*, which is being manufactured by **A. C. Spark Plug Division** of **General Motors,** and many more important contributions to the defense effort.

• **Within a decade**—Greater Boston Chamber of Commerce officials estimate there are more than 430 missile, electronics and nucleonics-connected industries—almost all founded within the past decade. These are scattered throughout the area. At last count, however, 63 were situated along Route 128.

One of the oldest research firms is the **Arthur D. Little Co.** of Cambridge, which among other items is deep in cryogenics and is preparing the design and specifications of MSE for fueling *Atlas* and *Titan*. **National Research Corp.,** also of Cambridge, has just come up with a new cryogenic storage vessel which has insulation improved by a factor of 15 over conventional devices.

At Waltham, **Infrared Industries** is producing missile guidance devices; at Lawrence, missile-carrying cases are being made by **Craig Systems;** and at Burlington, **Dynametrics Inc.** is hard at work on an Avco subcontract making measuring devices for *Titan* nose cones.

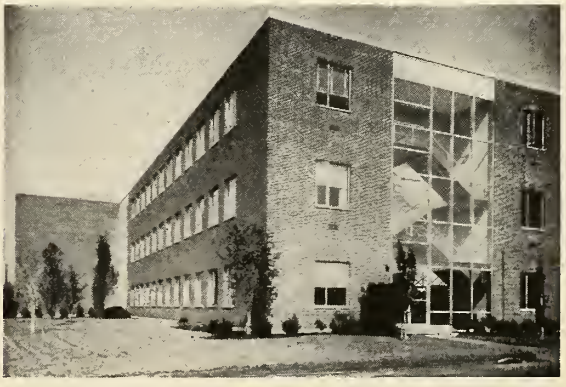
The activities of Greater Boston firms go into virtually every missile/space system, either as components or —as in the case of Raytheon, which has the prime contract for *Sparrow* and *Hawk*—the entire system.

The business scene shifts continually. **Bomac,** producer of Klystron tubes at Beverly, Mass., at the northern end of Route 128, recently merged with **Varian** of Palo Alto, Calif. **Texas Instruments** of Dallas has acquired **Metals & Controls Corp.** of Attleboro —the nation's first privately-owned nuclear fuel manufacturer.

Bostonians are looking to at least three firms to put them in the forefront of the space race. Avco at its new $23 million laboratory in Wilmington is working on interplanetary shockwave research and developing space systems. At the new **Goodrich-High Voltage Astronautics Inc.** in Burlington, work is being launched in development of ion propulsion engines. And at Raytheon engineers are working on a "sky station" which would hover miles above the earth in a fixed position—powered by microwaves beamed from the ground.



THAM Research & Development Park. Thirteen industrial are either finished or in final construction stages.



BUILDING AT the Arthur D. Little, Inc., West Cambridge Research Center, heavy in both cryogenics and major MSE.

First Things First— A Formula for Reliability

An expert decries our misplaced emphasis on perfecting assemblies and urges priority for materials

by John N. Dick
*(Colonel USAF, Ret.)**

WASHINGTON—A new word has made its way to the top of the vocabulary of modern weapon systems—the word RELIABILITY.

The concept of reliability as applied to military materiel is not new, of course, but with the coming of everyday missile firing and the approach of manned space travel, the word has assumed new importance. Contributing to awareness of the vital importance of component reliability have been:

• Serious and substantial failures of critical aircraft, rocket and missile missions, including some repeated failures of missiles considered to be operational.

• Recognition that the failure of one small and perhaps inexpensive part can abort a mission costing millions of dollars.

• The tremendously high costs of modern systems and equipment, including both astronomical initial cost and continuing high costs of maintenance.

Recognition of the necessity for reliability goes beyond the military, of course. Intense national interest has developed as a result of some spectacular and highly publicized missile failures, and as a natural by-product of the international race in space travel. As a result of this interest, accompanied by some concern and doubt as to our scientific and production capabilities, Congress has looked into these areas.

As their awareness of the critical nature of component reliability has grown, military materials suppliers have come to recognize reliability as a functional responsibility of organization.

Although reliability problems have been better defined and some praiseworthy efforts made to solve them, on the whole these efforts have been too sophisticated for complete success. The basic flaw is that the primary effort to insure reliability is applied at the wrong end of the complex weapon system program. Too much engineering time and attention have been devoted to perfecting an assembly of complicated components, and not enough to perfecting individual parts and—even more important—the basic materials themselves.

How effective is it to require 100% testing of component parts for reliability without fully appreciating and perfecting the specifications of the basic materials from which they are produced?

• **Misplaced emphasis**—Because of the knowledge, ability and experience of topflight aeronautical designers, the emphasis in missile design has been on sophisticated performance of very complex systems; not enough attention has been given to development of materials capable of such performance. A by-product of this misplaced emphasis is that much research and development effort is expended not in the laboratory but on the shop or factory floor—the least efficient and most expensive place for research and development.

Despite the excellent technical advice and assistance which commercial suppliers can provide the military in areas of metals, ceramics, chemicals and other materials and services, the systems designer and operator often have the impression that they must work only with whatever materials are in being. Except in the laboratories of some progressive suppliers, the concept of vigorous and thorough basic R&D of new materials, designed for spe and exacting performance requireme is not well-established. The resul "fire-fighting" system of stamping weaknesses and "crash programs" rected at troublesome areas boost terials costs and subtract from overall quality which could be obta with available funds.

If a broad solution to the prob is to be found, policy thinking al defense will have to be re-orier Basic research will be required to a better perspective on the system the future.

• **Present and future**—Immec solutions to the practical problem reliability will demand more atten (and surely more funds) for:

• More thorough study of the terials now in use in systems and c ponents.

• Determination of their stren and weaknesses, their full capabil and their shortcomings.

• Determination of the pre qualities required to make the mate more useful and the systems more liable.

• Determination of which mate are most likely to succeed as hardv and fuel in the Space Age.

• An aggressive research prog in those most likely to succeed, fle enough to change direction and em sis in the future.

Future solutions will require:

• Constant review of weapons defense systems—those in being, t in design and even those that are a wild gleam in some designer's eye

• Determination of extreme quirements of environment, invol temperature, stress, erosion, corro radiation, shock, friction, acous elements and expectable life of terials.

• Continuous review of all kn materials which show promise of solving any of the problems raise these environmental factors. Majo search effort should be applied in direction.

• A wedding of materials rese with fabrication research in orde achieve maximum results in both a

• Prospecting for new areas of terials research, keeping uppermo mind the environmental problems the directions of progress indicate accomplished research.

By putting first things first, by orienting our thinking to give a priority to basic materials research should eventually make it possible the systems designer to specify his terials requirements and fabric methods, and incorporate these ta made materials into his gimmick o morrow with a much higher degre reliability than he can achieve toc

*Washington District Manager Allegheny Ludlum Steel Corporation

Missile Troops in Italy

by Clarke Newlon

ıe following dispatch was sent Italy by M/R's Executive Editor, ouring Europe.

CENZA—The Western World's rmy missile command is stationed s part of NATO-earmarked forces are armed with obsolete weap- recently reduced in strength by and still a potent force because "mystery of atomic power."

ıe missile unit is part of the ern European Task Force AF) and operates under the and of Col. Melville B. Coburn. ıtil June of this year it had been with the *Corporal* missile and *onest John* rocket, both with nu- warheads. On June 30—by coin- e, perhaps, the end of the U.S. year—the two *Honest John* bat- were formally turned over to ılian army, which had been train- use them since Jan. 1. Simul- ısly, the command's personnel ut in half, from 4000 to 2000. he fact that we have obsolete least obsolescent weapons is not tant to the people of Italy," Co- said. "To them SETAF is a estation that there is an atomic in Italy and that it is here to It is a part of the mystery of power."

e recalled that last October his command loaded an *Honest John* wo USAF planes—a C-124 and 30—one carrying the rocket and her support equipment, and flew Salonika, Greece. There they fired th only a conventionally-loaded ad—at a target on the hillside.

Ve had no right to be that ac- ," said Coburn, "but we hit the dead center. The Greeks were ndously impressed that in just ours we had flown in and fired omic weapon. And when they us unload the rocket from the they were not at all sure it wasn't ningly atomic."

TAF itself is under the com- of Maj. Gen. John P. Daley and ated in Verona, some 33 miles Vicenza. In addition to the 1st Army Missile Command, it in- the SETAF Logistical Command rona.

Organized in 1955—In the spring 55 it became apparent that the an peace negotiations were headed l success, which meant the with- l of Allied troops from Austria. Thus NATO moved to create a new American military command in Italy as a defensive move to fill the void created by the neutralization of Austria, and SETAF came into being on Oct. 25, 1955.

The Missile Command still operates two battalions of *Corporals*, sky cavalry which would drop reconnaissance teams behind enemy lines in time of war, an engineering battalion and a signal company. It works with Italian forces to carry out atomic demolition. The area covered by the command is 175 miles broad and 100 miles deep, all of it roughly north of Vicenza.

Facing this area are the six passes over the Alps through which enemy invaders traditionally come. They are, from north to south, Resia, Brenner, Dobbiacs, St. Croce, Tarviso and Gorizia. The latter leads from the famed Ljubljana plains of Northern Yugoslavia.

In event of war, one of several major jobs facing the missile command would be demolition of these passes by atomic blasts. The Italians have the actual responsibility for destroying the passes, or making them impassable, but the missile command has control of the atomic demolition packages and the job of getting the Italian forces and the nuclear explosives to the scene.

To do this, the command has worked out three teams of three helicopters each. The first would carry the atomic store. This, it was revealed, weighs 1500 pounds, the same weight as the warhead of the *Corporal* and *Honest John*, regardless of what force the atomic blast may be. The second 'copter carries equipment and the third personnel.



MISSILEMEN of U.S. Army's 1st Missile Command, Southern European Task Force, supervise an Italian Army cadre servicing the *Honest John* solid-fueled rocket.

The Italians are expert, Col. Coburn said, in the art of destroying tunnels, bridges and roads. By boring a "room" some 40 feet into the side of a mountainside at just the right place to strike a "fault," they can, with the force behind an atomic blast, bring down the entire mountainside. Asked if they would close all the passes in the event of war, Coburn said, "Yes, if we were so directed."

• **Living by mobility**—The colonel feels that if war comes the primary job of his command is to stay alive by mobility. He said his force has shown that it can move the huge carriers of the *Corporal* and *Honest John* around the mountain roads of the extremely rough terrain of the area. In combat, the units would fire from one prelocated position and race to another, never firing twice from the same place.

Coburn said that each of the battalions turned over to the Italians was equipped with 254 *Honest John* rockets, but did not say whether all were nuclear-armed. The solid-fueled rocket weighs 5900 pounds; in a demonstration, an Italian Army team trucked one up, transferred it to the firing platform and theoretically fired it in about 10 minutes. It is fairly accurate at its 15.8-mile range.

The *Corporal,* two battalions of which the missile command retains, is fueled with nitric acid, aniline and compressed air. It is guided to the target by radar and has a range of 80 miles.

"The *Corporal,*" said Col. Coburn, "is either extremely accurate or horrible. And we're never quite sure which it will be."

Col. Coburn would like to have the *Sergeant,* a follow-on to the *Corporal* which is solid-fueled and much less complicated in its guidance system. In the event of war each of his battalions could get off four *Corporals* on the first day, if all went well, but only one each 12 hours thereafter, largely due to the preparation-for-firing complications.

• **Waiting for** *Pershing*—In addition to the *Sergeant,* which the colonel isn't counting on getting any time soon, he also has a great yearning for an 800-mile missile—typified perhaps by the *Pershing,* now under development by the Army, although its range will probably be more in the neighborhood of 500 miles at first.

ARPA Seeks 'Blue Sky' Defense Against Russian Missiles

More than $208 million has already been spent or earmarked for Project Defender—the search for something better than Zeus

by James Baar

"Come, we shall have some fun now!" thought Alice. "I'm glad they've begun asking riddles . . ."
—Alice's Adventures in Wonderland

WASHINGTON—Scratch a military man and he will tell you that sooner or later a relatively cheap and workable defense is found for every new weapon.

This is the faith that led the United States, through the Pentagon's Advanced Research Projects Agency, to put up $80 million in FY 1959 for research aimed at trying to find a "blue sky" defense against Soviet ICBM's.

The same faith encouraged the United States through ARPA to plan to throw another $128 million into the same program in FY 1960. As of now more than 30 private companies and institutions are taking part.

The program—called Project *Defender*—is of such fantastically increasing complexity that it makes such medieval problems as counting angels on the heads of pins appear easy by contrast. It involves study of such possibilities as death rays, anti-gravity machines and magnetic walls.

The glittering goal of the entire effort is the development of an ICBM defense that would be both much better and much cheaper than the Army's *Nike-Zeus*—the multibillion-dollar system being developed by **Western Electric** and **Bell Telephone Laboratories.**

The *Zeus* program is considered to be America's only chance to have an AICBM within the next eight to 10 years. It is scheduled to be operational in 1963.

• **In the dark**—"Maybe *Zeus* is the best kind of thing we can ever get," one top Pentagon scientist said recently. "But we feel there must be something else.

"We're like men in a pitch-black hallway looking for the key to a locked door. Maybe in the end we'll find there is no key at all. Or, maybe we'll find it in one of our pockets."

He shrugged and stared at a blackboard partly covered with half-erased formulas and sketches.

"You know, we really know so damn little about ICBM phenomena," he said. "That's what this research is all about. We're trying to find out more about it."

• **The fat pitch**—In its simplest form, the ICBM defense problem involves one nuclear-tipped ICBM hurtling toward you at a speed of Mach 24.

Let us say this ICBM is fired at you from Russia at 7 A.M. EST almost any day in 1961 as you sit down to eat breakfast in New York. It will arrive about 7:30, giving you hardly enough time to have a second cup of coffee.

However, you are not incapable of coping with this kind of threat to your breakfast and all future ones besides.

BMEWS, the huge radar system being constructed in Alaska and Greenland, is designed to alert you that an ICBM is on the way. Thanks to BMEWS, you would have about 20 minutes to do something about it.

If you had *Zeus* handy, which you won't in 1961, you could pick up the ICBM when it was about 10 minutes away with the powerful *Zeus* tracking radar.

The radar would feed tracking data into the big *Zeus* computer. That, in turn, would calculate the ICBM's trajectory, launch a *Zeus* at the correct moment and direct it to an i ception point.

You may now go finish your fee. But you won't do it in peace. have too much to worry about. ICBM threat is certain to get more complex.

• **Complications**—Russia is pected to have the capability to la a devastating ICBM attack on United States about 1962. More this capability is expected to incre and not just in numbers and relial

If the United States puts an o tional *Zeus* in the field in 1963, R is expected to be able to reply by ing the game a lot tougher.

Five or maybe 10 ICBM's cou fired at a target. Also, the sitt could be further confused by se along decoys of varying degre sophistication.

For example, the ICBM casing and engine can be blow after its propellant is exhausted, viding dozens of objects that w with the warhead along the sam jectory.

Some weight can be sacrific that balloons or somewhat heavie like decoys can be separated fro payload and follow the same traje

All of these would begin t their efficacy upon re-entry. But more weight could be sacrificed t vide heavier decoys which would late warheads re-entering the a phere.

Also, it may be possible to d low weight decoys capable of si ing a warhead both beyond and atmosphere.

Nor is this all.

• **And more complications**— payloads could be designed to

naff to confuse tracking. Warhead
it could be sacrificed to install
us types of electronic counter
ures equipment capable of jam-
and further confusing radar. And
type of radar shielding or absorb-
naterial may be developed.
inally, warheads can be divided
ght—and possibly their course can
tered. Instead of five or 10 war-
flashing toward a target, you
have 50 or 100 warheads pack-
actional yields all still more pow-
than the A-bombs that devastated
hima and Nagasaki.
ere then is the full threat: Space
ky are crowded with hundreds of
ts. All are flying the same ballistic
at Mach 24. Many possibly
e course. Score on score of them
ecoys. Dozens more contain va-
types of anti-radar equipment.
omewhere in this mass are scores
clear warheads.
is pattern of attack would occur
aneously over not one or two ci-
AC bases or industrial sites, but
eds.
RPA contends an attack of this
is fully possible by 1969—only
ears away. It contends many
s of it are possible before then.
ch an attack would confront a
se system with the extremely dif-
triple job of:
Fighting off the electronic count-
sures.
Detecting which among thou-
of speeding objects are heading
hich target.
Discriminating among all objects
g for a particular target to de-
e which are warheads that must
ercepted.
he only active defense alternative
aying this vast game of "war-
warhead who has the warhead"
prevent all of them from getting
gh.
any Pentagon experts agree that
could handle the early stages of
hreat with reasonable if costly
s. Army officials also contend
Zeus is flexible enough so that
threat becomes more and more
ex *Zeus* can be improved to meet
t here there is disagreement.
Something else—A number of
gon scientists believe that there
point beyond which the *Zeus*
computing system can not be
eably improved and the con-
use of *Zeus* would involve
omical costs. Therefore, they
d something else is needed. Here
's Project *Defender* begins.
efender, which absorbs about
of ARPA's annual effort, is
Harold N. Beveridge, formerly
erophysics Development. Dr.
rd Holbrook has been serving as assistant chief of ARPA's scientific missile defense branch while on leave from the **Rand Corp.** The program, in turn, is divided into seven areas including radar, interception, discrimination and advanced programs.

At present, the project's main work is to collect and evaluate large amounts of data on ICBM flight phenomena.

One way that this is being done is through minute observation of ICBM and IRBM flights from the Atlantic and Pacific Missile Ranges. ARPA maintains ships for this purpose off both the East and West Coasts.

Another way is through minute measurements of launchings of a special six-stage missile developed for ARPA by the National Aeronautics and Space Administration. It is capable of launching at relatively low cost a payload that re-enters the atmosphere at the speed of an ICBM. Launchings are being conducted at NASA's Wallops Island Test Center.

"We are looking for vulnerability," an ARPA official explained. "Where can we get at those warheads? How?"

• **Spending**—The 1959 ARPA budget provided $25 million for the study of missile flight phenomena. The 1960 budget provides $44,650,000.

Here are the budget figures for the program's three other major categories:

Identification and kill—$10,000,000 in FY '59, $17,600,000 in FY '60; radar and computing—$23,000,000 in FY '59, $35,250,000 in FY '60; exploratory research—$22,000,000 in FY '59, $30,600,000 in FY '60.

One of the most intriguing exploratory research projects is GLIPAR—the Guide Line Identification Program for Anti-Missile Research.

The first phase of the program—$1.5 million worth of contracts spread out among 12 firms—calls for thinking up and studying any "blue sky" idea that might lead within the next 20 years to an anti-missile weapon. The firms are to try to prove that the ideas are not feasible because they violate natural laws or some other permanent factor. Anything not rejected on these grounds will be considered for future investigation.

Meantime, ARPA has been conducting research and exploratory studies on such proposed anti-missile weapons as:

• Death Rays—The intense concentration of beams of electromagnetic radiation, causing incineration. A big drawback would be cost.

• Anti-Gravity—The search for some means to reverse the effect of gravity on an incoming ICBM. The missile and all other incoming objects would be hurled harmlessly into space.

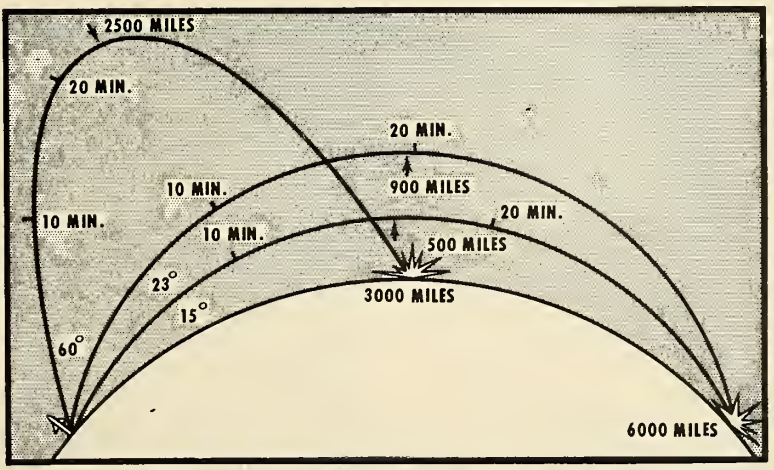
• Giant Shields—The creation of a magnetic shield through which warheads and decoys could not pass.

• AICBM Spacecraft—The stationing in orbit of a manned space craft from which ICBM's would be intercepted shortly after they are launched—when they are extremely vulnerable.

"Money is very important in all this," an ARPA official said. "We want something that costs us no more to use against an ICBM than it cost the enemy to launch the ICBM against us. Otherwise, if it costs us a million every time he spends $100, he'll ruin us."

Obviously the most desired goal is to find something that costs a lot less than the enemy must spend.

"Put it this way: We want something simple and cheap," one official said. "Ideally, if we could have a bunch of monkeys armed with .22's sitting around the enemy's ICBM bases waiting for launching, we'd be all set."



AN ICBM with a range of 6000 miles could have any one of these trajectories. Trajectories show amount of reaction time available for interception by AICBM.

BRITISH ASTRONAUTICS

- *Armstrong Whitworth's Flutter Dart*
- *Rocketdyne's Dixon on storable propellants*
- *Astronautical conferences coming up*

by G. V. E. Thompson

LONDON—A rocket test vehicle that offers substantial economies in the investigation of aircraft wing flutter has been developed by **Sir W. G. Armstrong Whitworth Aircraft Ltd.** of Baginton, Coventry. Named the *"Flutter Dart,"* this test vehicle was exhibited at the International Transistor Exhibition held in London recently. The vehicle shown had been recovered after a test flight.

Armstrong Whitworth carrying out research into the problems of supersonic airliners, decided that a method of studying wing flutter cheaper than wind tunnel testing was needed (A.W.'s high-speed tunnel costs about $300 an hour to run). Another advantage of the *Flutter Dart* is that the speeds which the missile can attain enable the wings to be tested to destruction.

The vehicle carries strain gauges, equipment for measuring movements of the wing and control surfaces at supersonic speeds, and transistor amplifiers. The performance data are radioed to the ground. The illustration shows *Flutter Dart*'s electronic equipment being checked at the Company's laboratories.

•**Storable propellents**—T. F. Dixon, Chief Engineer of the **Rocketdyne Division** of **North American Aviation,** addressed the Royal Aeronautical Society on storable propellants recently. He said that while most of the liquid fuels in current use—alcohols, hydrocarbons, amines and hydrazines—were stable and easily handled, the oxidants did not comply with the definition of a storable propellent—one which can be continuously stored in a missile in a state of instant readiness for relatively long periods of time without evaporating or corroding the containing structure.

The fuel with the highest performance per unit mass—liquid hydrogen—also did not meet these requirements and special equipment was needed for its liquefaction, storage and transportation.

Storable propellants in use or under development had sea level specific impulses of 263-294 sec., but this should be raised to around 380 sec. in the next five years.

The present importance of storable propellants lay in the necessity for keeping ballistic missiles in a state of instant readiness for operational use. Their importance to astronautics would grow in the future: space vehicles undertaking flights of some duration and needing to use rocket engines to alter course would have to be fitted with efficient storable propellant systems.

• **Mk. 2** *Thunderbird*—**English Electric's** Mk. 1 *Thunderbird* (M/R, June 29) is vulnerable to radar countermeasures. As reported earlier, a more advanced Mk. 2 missile is under development. This will probably be fitted with constant-wave radar guidance, making it practically immune to these countermeasures.

Other advantages of constant-wave over pulse radar are the reduction in signal-to-noise ratio, greater range, greater accuracy, and ability to deal with low-flying targets. Constant-wave guidance may also be used with the **Bristol/Ferranti** Mk. 2 *Bloodhound,* now being developed.

• **British Commonwealth Spaceflight Symposium**—When last summer the British Interplanetary Society agreed to organize the Tenth International Astronautical Congress of the IAF (to be held in London, 31 August to 5 September) it was realized that the presence of delegates from the various countries of the British Commonw would make it possible for them to and discuss astronautical matter common interest. The BIS ther decided to precede the IAF Con with a short Commonwealth Space Symposium.

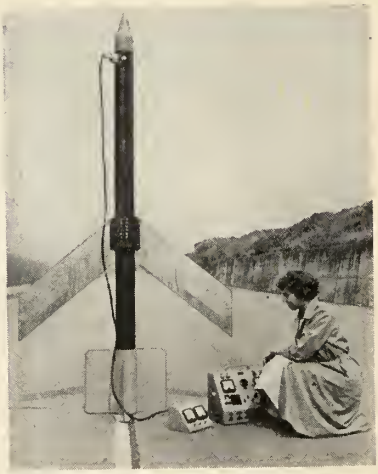
The decision of the British Go ment a few weeks ago to institu spaceflight programme has natu increased the interest in this sy sium, particularly as both industry the BIS consider that this progra is not ambitious enough. So man pers have been received from the craft and missile industry that i proved necessary to extend the posium to three days (27-29 Aug

At present the programme inc six papers from the Hawker-Sid Group **(Armstrong-Whitworth,** an **V. Roe),** two from the Indian A nautical Society, and one each **Bristol/Aerojet, de Havilland Pr lers,** Jodrell Bank Experimental St **Pye Ltd., Normalair Ltd.,** *The F cial Times,* University College Lo the College of Aeronautics, anc Weapons Research Establishment tralian Ministry of Supply). Other tributions are expected from C and New Zealand, and there wi a guest speaker from the U.S.

• **Missile salesmanship**—An rial in the London *Daily Herald,* paper of the British Labour criticized the country's missile aircraft sales methods. It said despite British achievement claimed by Western experts at the Air Show, "firms could not co against America's 'salesmen in uni and at the same time fight the a that the British Government and tary top brass show towards wi new orders."

The U.S.A.F. produced a Force" at the show complete command post, white-belted m police and massive equipment to American aircraft and missiles. In trast, Britain sent a Royal Ar captain and six gunners to demon the English Electric *Thunderbir* only when the firm had agreed t all the soldiers' expenses for the

Few orders came to British but U.S. sales were good.



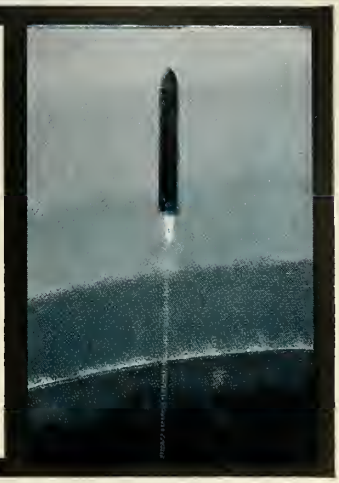
CHECKING electronic equipment of the Armstrong Whitworth *Flutter Dart.*

To further serve the diversified missile industry

NNESOTA MINING and MANUFACTURING COMPANY

announces and offers the services of its

MISSILE INDUSTRY LIAISON



More than 27,000 products are manufactured by Minnesota Mining and Manufacturing—the 3M Company. Every day, more and more 3M products are playing important parts in missile and space operations.

The technical and sales staffs of some fifteen 3M divisions, subsidiaries and groups make daily contacts with missile manufacturers and subcontractors. Their efforts are implemented by 22 divisional and four staff research laboratories.

However, like the missile industry, the 3M Company is a growing *and a diversified* operation. The use of 3M products and capabilities increases every day.

To further serve this growing, diversified industry, 3M has formed the Missile Industry Liaison. This group, staffed by technical personnel experienced in rocket propulsion and other phases of space technology, is well qualified to translate *your problems* to those 3M specialists in your field of interest. Too, information on all 3M Company products—or interests applicable to missile research, development or production—is thus available to you through *one* convenient source.

For a cross-section view of 3M Company products for the industry, send for your free copy of the brochure "Products and Capabilities." Write: Missile Industry Liaison, 402 McKnight Road, St. Paul 6, Minnesota.

The Missile Industry Liaison is associated with these 3M divisions and subsidiaries:

Zenith Plastics Company
Reinforced Plastics Division
Electrical Products
American Lava Corporation
Irvington Division
Mica Insulator Division
Magnetic Products Division
Central Research Group
Mincom Division
Duplicating Products Division
Reflective Products Division
Industrial Trades Tape Division
Mid-States Gummed Paper Division
Chemical Division
Adhesives, Coatings, and Sealers Division

For more information on 3M products, contact your 3M representative or the Missile Industry Liaison, 402 McKnight Road, St. Paul 6, Minn.

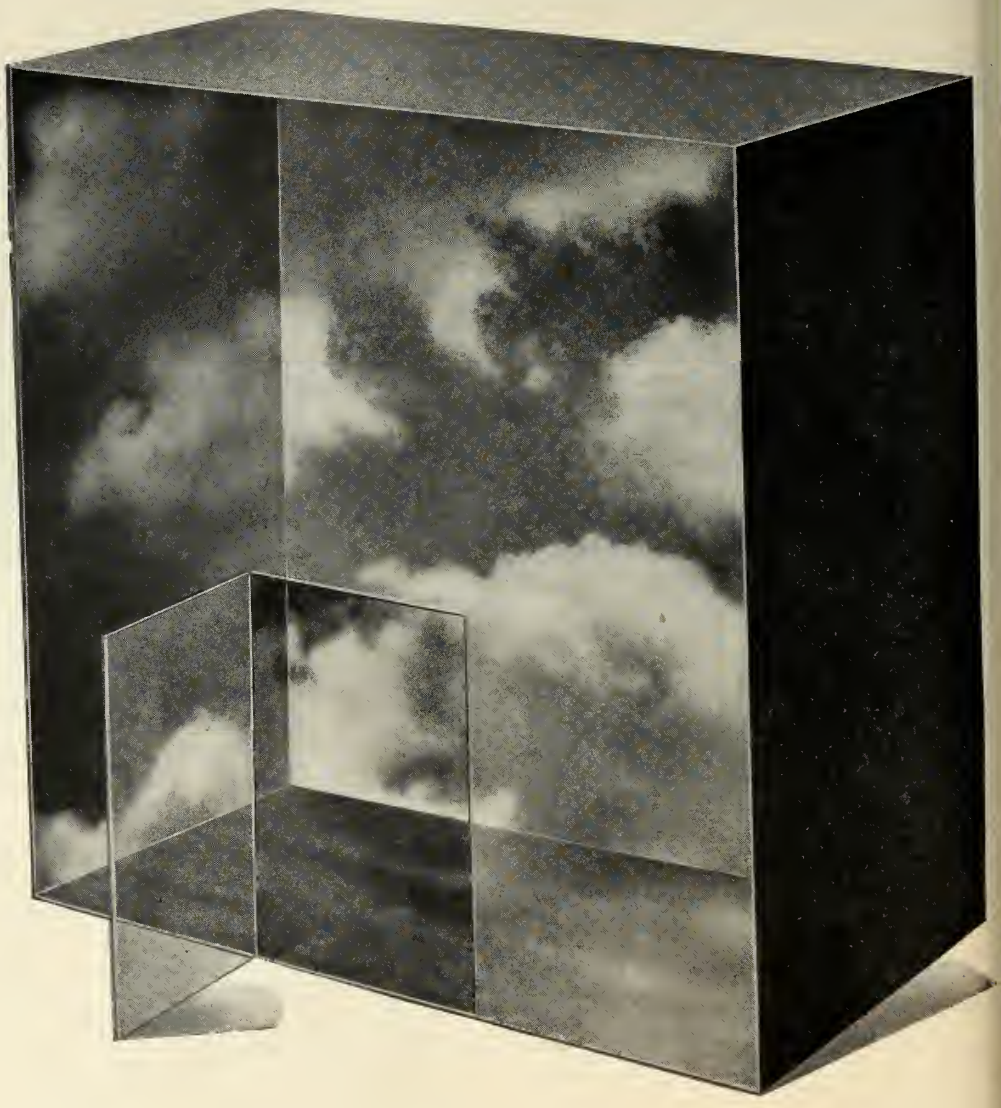
INNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

MISSILE INDUSTRY LIAISON

Circle No. 4 on Subscriber Service Card.

B.F.Goodrich



Bring the wild blue yonder indoors...

If you have to figure what happens up there . . . you'll come considerably closer by tes
with B.F.Goodrich Microwave Absorbents. The specifications and details are many. Suffic
to say—*all* the information is in a comprehensive new booklet. Write to The B.F.Good
Company, 585 Derby Place, Shelton, Connecticut.

B.F.Goodrich ***microwave absorbents***

Circle No. 5 on Subscriber Service Card.

The AF's 'Integration' Approach

How the Aeronautical Systems Center moves into responsibility for management of a weapon system after a decision is reached putting it into production

by Betty Oswald

WASHINGTON—"Integration," a word quently in the news, has a very ial meaning in the Air Force. It s not with race relations but with equally difficult job of fitting to- er all of the jigsaw pieces of a on system. It deals also with the of welding into a smooth-running all of the divergent interests h must be considered in converting eapon system into an operational on in the hands of the troops.

We have seen in earlier M/R stor- hat the instrument of integration is Weapon System Phasing Group and Weapon System Project Office, aged in its early phases by Air arch and Development Command in later stages by the Aeronau- Systems Center of the Air Ma- l Command.

• **Enter ASC**—ASC comes into the re as manager of the integration t only when a decision is made the weapon system has reached int warranting a production order. latively new organization, ASC is operating arm of Air Materiel mand in all areas except ballistic iles.

This means it handles management e weapon system during the period production for inventory. In the er phases, when ARDC has execu- management responsibility, the r agency is still responsible for urement. The key man during this e is the contracting officer respon- for the contract—how it is writ- and what it contains. He is as- d to the weapon system project e.

n some cases, the prime weapon m contractor is made responsible certain subsystem development or production. In such cases ASC ws proposed subsystem sources, g a subcontract advisory panel, to re maximum consideration of the rience and technical programs of AF and industry. Review involves questions as the technical capa- y of the subcontractor; manage- t approach to development and test; luction capabilities and facilities; performance in meeting schedules; quality control; overall company management structure and costs.

• **AF control**—AF reserves the right to reject the contractor's recommendations. As soon as possible, a decision is reached on so-called "make or buy" plans which involve such questions as maximum utilization of available industry capacity; minimum acquisition of new Government facilities; maximum use of specialized industries; maintenance, if possible, of a healthy basic aeronautical industry; maximum competition; utilization of small business to the greatest extent practicable; maximum use of standardized components, and elimination of unnecessary duplication of development. After they're agreed on, these plans can't be changed without prior AF approval.

Once this is done, AF keeps its finger in day-to-day management of the project. Each contract is assigned to an administrative contracting officer who—in the case of a major contract—will normally be in an AF plant representative office at the contractor's plant, to which specialists in cost analysis, quality control, production, property administration and audit are assigned.

His link at headquarters is the Weapon System Project Office at ASC. Headed by Maj. Gen. Beverly H. Warren, the organization is composed of seven directorates: contract support; logistic support; strategic systems; air defense systems; tactical and support systems; equipment and services, and the directorate of resources.

In addition, Gen. Warren has under his command the Aircraft Production Resources Agency on which representatives of the Army, Navy and AF serve. This agency's job is to schedule production of what have been termed "aircraft common components" and to be sure that the necessary materials are available.

Also part of Warren's organization are a program and analysis office and an office which provides management services.

• **How it's divided**—Under the directorate of strategic systems are weapon system project offices for the B-52H, the B-58, and the KC-135 tanker, for which ASC has executive management responsibility. In addition, there are Weapon System Project Offices for the B-70, for which ARDC is responsible, as well as undescribed advanced systems, strategic missiles (air breathers) and the *GAM 77/72—Hound Dog* and *Quail.*

Weapon System Project Offices reporting to the directorate of air defense systems include: F-106, F-101, F-108, *Bomarc* and drones. In the directorate of tactical and support systems, there are Weapon System Project Offices for the F-105 Thunderchief, transports, trainers, F-104, Star Fighter, tactical missiles and helicopter liaison.

The directorate of equipment and services is divided into divisions including accessories, weapons guidance, propulsion, communications and reconnaissance, specialized procurement, and Government-furnished aircraft equipment (GFAE).

The directorate of resources is responsible for industrial facilities, manufacturing methods (breaking the producibility barrier) and materials control.

• **Beefing up**—Actually, the idea of the Weapon System Project Office is not new. What is new is the way that the office has been beefed up in importance to serve as a focal point in the cradle-to-grave support of the weapon system.

This means among other things that while the program is in its research and development phase, as well as in the production phase, such requirements as maintenance and supply, along with training and operations, are cranked into the Weapon System Project Office—to provide an operational system which is entirely maintainable at the earliest possible time.

It also means that when the weapon system finally passes through production and the problems are only those of logistic support and maintenance, executive management responsibility moves out of Dayton to one of the Air Materiel Areas which have been given responsibility for support (spares, etc.) and maintenance of the weapons.

Even then, ASC and ARDC handle such questions as product improvement and technical failures.

Printed Circuitry Pays Dividends

An M/R survey finds missile business has helped to spur rapid growth of circuits that enhance reliability, cut assembly costs and permit fast repair

by Charles D. LaFond

WASHINGTON—The growing trend toward miniaturizing and modularizing electronic equipments, particularly in the missile industry, has brought rapid development of small, highly compact wiring assemblies, known throughout the industry as printed or etched circuits.

Although these circuits were not originally developed for direct application to missiles, certainly the missile business has provided a goodly share of the incentive needed to promote their growth.

The need for lightweight, extremely compact electronic equipment in miniature and subminiature assemblies called for something other than heavy bundles of inter-connecting cables and wires. New techniques have evolved better products, and new equipment for the production of printed circuits has resulted from this increasing effort throughout industry. Along with the increasing need for microminiaturization, industry has kept up with its small printed circuit cards.

The use of printed circuits has aided equipment design improvement and has greatly helped to increase reliability and cut assembly costs of complex equipment. At the same time, the new and equally complex packaging has contributed to improved component mobility. In addition, of course, modularization simplifies maintenance, increases equipment flexibility through rapid interchangability of units, and in general permits rapid repair in almost any system.

Besides its other physical attributes, probably one of the strongest arguments for the use of printed circuitry in missiles and rockets is its inherent ability to withstand heavy vibration and shock. A most troublesome area in conventional wiring is separation of soldered joints under an environment of high vibration or sudden shock. With the passage of time and the normal acquisition by manufacturers of increased experience, quality products are now available that employ almost unheard-of tolerances. New techniques permit high reproducibility, faster and cheaper.

MISSILES AND ROCKETS recently conducted an industry survey to determine progress in the field of printed circuitry in the past year. Here are some of the highlights of the survey returns.

• **Printed circuit usage—Burroughs' Military Electronic Computer Division,** a prominent manufacturer and user of printed circuitry, produces between 30,000 and 40,000 circuit boards per month. This is extremely high volume production, yet Burroughs maintains that to date they have not had to replace a printed circuit card in any device now in use in the field.

An indication as to just how much printed circuitry is in use is revealed by Burroughs's estimate of 95% for the equipment they produce. A company spokesman said, "We range the AN/FST-2 in SAGE, which about 65% printed circuits, to the ground guidance computer which ploys about 95%.

"In some equipment, the circuit are entirely by printed boards. Some our basic design equipment does contain printed circuit cards, but new models do, as well as the peripl devices linked to them."

• **Microminiaturization**—Alth actual application is still highly cl fied, Burroughs Research Cente Paoli, Pa., has indicated that it is microminiaturized blocks extensivel research and development and ex to make heavy use of equipment reduction techniques in the future. One spokesman went so as to say, "in ten years, you won't anything but micromodularization electronic equipment.

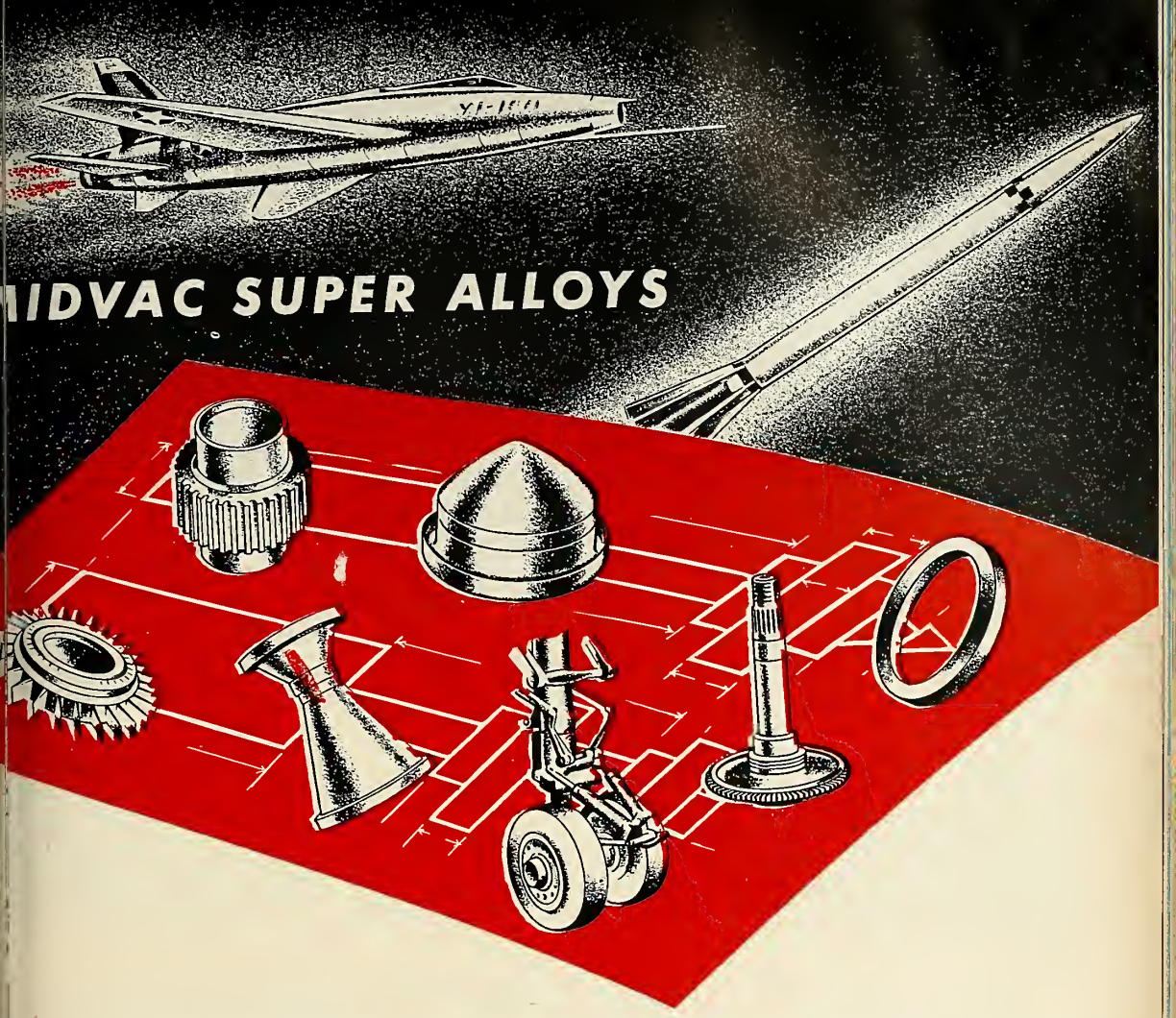
The company's new packaging t nique, which increases a module ca ity to 300 components per cubic i was revealed here last week at the stitute of Radio Engineers' 1959 tary Electronics Conference. The roughs high-density packaging achieved through "macro-modula tion" of components already mi miniaturized.

The new stacking technique, w decreasing total packaging volume available surface areas, provides munity to thermal and physical sh in environmental conditions. The c pany has also indicated that along these attributes circuit interconnec and power input requirements been controlled in equipment des

In Table 1, comparative specif tions for three recent data processor



NEW TECHNIQUE by Burroughs Corp. in micro-miniaturization of electronic components. The small wafer was miniaturized from a printed circuit board some 20 to 30 times larger.



OLVING MODERN DESIGN SPECIFICATIONS

Parts for Missiles—Rockets—Jet Engines are constantly calling for newer alloys to operate at higher temperatures. Alloys made by the Midvac process of consumable electrode melting are currently answering these needs and new ones are being developed in anticipation of more critical operations.

Midvac Alloys insure increased tensile and impact properties, improved stress rupture strength at elevated temperature, and longer fatigue life.

Standard commercial alloys can also be made with increased cleanliness resulting in higher properties than have been available under conventional means.

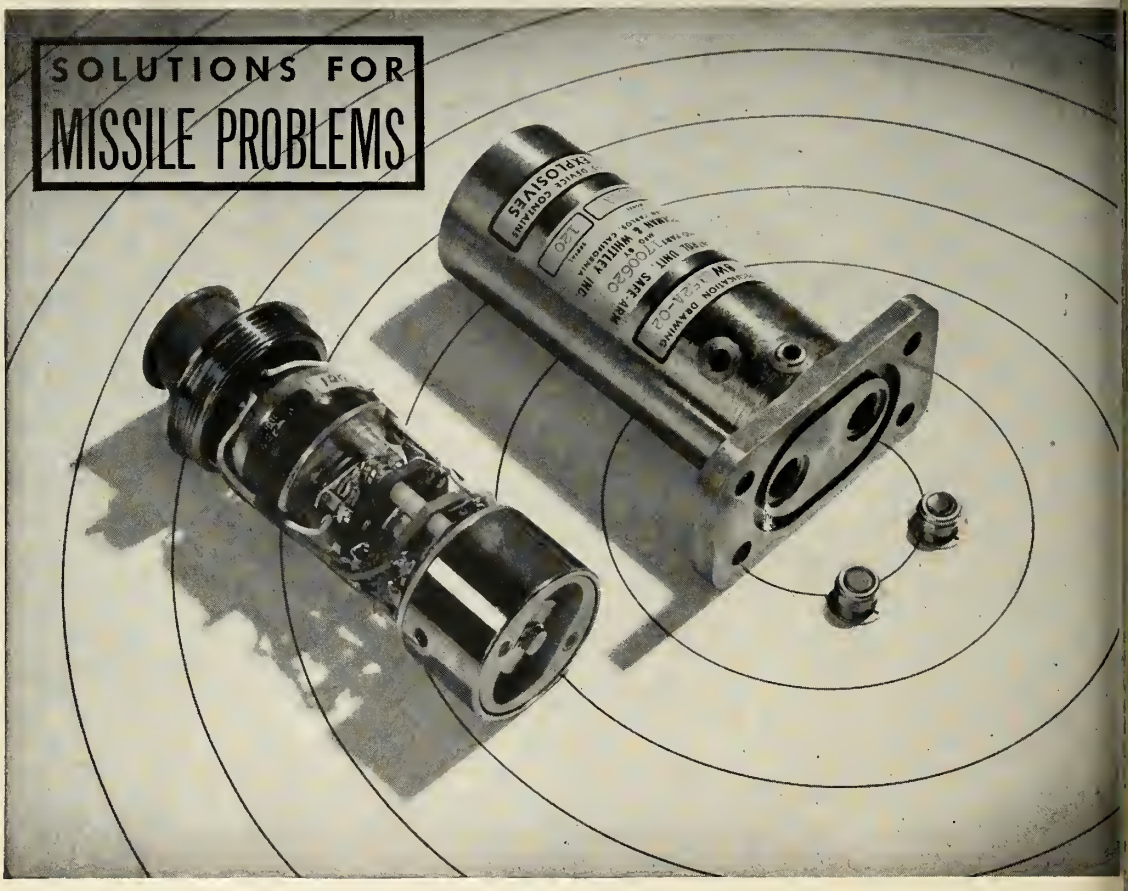
Offered in ingots, billets or forgings for the production of missile combustion chambers, tail cone assemblies, jet engine parts, aircraft landing gear components or any other parts requiring properties beyond the capabilities of conventional steels.

MidVac Steels

MIDVALE-HEPPENSTALL CO., NICETOWN, PHILADELPHIA 40, PA.

Subsidiary of HEPPENSTALL COMPANY, Pittsburgh, Pa.

Circle No. 6 on Subscriber Service Card.



safe/arm initiators

Ten years of pioneering in the missile component field has made possible this new line of Beckman & Whitley solenoid-operated safe/arm explosive initiators. Unit on the left has cover removed to show internal arrangement.

Weighing only 1.85 lb loaded, this model is 5 in. by 3 in. by 1¾ in. It was designed to military requirements. It can be armed or disarmed by remote electrical signal and includes both visual and electrical telemetering facilities for indication of armed or disarmed condition. On reception of a command firing signal, the unit will initiate associated primacord, low-energy detonating cord, (LEDC) or bulk charges.

This may be just what you need. On the other hand, Beckman & Whitley can provide the engineering capability, the production facilities, and perhaps most important, the speed necessary to give you anything you *do* need in the line of propellant-actuated devices.

Just tell us your problem.

Beckman & Whitley INC.

SAN CARLOS 16, CALIFORNIA

Circle No. 7 on Subscriber Service Card.

ariety of approaches

lopments at Burroughs are shown to ustrate the evolution in miniatur- ng systems. Note that the tempera- re rise from 55°C to 100°C was ac- mpanied by a power increase from 0 watts to 2200 watts.

To achieve 100°C operation, sili- n transistors were employed effect- g a power input rise. At the same ne power dissipation increased, vol- ne decreased (it should be noted that e increased concentration of power ssipation per cubic foot was solved this instance by integrating an effi- nt heat exchanger into the overall uipment design).

A basic design philosophy held by e company is that the circuit must be ilt essentially in two dimensions, with e system being in the third dimen- n. In the macro-module technique, e true two-dimensional form is ughly maintained. As components d circuitry become smaller, this in- -connection technique may prove to the principal element in a given com- x assembly. By retaining the third mension for the system, with con- uing miniaturization, this dimension comes largely available for system ring.

As a result of the macro-module chnique, they have achieved a quick oduction capability, principally be- use the design permits the acceptance components from many vendors. ese components can be tested prior assembly into circuits and the cir- its can be assembled prior to final sembly. The final assembly then can tested before the complete unit is aled.

• **ITT's approach**—Another pioneer the development of miniaturized stems employing printed circuits is e **International Telephone and Tele- aph Laboratories.** Since missile pay- ads require extensive weight and e reduction in electronic units, this mpany has taken the approach that mponents, because of microminiatur- ation, will have to be produced with improved ability to withstand high mperatures. The smaller size for heat ssipating components such as resis-



ORIGINAL artwork for printed circuits in sub-miniature assemblies is drawn twice desired size, reduced photographically. Ryan technician checks camera.

tors implies a need for materials having greater heat stability.

ITT believes that the increased use of small semiconductor devices because of their very rapid development has gone far ahead of the normal evolutionary size reduction of resistors, capacitors, etc. The problem is that these components are still scaled and sized to accommodate vacuum tubes.

Based on their early experience with small printed circuit amplifiers for time proximity fuses, the ITT Missile and Space Systems Laboratory has been employing similar techniques to develop printed circuits, and small components for use with them, to a point of reliability and practicability acceptable for missile and space usage.

The Lab chose as its starting point its DOVAP telemetering sub-carrier oscillator. This is a transponder in wide use in missile testing as a doppler-measuring, projectory data-gathering system. The resulting metamorphosis in the sub-carrier oscillator from the conventional wire version to the final subminiature printed component device that has resulted from their efforts is shown in the photo at top of page 26.

To achieve this great reduction in size, new equipment for the production of carbon composition printed resistors had to be constructed. Work is still continuing at the Laboratory in developing techniques for the practical fabrication of printed subminiature circuits.

Because resistors constitute more than 50% of the circuit components in general, a major effort has been assigned to the area of subminiature carbon composition and metal film resistors. There are other attributes of printed resistors beyond that of mere size reduction. Resistors in a similar range can be printed several at a time. They need not be inserted into a circuit and the size may be almost a strict function of dissipation required. The lab also believes that printed resistors offer maximum potential for completely automated production. In addition, printed resistors need not be handled—a primary reason why, in their opinion, conventionally designed small resistors do not enjoy wide application.

• **High-quality production—Avion-Alexandria,** a division of **ACF Industries, Inc.,** has had its own printed circuit facility in operation for four years. Of prime concern to the company has been development of processes aimed at producing unusually high quality etched boards.

To achieve this, the company has developed what it believes is better-than-usual processing equipment. The results are best shown by an example of the tolerances achieved in production: spacings ±0.001 in. conductor widths and lengths ±0.002 in.; registry front and back ±0.002 in.

In addition to normal printed circuit boards and assemblies, the company has developed high-quality printed circuit techniques for rf stripline components including filters, couplers, and power dividers.

• **Advanced facilities—Ryan Aeronautical Company's** latest—and most modern in equipment—is a new photographic facility designed and equipped especially for manufacturing printed circuitry.

Since printed circuits must be treated, by means of photographic processes, to enable the narrow silver-plated lines to conduct electric currents, Ryan considers the new photographic unit a necessity for its missile subsystems. The facility was planned and equipped for the express purpose of manufacturing etched boards with the greatest dispatch and accuracy.

Highly compact, the photographic unit covers only 364 square feet of space. Windowless, to eliminate drafts and dust and to keep out the fluorescent

COMPUTER / SPECIFICATION	I	II	III
No. of Components	32,559	39,809	30,000 Approx.
Volume	500 Cu./Ft.	13 Cu./Ft.	3.5 Cu./Ft.
Power Required	1 K Watt	850 Watts	2200 Watts
Operating Temp.	24°—27° C	55° C	100° C
Clock Rate	210 KC	1.4 mc	1.3 mc
Add Time	50 Micro Sec.	25 Micro Sec.	10 Micro Sec.
Multiply Time	512 Micro Sec.	75 Micro Sec.	40 Micro Sec.

light of the adjoining electronics laboratory, the unit is air- and temperature-conditioned. Its construction is such that hallways and shielded doors completely screen off light and activity in one room from light-sensitive work going on in another room. The whole facility is operated as a "clean" room.

The precision photography applied to intricate miniature boards is achieved with a select collection of equipment—$7000 worth of the finest industrial photographic apparatus, according to the company.

In addition to three major electronic projects—automatic navigator, helicopter hovering device and missile guidance systems—Ryan has more than a dozen others under development, each calling for subminiature electrical assemblies based on printed circuitry. The program places great emphasis on the need for an integrated, modern facility for supplying precision-built circuits on a production line basis. Already set up to turn out a board a minute as a one-man operation, Ryan believes that printed circuit photographic units can easily increase this rate.

A new and highly versatile equipment that appears to be an asset to printed circuit production, has been revealed by the **Fuller Brush Company** of Hartford, Conn. Called a printed circuit pumice scrubber, the unit scrubs, rinses and dries printed circuits and laminates in one operation. The machine will also prepare items for masking, etching and soldering in less time than by conventional means, Fuller says. Operating at a rate of 5 to 15 feet/minute, it will: (1) remove all surface dirt and oxide; (2) with a dip, remove all photo-resists after etching; (3) prepare plates for more effective soldering; and (4) deliver plates clean and dry.



CONVENTIONAL wired subcarrier oscillator is shown at rear, printed circuit chassis in the middle, and a subminiature printed component device at front.

• **New material**—Another recent innovation in printed circuit development is the use of a new material developed by **Corning Glass Works** at Bradford, Pa. Copper metalized printed circuit boards made of high-strength, high-temperature Fotoceram have been produced by the company for high-reliability military applications for missile guidance and communication systems.

Automatically produced by a chemical machine process which permits extreme accuracy, the boards are capable of continuous operation between minus 55°C and 250°C. Through-hole plating is standard and repeated resoldering does not result damage on circuit runs, according Corning.

Fotoceram is a crystalline vari of Corning's Fotoform glass and a flexural strength of 25,000 ksi.

In processing, the original pho sensitive glass is exposed through ne tives to ultraviolet light and board holes are then etched out subsequent heating and immersion a dilute hydrofluoric acid. Finally, ditional heating converts the glass i a crystalline state and the circuit p is applied to the board.

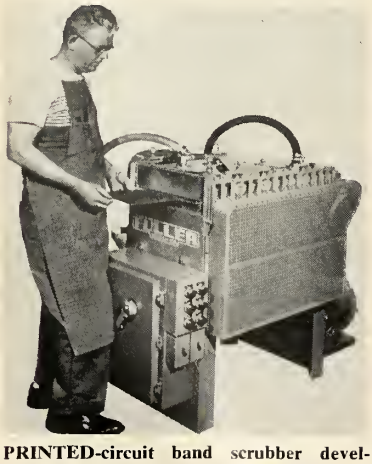
The company has said that in ad tion to its high thermal endurance, Fotoceram board will not bow, be warp, or burn and is impervious to s vents.

Vibration tests recently perform on the boards indicated that they w withstand more than 60 g when pr erly mounted.

In tests performed on Fotocera circuits components have been ha resoldered to the same circuit run m than 50 times without indication failure. To test solder-heat resistan the circuit boards have been floa or immersed in 565°F molten sol for over five minutes without evide of any blistering or lifting of circ runs, a company spokesman said.

• **Plated-through holes**—A sn controversy has arisen among ma users of printed circuit boards w feel that eyelets and plated-throu holes cause unreliable assembl **Packard Bell,** for example, prefers use soldered leads inserted throu holes in the boards.

In the July 27 issue of M/R, will present a defense of the use plated-through holes based on the sults of a test program performed **Motorola's Military Electronics D sion.**



PRINTED-circuit band scrubber developed by Fuller Brush Co., Hartford.



PHOTOSENSITIVE glass is processed at the new Corning Glass Works plant at Br ford, Pa. Each rectangle will be a printed circuit board for high temperature u

THE BOEING IM-99 BOMARC . . . *is a long range, extremely high altitude supersonic missile designed to intercept and destroy enemy aircraft and missiles. In full production, it has a greater range than any other air defense missile.*



STRUCTURAL EFFICIENCY CONTRIBUTES TO GREATER PERFORMANCE

The airframe of the Bomarc reflects a successful solution to structural and fastening design problems typical to high performance missiles and aircraft. The airframe combines high strength with high temperature resistance, without adding unnecessary weight which could effect performance.

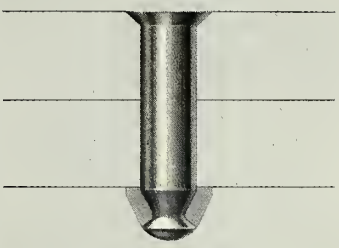
Three different fastener problems in the Bomarc are solved by stainless steel Hi-Shear fasteners. Hi-Shear Rivets are used in structure subjected to engine and rocket boost heat . . . Hi-Torque Bolts fasten removable panels and the nose section where heat, surface smoothness and ease of removal are factors. Blind Nuts eliminate hole/nut coordination problems in congested areas.

Continuing fastener environmental studies are being conducted at the Hi-Shear Test and Research Laboratories in a variety of strength and temperature resistant material combinations for advanced structural requirements.



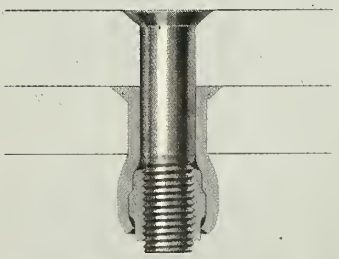
HI-TORQUE BOLT

IDEAL FOR FASTENING STRESSED ACCESS AND CLOSE-OUT PANELS. ITS UNIQUE SHALLOW RECESS LOCKS THE DRIVER INTO IT WHEN A HIGH TORQUE LOAD IS APPLIED DURING INSTALLATION OR REMOVAL.



HI-SHEAR RIVET

HAS THE LIGHTEST STRENGTH-WEIGHT RATIO, LEAST PROTRUSION AND LOWEST COST OF ANY SWAGED TYPE FASTENER. INSTALLED WITH STANDARD RIVET GUNS OR SQUEEZERS FITTED WITH HI-SHEAR RIVETING SETS.



BLIND NUT

FOR BLIND OR OPEN APPLICATIONS, THE BLIND NUT CUTS PRODUCTION COSTS BY USING ONE HOLE INSTEAD OF THE NORMAL THREE REQUIRED FOR NUTPLATES. INSTALLATION SPEED IS ABOUT TEN PER MINUTE BY ONE MAN USING A LIGHTWEIGHT, HYDRAULICALLY OPERATED GUN.

U.S. PATENT PENDING. FOREIGN PATENTS GRANTED AND PENDING.

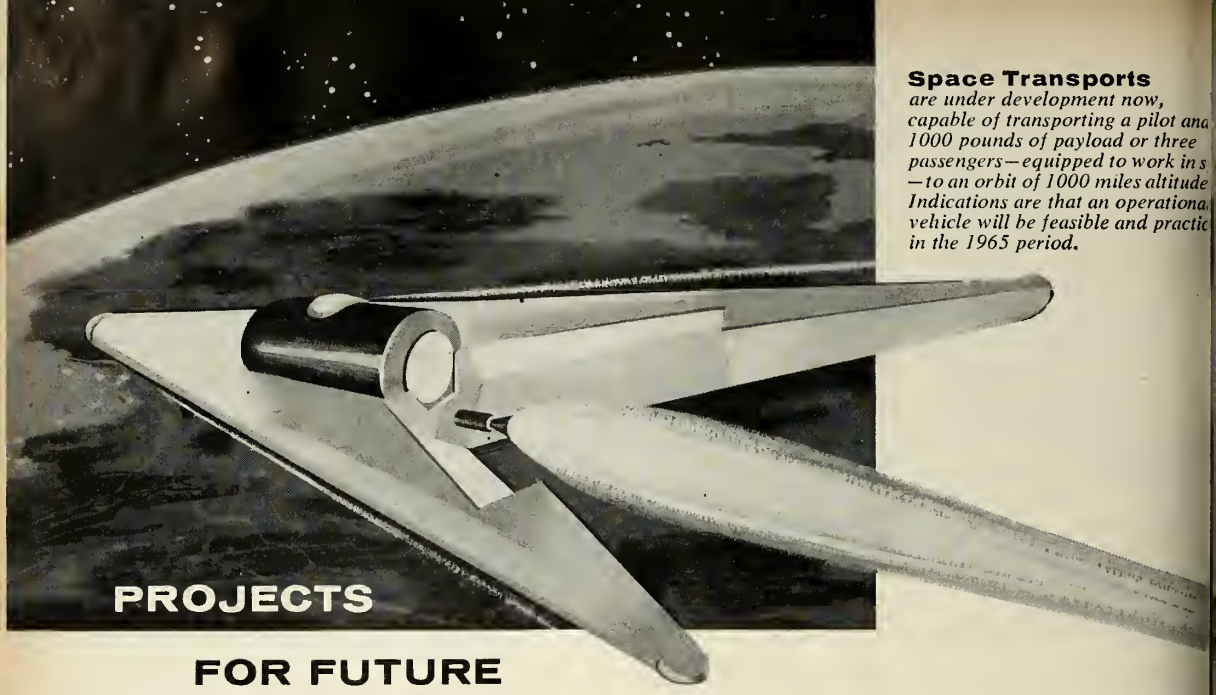
"HI-TORQUE" TRADEMARK REGISTERED IN U.S. PATENT OFFICE.
U.S. PATENTS NO. 2,677,985; 2,745,120 AND 2,782,039.
U.S. PATENT PENDING.

"HI-SHEAR" TRADEMARK REGISTERED IN U.S. PATENT OFFICE.
U.S. PATENTS NO. 2,355,529, 2,355,580; D-138,579;
OTHER U.S. AND FOREIGN PATENTS PENDING.

hi-shear RIVET TOOL COMPANY

2600 WEST 247TH STREET, TORRANCE • CALIFORNIA

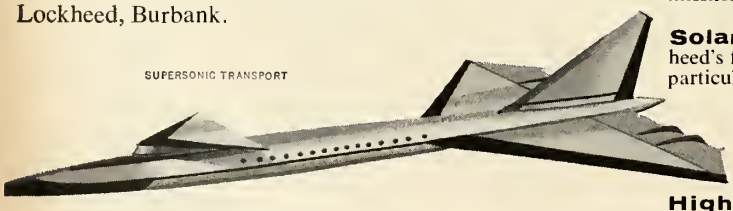
Circle No. 8 on Subscriber Service Card.



Space Transports
are under development now, capable of transporting a pilot and 1000 pounds of payload or three passengers—equipped to work in s —to an orbit of 1000 miles altitude Indications are that an operationa vehicle will be feasible and practic in the 1965 period.

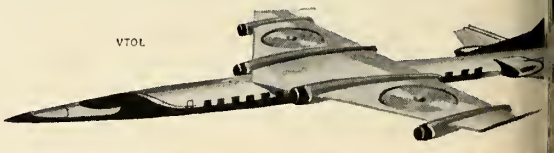
FOR FUTURE DECADES IN SPACE... *another Lockheed Progress Report to Engineers*

Plotting the nation's future space exploration projects requires the capabilities of a forward-looking company; one with vision, superiority in technical skills and advanced facilities. Lockheed, Burbank, long a leader in extending the science of flight, is placing its vast resources and accumulated knowledge into programs designed to provide major breakthroughs in the fields of: Basic and applied research; manned aircraft of advanced design; missiles and spacecraft. Shown here are artists' renderings of a few of these important projects. Such project diversification calls for high-level technical skill, offers genuine challenge to experienced engineers. At Lockheed these varied projects require engineers in many fields. Take advantage of this need. Go forward with a forward-looking company: Lockheed, Burbank.



Supersonic Transports—have held an important place in our thinking for the past several years. Extensive wind tunnel tests have been conducted on many design concepts, supplemented by exhaustive laboratory and structure studies. Lockheed is prepared to build an airliner that will travel at speeds in excess of Mach 3 at an altitude of 75,000 feet.

Infrared Systems studies are being conducted us advanced method of detecting fast-moving missiles and high aircraft. A new facility, which includes an advanced labor with an infrared tunnel, for basic research and developm prototype equipment in this expanding field, has been set push Lockheed, Burbank, to the forefront in infrared stud



Vertical Take-off and Landing Projects— heed, Burbank, is engaged in exploring the potential of projects on a very broad scale. Different VTOL features are e ied in each proposal. Considerable emphasis is being plac VTOL "air recovery" vehicles, designed for air rescue and r missiles recovery missions.

Solar Radiation Studies—are being conducted at heed's flight test radio station at Briar Summit, California, p particular emphasis on solar flares as our contribution to the national Geophysical Year. We have already accum more than a quarter of a million images of the s analysis. In cooperation with other companies, v determine the processes by which solar energy is re

High caliber scientists and engineers are invited t advantage of Lockheed's outstanding career opportunities. ings now exist in: Electronics; aero and thermodynamics; p sion; servo-mechanisms; materials and processes; structur stress; operations research; research in optics, infrared, acc magnetohydrodynamics, instrumentation, mechanics and h lics; mathematics; and in all phases of design. Write tod Mr. E. W. Des Lauriers, Manager Professional Placement Dept. 1707, 2400 North Hollywood Way, Burbank, Califo

LOCKHEED / CALIFORNIA DIVISION • BURBANK, CALIFO

Circle No. 9 on Subscriber Service Card.



elding Process Gives Good Control

A new welding process, called ort-Arc," welding has been deoped by **Linde Company,** Division **Union Carbide Corporation.** It pers manual and mechanized welding hin material with excellent control he weld puddle.

The outstanding feature of this new t-gas consumable-electrode process he ability to make manual fusion ds in the range of thickness of 0- to .100-in. of all common metals, h as carbon steel, stainless steel, minum (.040 in. minimum), copper, t, in all positions and types of joints.

The "Short-Arc" process exhibits rent advantages over other welding hods for welding sheet metal by viding a more-readily-controllable ing process at high welding speeds, er production of fillet welds, ability weld in all positions, and—of sigant importance—the ability to weld t metal in a range of thicknesses tofore not considered readily weldby any process.

Successful operation of the process ended on the development of several factors: proper power source, ction of shielding gas, and appas for feeding small diameter wires.

Normal fusion welding operations g conventional type power supplies either covered electrodes or inert-shielded processes, give too much and cause uncontrolled melting when making butt, lap, or fillet welds in thin gauge material. The Linde "Short-Arc" process has been made possible by the use of constant potential power supplies incorporating a drooping characteristic.

With the development of this new type of power supply it was found that surge currents could be controlled to limit the time duration of arc outages, prevent wire ejection, and produce a stable buzzing type of arc. This arc, operating in the range of 30 to 125 amp., 14 to 19 volts, short circuits dozens of times per second.

This produces a small cold puddle pinpointing the location of the arc heat and enabling the welding of thin materials in all positions. It is used primarily with .030-in. diameter wire, although .020-in. diameter hard wire works well on material in the very low end of the thickness range.

Considerable study has been given to evaluating shielding gases and mixtures and selecting the best in each instance. Argon has been found suitable for most metals such as aluminum, copper, and Everdur. For stainless steel and carbon steel, argon-oxygen and argon-carbon dioxide mixtures are finding wide acceptance.

Pure carbon dioxide is being used for some steel applications, but it produces somewhat more spatter and poorer head formation. The use of argon-carbon dioxide mixtures provides many advantages over either argon or straight carbon dioxide on carbon steel. Their use provides superior wetting action with the minimum amount of deposited metal resulting in a vastly improved bead contour. An approved mixture is now commercially available.

A key factor in the success of "Short-Arc" welding was the development of both manual and mechanized equipment to feed wires as small as .020- or .030-in. diameter.

The process is easy to use. Very little training is required for adaptable personnel. Manual welds can be made readily in all positions on most commercial light-gauge materials.

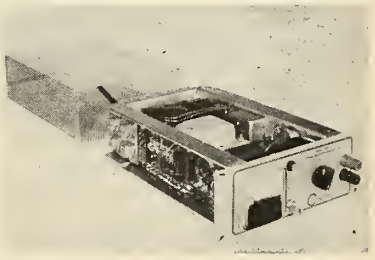
The Linde "Short-Arc" process makes high quality welds quickly and economically in carbon steel, stainless, aluminum and other metals. Distortion is minimized due to the pinpoint-type arc and there is little or no post-weld cleaning. Joints with poor fit-up are easily accommodated with manual welding. For example, ¼-in. gaps on 14-ga. carbon steel have been bridged with ease.

Circle No. 238 on Subscriber Service Card.

Solid State Power Supply Is Short Circuit Proof

Electronic Research Associates, Inc., announces new model additions to their Magitran line of solid state power supplies which combine the characteristics of magnetic and transistor regulators.

These new units are intermediate current types, and like the high current units of the line, offer full automatic



protection against all types of short-circuits or transients, either on an intermittent or continuous basis, with instantaneous recovery.

Other advantages include fast transient response, transistor dissipation independent of line voltage variations, close regulation, low ripple content,

continuous wide-range adjustable output, instant warm-up time, and many other features.

These units are of the space-saving type, with panel dimensions which are multiples of the standard 19-inch relay rack, and two units may be mounted horizontally in the standard rack dimension. These models are intended for all types of laboratory and equipment application.

In these new designs, the properties of a special magnetic control are combined with the fast transient characteristics of the transistor regulator. Pre-regulation and line transient protection is achieved by the magnetic controller.

This component is also designed in a manner so as to provide zero output in the event excessive current flows due to overload or short in the external circuit. The transistor regulator accommodates all fast line or load variations and transients, as well as providing for ripple reduction. This combination results in minimum heat dissipation for all transistors independent of line voltage variations.

Under short-circuit conditions zero voltage appears across the transistors and thus complete protection is obtained under the most extreme conditions. Other design features include the use of differential dc amplifiers, compensated zener references, silicon rectifiers, and conservatively rated transistors and components. Despite the advantages of the design, units are conservatively priced.

The new models have been given the model designations of 202M and 203M.

The Model 202M provides adjustable output over the range 10-150 VDC at 0-200 milliamperes, and the Model 203M has an output adjustable over the range 10-300 VDC at 0-200 milliamperes.

Other specifications common to both models include input, 100-130 VAC, 60 cps; line and load regulation, within 0.05%; ripple, less than .005%. Units are for bench or sub-relay rack mounting, and panel dimensions are 3½ x 9½ inches.

Circle No. 239 on Subscriber Service Card.

Miniaturized Choppers Have Varied Uses

A series of general-purpose miniature choppers, designed for aircraft and line frequencies, has been developed recently by **Collins Electronics Mfg. Corp.**

The choppers are now available in single-pole double-throw, or double-pole double-throw types, 60 cps or 400 cps, in both make-before-break or break-before-make designs.



Miniaturized for space and weight economy, they are hermetically sealed and drygas filled for operation in any known climate. To make insertion and removal simplified, as requested by field servicing firms, these Collins units have connections brought out through the base.

Maximum noise created is 450 microvolts across 1 megohm at 400 cps. They have been designed to meet all applicable military specifications.

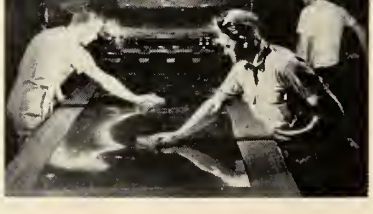
Circle No. 240 on Subscriber Service Card.

Thin Gaged, Large Sheet High Alloys Available

Haynes Stellite Company, Division of **Union Carbide Corporation,** has just announced the availability of several high-temperature alloys in wider cold-rolled thin-gage sheets than were previously available. Sheets measuring 0.010 in. thick, 36 in. wide, and 96 in. long are now being rolled as a result of recent refinements in technique at the Company's expanding wrought alloy facilities.

This development, virtually an industry "first," opens new markets for high-alloy sheet where size limitations were an intolerable restriction to its consideration for certain applications.

Several companies are now investigating the use of large thin sheet as outer skin material for space craft,



shrouding for hot sections of conventional jet aircraft, or facing sheets for honeycomb constructions.

Alloys currently available in sheet form are "Haynes" alloy No. 25, "Multimet" alloy, "Hastelloy" alloy R-235, "Hastelloy" alloy X, and General Electric's "Rene 41" alloy. These alloys are among the leading materials in the field of high-temperature metallurgy.

Circle No. 241 on Subscriber Service Card.

Current Sensitive Relay Can Withstand 100 G's

A current sensitive relay of "Pc mite" micro-miniature relay series been produced by **Filtors, Inc.**

Known as the "S" type, this addition to the rotary "Powrm series meets shock tests of 100 for 11 milliseconds and vibration t of 10-55 cps @ .06 double amplitu 55-2000 cps @ 30 G8s.



Other specifications: contact rangement: 2C (DPDT): ambient t perature range; −65° C. to 100° dielectric test: (at sea level) 10((750 V. between open contacts): tact rating: 2 amps resistive; pul time: 5 milliseconds maximum; 0.5 maximum weight. Coil resistances f 185 to 10,000 ohms are availabl standard values.

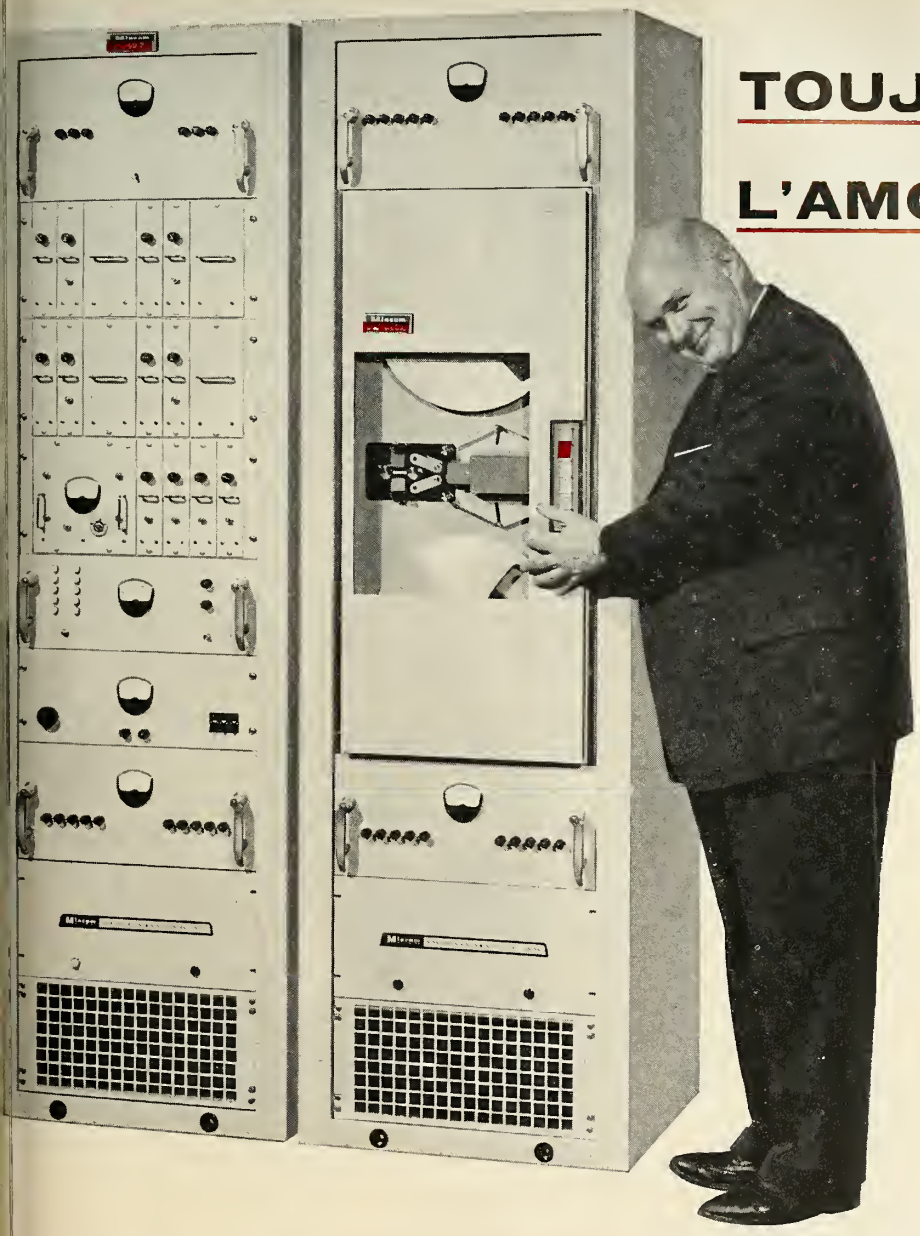
Circle No. 242 on Subscriber Service Ca

Marking Method Speeds Identification of Bearing

A new method of speedy, infal visual identification for tiny instrur bearings—overcoming a long stan problem of the industry—is curre being introduced by **New Hamps Ball Bearings, Inc.**

Specifications occasionally call bearings about the size of the pe at the end of this sentence. The o and inner rings of the bearing, th fore, do not allow much room identifying markings.

New Hampshire Ball Bearings, solved this problem through a ra simple but effective method.



TOUJOURS L'AMOUR

Seven 1-megacycle video channels on a single half-inch tape — that's why there's an affectionate reaction everywhere to the new Mincom Model CV-100 Video Band Magnetic Recorder Reproducer. Tape speed of 120 ips, plus special recording and playback heads, produces reliable frequency response from 400 cycles to 1.0 megacycle (each track). Only 12 moving parts, four simple adjustments. Only 0.1% flutter and wow. No mechanical brakes. All plug-in assemblies, carefree maintenance. Interested? Write for specifications.

3M COMPANY ... WHERE RESEARCH IS THE KEY TO TOMORROW

MINCOM DIVISION MINNESOTA MINING AND MANUFACTURING COMPANY

2049 SOUTH BARRINGTON AVENUE • LOS ANGELES 25, CALIFORNIA

Circle No. 10 on Subscriber Service Card.

Sets of double lines, either 120° or 180° apart, applied to one face of the outer ring, supply three important pieces of information at a glance.

First, the marks indicate whether the bearing is made of Stainless Steel (120° apart) or Chrome Steel (180° apart). Second, that the precision instrument bearing is ABEC 7 tolerances, or better. And, third, for inventory and specification purposes, that the bearing is made by New Hampshire Ball Bearings, Inc.

The new method of marking was introduced after careful analysis proved that it produced no change in dimensions, no distortion, or destruction of surface finish, and does not affect mounting or performance of the bearings. This is because the marks are applied on the outer ring by impact before grinding and heat treating.

Circle No. 243 on Subscriber Service Card.

4-Stage Amplifier Claimed To Be World's Smallest

What is said to be the smallest 4-stage amplifier ever constructed is now available in production quantities from **Centralab,** a division of **Globo-Union, Inc.**

Measuring only 0.531″ in diameter and 0.228″ in height, including the hermetically sealed case, the unit contains 12 resistors, 5 capacitors, and 4 transistors. It weighs 1/16 of an ounce. According to Walter E. Peek, Centralab's General Sales Manager, this means that the amplifier has a component



density of well over half a million components per cubic foot.

Mr. Peek emphasized that this is not a developmental unit or laboratory curiosity, but is in actual production, and is now being delivered to a number of leading manufacturers. It has application in hearing aids, computers, missiles, and a variety of other military electronic devices.

The new unit is known as the TA-12, Mr. Peek said. Prior to its development, the smallest available 4-stage amplifier was Centralab's TA-11, which measures 1.175″ long x .250″ wide x .665″ high.

The TA-12 has a gain of 73 to 78 db at 1 KC with 1000 ohm load. Its nominal input impedance is 2000 ohms. Signal to noise ratio is 42 db below 1 volt. Supply voltage is from a 1.3 volt mercury cell; current drain is 2.1 milliamperes maximum. At 300 CPS the frequency response is down 6± 3 db; it is down 4± 2 db at 3000 CPS. Load impedance is 1000 ohms inductive load with 400 ohms maximum d.c. resistance. According to Mr. Peek, these standard performance limits may be modified for special applications.

Circle No. 244 on Subscriber Service Card.

Tiny *Vanguard II* Motor Commercially Available

Inside *Vanguard II,* the weather satellite which is expected to be orbiting for several hundred years to come, is a tiny two-ounce motor, installed to drive a miniature tape-recorder. In size, it is the only one of its kind, but it was manufactured by the **A. W. Haydon Division** of **Consolidated Electronics Industries Corp.** for the Army Signal Corps as a scaled-down version of the Company's standard DC model.

This sub-miniature motor enabled the weather satellite to respond to interrogation, on command from certain of Earth's monitoring stations, 152 times during its first 211 cycles before the transmitters ceased operating, according to the National Aeronautics and Space Administration. *Vanguard II* was launched on February 17, 1959.

Less than one inch in diameter and only 1 3/8 inches in length, the Haydon Company's sub-miniature motor operates on only a tenth of a watt of power. Thirty of these motors would use no more than the same amount of power as an everyday household clock, or seven of them would require the same power as a two-cell flashlight bulb.

The parts in the orbiting satellite's adaptation of the motor are all one-half of regular dimensions. It runs with a speed of 2,500 revolutions per minute, has a permanent magnet within the rotating coils, and is equipped with ball bearings.

The A. W. Haydon engineers are certain that tooling can be obtained



promptly for production of the s
miniature motor to meet such mai
demands as may develop.

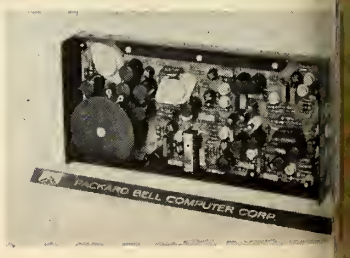
Circle No. 245 on Subscriber Service Cor

New Line of Solid State DC Amplifiers Marketed

Packard Bell Computer Corporat
has announced a new line of solid-s
DC amplifiers designed to meet
urgent need for wide-band, highly
curate amplification where reliabi
is of prime importance. This is the
available line of low-noise, comple
solid state amplifiers with transi
choppers.

Because of the rapid developm
of new weapons and numerous tes
requirements, instrumentation relia
ity is a prime factor. Normally, eq
ment can be tested only once bec
of the complexity and cost of such t

One of the basic pieces of eq
ment required to take measurem
is an amplifier. It is used to amp
signals for processing into data log



equipment for later evaluation.
major weakness in today's amplifie
the use of mechanical choppers w
tend to be unreliable and cause a
nificant failure rate.

To alleviate this condition, a
of amplifiers which use all solid-s
circuitry, including the chopper,
been designed and is now available
application in systems. With this
cal design, amplifier reliability,
system reliability, is increased at
one order of magnitude.

Wide-band differential, operati
and potentiometric amplifiers—all
izing completely solid-state circuit
are offered by Packard Bell under

xclusive arrangement with REDCOR, o meet the diversified need for a line f instrumentation amplifiers.

Differential amplifiers have many pplications in the data reduction field. Vherever a low level signal of unde- ermined reference is measured, a neans of isolating it and recovering ow amplitude signals from high noise evels is required. The low-level, wide- and, low-noise differential amplifier as been designed to meet most of hese requirements. This is the first such ifferential amplifier offering input im- edances up to 10,000 megohms, noise n the microvolt range and a common node rejection of 120 db at dc.

Operational amplifiers have many ses in data handling systems. They re used most commonly to provide mpedance matching and signal in- ersion.

Potentiometric amplifiers are pri- arily used as a buffering device to olate the source of the measurement rom the measuring device.

The three types of amplifiers des- ribed here offer bandwidths at –3 db t 200 KC. Gain accuracies, linearity nd drift figures are better than .002% n most models. The units are extreme- y small, measuring 8" by 4" by 1½", nd all have self-contained power sup- lies.

This line of completely solid-state mplifiers, for which Packard Bell Com- uter Corporation has exclusive rights, eportedly makes the amplifier one of ne most reliable pieces of equipment n the data logging field.

Circle No. 246 on Subscriber Service Card.

New Low-Current Thermal Relay Available

A low-current, sub-miniature ther- al relay with a firing sensitivity of nly 0.2 amps is announced by **Net- orks Electronics Corp.**

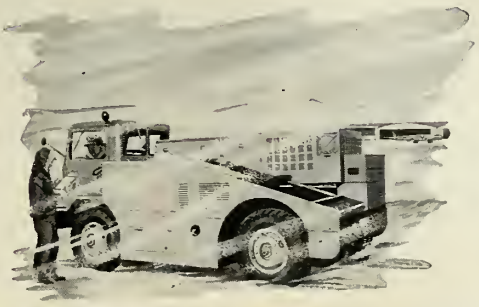
Relay is hermetically sealed by an xclusive method of bonding metal eaders to high thermal-shock resistant lass housings. The use of a transpar- nt glass case permits visual inspection f all working parts.

This tiny unit measuring only 65" dia. x .550" length, meets all



ertinent military specifications . . . perates under vibration of 20 to 2000 ps at 15 g, with a shock rating of 0 g. The temperature range extends

HEAT in military applications





HUNTER ENGINE HEATERS

starting aids for internal combustion engines

Hunter Engine Heaters, designed and manufactured in conformity with military requirements, are standard winterization gear for engines in military vehicles, hydraulic test stands, battery starting carts, generator sets, compressors, other ground support and special purpose equipment, etc. They burn any type gasoline or JP-4 fuel, with cold starts as low as –65°F. Input ranges from 30,000 to 90,000 BTU/Hour. Both uncontaminated and exhaust heat is utilized. Compact, light-weight, high capacity units, they deliver high temperature, high volume air as required for specific applications.







MODEL UH-86 This heavy-duty model has 90,000 BTU/Hr. input for delivery of high volume, high temperature air against extreme resistances to the engine, battery and lubricating oil • starts to –65°F under the most extreme conditions • used on PE-90, PE-150 and PE-200 Engines employed in ground support equipment such as C-26, MD-3A, MA-3, hydraulic test stands, battery starting carts, etc. • weighs 38 pounds, less than 27" long, 8" diameter • burns ¾ gal. fuel per hr., any grade gasoline or JP-4 fuel.

Space and personnel heaters, instant lighting torches, refrigeration and air conditioning units are other Hunter products designed for military applications.

• • •

Hunter personnel and facilities are available for all types of R & D for military heating and air conditioning.

get these brochures TODAY!

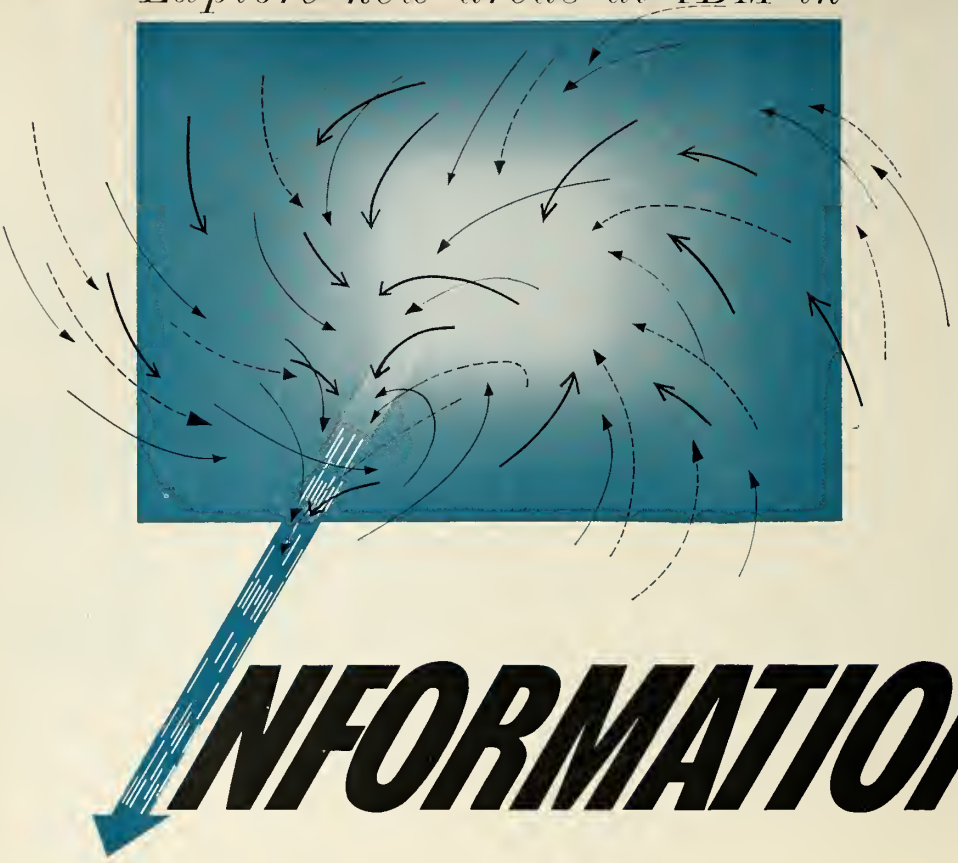
MH-166 "Engine Heaters" MH-162 "Space Heaters" MH-167 "Military Torches"

HUNTER MANUFACTURING CO. | HEATING AND REFRIGERATION SYSTEMS

30533 AURORA RD. SOLON, OHIO

Circle No. 11 on Subscriber Service Card.

Explore new areas at IBM in



INFORMATION

Information retrieval is a major area of study at IBM. Current investigations may lead toward such benefits as the instant accessibility to knowledge in the Library of Congress—or toward a system which can translate any of the earth's languages into English in real time.

Problems in information retrieval have defined entirely new concepts for the design of storage, input-output and "memory" units—achieving far greater capacities than any known today. These facilities will provide for the handling of the tremendous amount of updated information needed by business, science and government. With extremely rapid accessibility to vast amounts of information electronically stored, industrial and research efforts can be materially expedited. IBM needs engineers and scientists with the vision and the ability to pave the way to tomorrow.

You will enjoy unusual professional freedom and the support of a wealth of systems know-how. Comprehensive education programs are available plus the assistance of specialists of many disciplines. Working independently or as a member of a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

CAREERS AVAILABLE IN THESE AREAS

Applied mathematics & statistics
Circuit design & research
Component engineering
Human factors
Inertial guidance
Information theory
Logic
Operations research
Optics
Programming
Real-time engineering
Semiconductors
Solid state development
Systems analysis & design
Transistor device design

QUALIFICATIONS

B.S., M.S., or Ph.D. in Electrical or Mechanical Engineering, Physics or Mathematics—and proven ability to assume a high degree of technical responsibility in your sphere of interest.

SOME TYPICAL ASSIGNMENTS

704 PROGRAMMER ANALYST to study data flow diagrams and write differential equations of a circuit diagram; to investigate analog and digital real-time control systems, using high-speed electronic digital and/or analog computers. Must be familiar with variable length alphabetic data, transforms, numerical analysis.

RETRIEVAL

COMPUTER OR SYSTEMS ENGINEER, MATHEMATICIAN OR PHYSICIST to design advanced computer, and work on development of new information retrieval program. Must have strong interest in transistor circuit design or in logical or systems applications of solid state circuitry.

MATHEMATICIAN to do programming of information retrieval research and plan construction of advanced systems. Will play an active part in automatic programming techniques, numerical analyses, criteria selection, probability and game theory.

SENIOR ENGINEER, MATHEMATICIAN OR PHYSICIST interested in systems; experienced in operations research, communications, missiles or radar.

For details, write, outlining background and interests, to:

Mr. R. E. Rodgers, Dept. 604-G2
IBM Corporation
590 Madison Ave.
New York 22, N. Y.

IBM®

INTERNATIONAL BUSINESS MACHINES CORPORATION

. . . new missile products

from −100°F to 400°F. Unit is SPST-NO, with a contact rating of 1 amp. Normally-closed operation is provided in a somewhat larger unit.

Designated Series M555, relay will handle a continuous fuse current of .120 amps max., and a firing current of .180 amps min. Fuse resistance is 15 ohms ± 15%.

The original design of this unit is based on the "fuse burnout" principle, and provides wide latitude in systems design. Manufacturer states that there has been no failure in 1,000,000 delivered units. Relay can be used as a low-current sensing device, or as overload protection in missile circuitry and other complex electronic equipment. Complete data will be sent upon request.

Circle No. 247 on Subscriber Service Card.

Micro Miniature Relay Has All Welded Construction

Contact contamination—one of the greatest problems in achieving relay reliability—has been significantly reduced by the use of all-welded construction in a new **General Electric** micro-miniature relay.

Solder flux has been one of the primary causes of relay contact contamination. The new four-pole, double-throw relay is assembled—without using solder—by an inert arc welding process which hermetically seals the header to the can.

Weighing about one ounce, the relay is rated two amperes at 26.5 volts



dc or 115 volts ac, and is dc operated using a highly efficient E-type magnet.

For application in a wide variety of equipment, including aircraft and missile electronic systems, the relay is well suited for high-temperature installations. The internal structure includes ceramic actuator and ceramic coil

spool. The relay is rated from 160 degrees C continuous ambient down to −65 degrees C.

Circuitry is symmetrical and wiring has been simplified, according to General Electric engineers. Socket mounted units may be turned end-for-end and cannot be plugged incorrectly. No polarizing pin is needed. The relay may be mounted directly on a printed circuit board or on a chassis.

Dimensions conform to standard grid patterns utilized by many electronic and component manufacturers. Terminals are on 0.2 inch centers and mounting holes are on 1.2 inch centers.

Knife edge armature bearing and other proven design features combine to yield a mechanical life of over ten million operations, according to General Electric engineers. Electrical life of the relay at rated load is in excess of 200,000 operations.

Operate and release times are six and four milliseconds respectively, including bounce. Pickup power is 400 milliwatts.

The relay withstands vibration tests to 2000 cycles per second at 30 G's and shock tests at 50 G's for 11 milliseconds.

Circle No. 248 on Subscriber Service Card.

Test Set Provides Both Swept and CW Signals

A new type of test set, which provides both swept and CW signals in a single compact instrument, is finding widespread use as a general-purpose laboratory and production-line tool.

Designated as the Model 303 Test Set by the maker, **Telonic Industries, Inc.**, the new unit contains three separate oscillators, all operating in the 20-40 mc range. Output of the three oscillator circuits is 1 volt RMS into 50 ohms. Each output is separately metered and may be attenuated from 0 to 140 db in 1 db steps, using toggle-switch attenuators.



To maintain an overall accuracy of attenuation of better than 0.5 db, hermetically sealed, deposited carbon resistors with an accuracy of 1/2% are used. A vernier attenuator covering a 0-10 db range is also provided. Extremely close control over RF radiation in the design and construction of the instrument allows accurate attenuation to output values as low as 0.1 microvolts.

The two CW oscillators are individually tunable by dials on the instrument panel calibrated in megacycles. In addition to the megacycle markings, a 0-100 logging scale with a 10:1 vernier is provided. The tuning-knob mechanism provides a choice of 1:1 or 50:1 rotation.

The CW oscillator outputs may be used directly as test signals for the measurement of gain and similar circuit characteristics, or they may be used as extremely accurate, variable markers for the swept signals produced by the third oscillator.

The center frequency of the swept output may be turned across the full range 20 to 40 mc, and the width of the signal may be varied from 0.05 to 40% of the center frequency. At maximum sweep width the signal demonstrates a flatness of better than 0.25 db, achieved by an internal AGC circuit acting on the B+ input to the oscillator. As a result, any departure from flatness in the demodulated signal is the result of the frequency response of the circuit under test and not accountable to the original test signal.

Sweep rate of the Model 303 Test Set is line frequency, 50 or 60 cps, with the oscillator turned off during the return sweep to provide a zero base line. Source VSWR of the instrument is below 1.2:1. An external signal of approximately 0.1 volts may be used to produce a "birdy" type marker on the oscilloscope trace at any desired frequency. Telonic produces crystal-controlled markers for this purpose. Harmonic markers that produce birdies at 1.0 mc intervals across the entire band are generally included with the instrument as standard equipment.

As in all Telonic sweep generators, Model 303 markers (including the two CW outputs when used as markers) are added to the signal after it has passed through the circuit under test, thus preventing any distortion of the measured result. The "Birdy-By-Pass" marker system is an innovation developed by Telonic Industries.

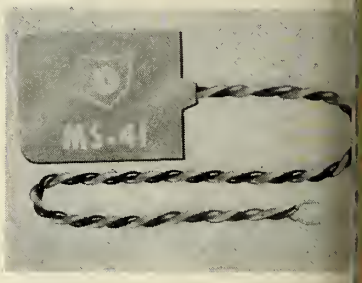
The Telonic Model 303 Test Set already in use as a production-line te instrument in plants where a major m sile guidance system is now in volun production.

Circle No. 249 on Subscriber Service Card.

Magnetic-Field Sensitive Resistor Now Available

Ohio Semiconductors, Inc. a nounces the commercial availability its recently developed semiconduct device, the Magnetoresistor.

The type MS-41 Magnetoresistor a semiconductor in which the electric resistance is a function of an appli magnetic field. It features a 10 to



change in resistance with an applie field of 10 kilogauss. Greater chang can be achieved at fields greater tha 10 kilogauss with a linear dependenc At lower magnetic field densities th Magnetoresistor obeys an approxima square function. Important features the MS-41 are low noise (on the ord of Johnson noise and fast response tim The theoretical response is limited on by the relaxation time of the charg carriers. In practice the lead inductan and capacitance sets the limit.

Non-inductive design with "thinn than a dime construction."

The MS-41 Magnetoresistor is mad possible by the commercial develo ment of new compound semiconducto by Ohio Semiconductors, Inc. O. S. is a pioneer and leader in the field compound semiconductors for infr red, thermoelectric and electronic a plications.

The compound—InSb, indium ant monide, is utilized in the MS-41 Ma netoresistor. The magnitude of the ma netoresistance effect is related to th mobility of charge carriers (electron within the solid. InSb displays the hig est known electron mobilities.

Fully developed and ruggedly pac aged, the MS-41 permits the use of th magnetic gaps. It is designed to satis many different applications.

Circle No. 250 on Subscriber Service Card.

A Big Step in Digital Telemetry

Space Electronics Corp.'s DIGILOCK system offers advantages of digital techniques minus some of its disadvantages for missile system development

by Hal Gettings

WASHINGTON—A new telemetry system just off the board shows promise of answering many of the problems plaguing this most important aspect of missile development. The system, named DIGILOCK by its developer, **Space Electronics Corporation,** combines many of the advantages of digital techniques and overcomes some of its disadvantages. It offers flexibility, accuracy, and small size.

The ideal telemetering system would weigh nothing, take no space, require no bandwidth, have unlimited sophistication as to selection of data, transmission accuracy and power, and be at once 100% reliable. It would consume no power and cost nothing.

The DIGILOCK system is, of course, not the ideal. It does, however, approach the maximum communication efficiency possible under information theory, and has several features not previously available.

• **Digital systems**—Digital techniques are generally accepted for a number of reasons as being superior for communications. Primary is the inherent accuracy of a digital system. Once above the threshold, the output signal-to-noise ratio is independent of the carrier S/N; if any information is received at all, it is correct information. In analog systems, noise can vary the information modulation to cause errors in the received data.

Digital offers other advantages—in speed and capability, bandwidth, and relative signal power required. A comparison of some of these parameters has been made by L. C. Watson and M. Goldstein of **Texas Instruments** in a paper presented at the 1959 National Telemetering Conference. A summary of their comparison is shown in the table (Fig. A).

The main objection to digital telemetry has been the large amount of hardware that must be carried in the vehicle. Complicated coders and multiplexers with their attendant power supplies and accessory items not only add to space and weight but compound the reliability problem. Furthermore, existing ranges are instrumented to handle only analog (FM/FM, etc.) data; a change to digital would require extensive and expensive modification.

The first problem has been improved by development of transistorized units and advanced packaging techniques. The only complete digital (PCM) system in use today—developed by **Radiation, Inc.,** for the Holloman AFMDC rocketsled track—has an entire "airborne" package in about one cubic foot.

The answer to the second problem lies in integrating "compatible" digital units into existing analog systems, to provide the desirable features of digital along with the economies of using present equipment. The DIGILOCK makes use of these principles and requires only the addition of a decoder, sync generator, and detector to the conventional analog ground equipment. If desired, the quantized data can be stored on magnetic tape for direct entry into a digital computer.

The DIGILOCK system was developed as a result of a study made by Space Electronics Corporation under contract to **Jet Propulsion Laboratory.** This study showed that an "orthogonal" telemetering system was the most efficient, based on the bandwidth and power required per bit of information transmitted. Both analog and digital systems were compared on an analytical basis and assigned relative figures of merit. Some of the results of this comparison are shown in the graph (Fig. B).

A second part of the contract work was to design and test the most promising result of the study.

The analysis showed that for the best telemetry system a modulation subsystem must have these features:

• Good communications efficiency

Summary of Parameters for Analog and Digital Modulation

Parameter	FM/FM	PAM/FM	PDM/FM	PCM/FM
Number of Data Channels	18	18	18	18
Q	4000	4000	4000	4000
RMS Error	—	±0.5%	±0.5%	±0.4%
Output S/N Ratio	42 db	46 db	37 db	—
Video Bandwidth	80 kc	28 kc	114 kc	28 kc
RF Bandwith	440 kc	224 kc	228 kc	57.6 kc
Deviation Ratio	1.5	1.1	0.6	0.6
Carrier Deviation	125 kc	31 kc	69 kc	16.8 kc
Threshold S/N Ratio	9 db	9 db	9 db	9 db
$\frac{S_p}{K}$ = Relative Required Signal Power x 10^{-3}	3450	1760	1790	453
$\frac{\left(\frac{S_p}{K}\right)\text{ db}}{\left(\frac{S_p}{K}\right)\text{ db (PCM)}}$	8.8 db	5.9 db	6.0 db	0 db

FIG. A—Digital systems provide speed and capability, bandwidth and signal power.

nearing the limit of efficiency . . .

- Variable data rate
- Variable accuracy
- Digital data transmission

• **Orthogonal systems**—The development of the DIGILOCK, undertaken to meet these requirements, was described in a paper by A. W. Newberry at the Semiannual meeting of the American Rocket Society in June. Newberry said the family of orthogonal systems closely approaches the theoretical limit of communication efficiency, as illustrated in the graph.

An "orthogonal" system is defined as one for which N messages can be transmitted, each of which consists of N degrees of freedom. Encoded messages are all equally different or equally spaced in an N dimensional space. The system possesses N matched filters at the receiver, one for each possible transmitted signal.

The signals and corresponding matched filters are chosen so that the outputs from all but one matched filter are zero after the signal is received.

• **Desired characteristics**—It has long been considered desirable in telemetry design to make a system as sophisticated, or "intelligent," as possible consistent with weight and space requirements. Ideally, a system would be able to choose only pertinent information and transmit it at selected times, thus saving considerably in bandwidth and power. The complexity of such an intelligent system, however, has precluded its use up until this time.

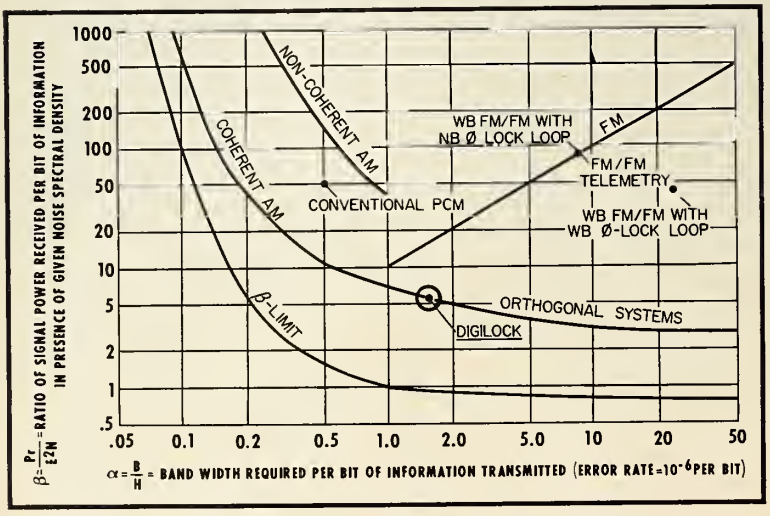


FIG. B—Comparison of the communication efficiency of various systems.

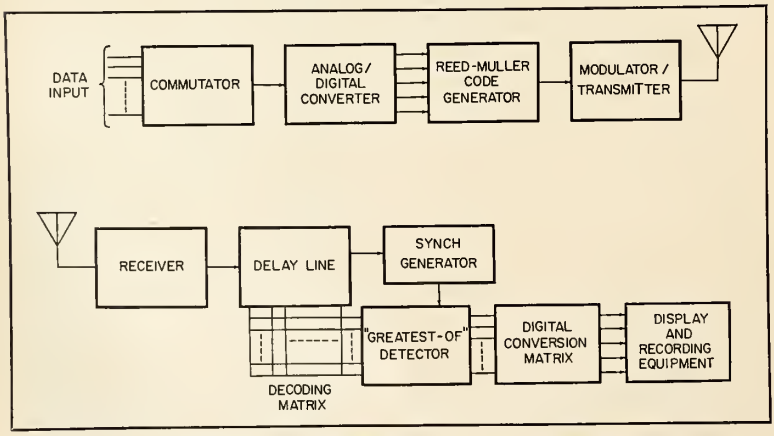


FIG. C—A block diagram of the workings of the DIGILOCK pulse code system.

To this end, the DIGILOCK equ ment has incorporated both varial accuracy and variable data rate. The features offer considerable economy a provide a more intelligent system.

In the first place, it is very in ficient to transmit information wi precision beyond the meaning of t data. It would be wasteful, for instanc to transmit continuous precise da when simple presence-absence or even per-unit-time information would sufficient. The available information b could better be reserved for measur ments where greater precision is r quired.

Variable data rate offers, primaril power economy. An example would a system alternately turned on and o When on, the data rate is some nomin maximum; when off, the rate is zer By controlling the on-off time, the e fective data rate can be varied over wide range. If the meaningful data properly encoded and stored, a wort while saving in power is provided.

But intermittent operation does n provide all of the desirable feature without some additional change, t maximum communication range r mains a fixed function of transmitt power, transmission bandwidth, and e fective ground station sensitivity. T possibility of variable transmissio bandwidth is a feature inherent DIGILOCK and offers greater a vantages. Variable transmission ban width can result in the adjustment data rate to match a specific missio requirement. Even more important, a justment can be made during a tran interval, allowing the decrease of da rate with increasing communicatio range—thereby making possible operating link at distances otherwi impossible.

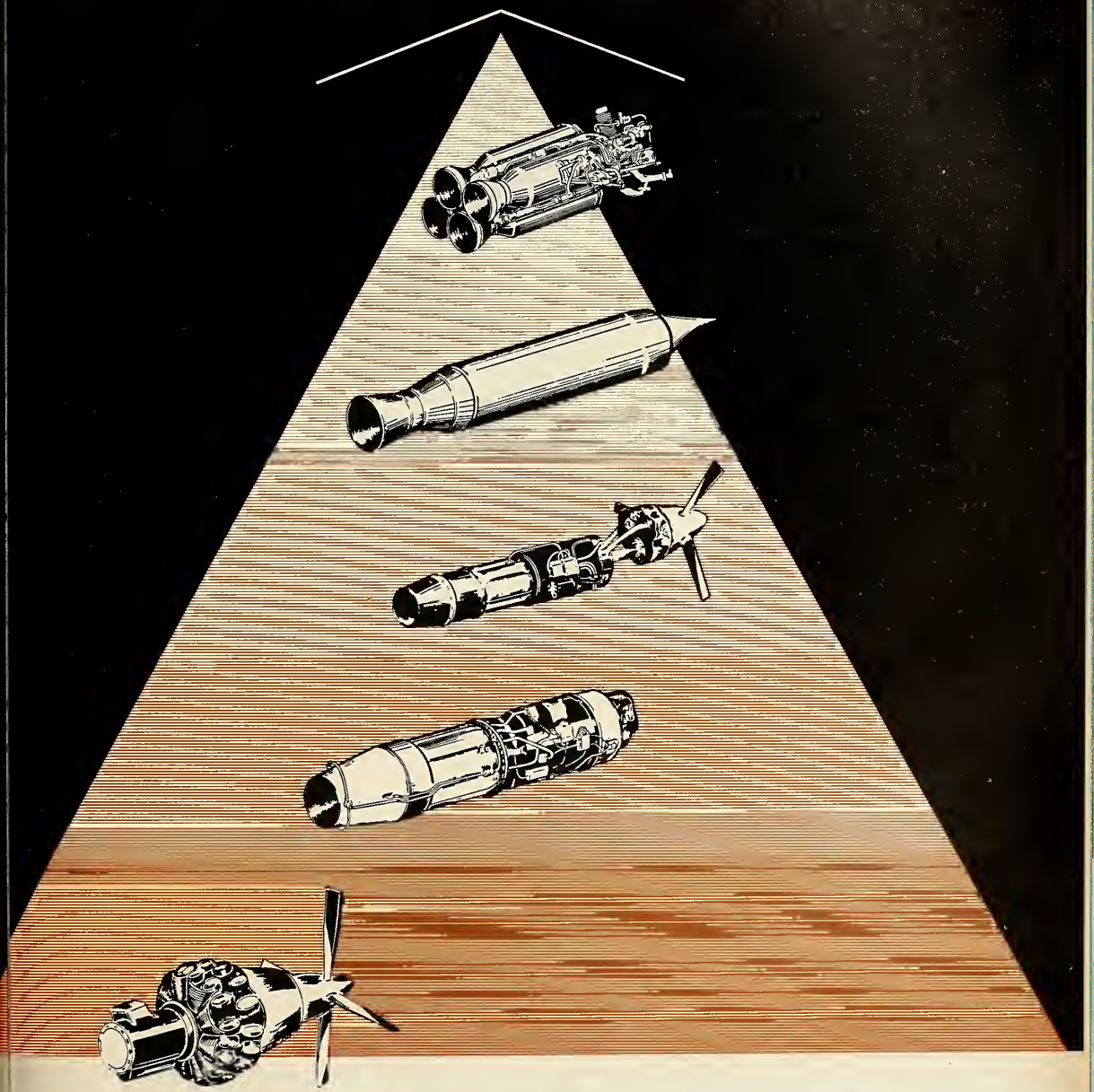
• **DIGILOCK operation**—DIG LOCK is a pulse code (PCM) syste and, therefore, a time-division mult plex system. Primary operation co sists of sampling an input data sourc quantizing the data sample, transm ting a coded representation of t quantized data sample, receiving ar decoding the data, and either storin or displaying a measure of the info mation received (Fig. C).

In an orthogonal system, messag must be encoded so that they are equally different or equally space Also, each message must be recognize by its own matched filter. The matche filter decoder is therefore the heart the system and its operation must l understood if the operation of t complete system is to be understood

• **Delay line**—The principal el ment in the matched filter decoder a multiple-tapped magnetostriction d lay line, which provides a means storing many bits of information r

CONTROLS

FOR THE FULL SPECTRUM OF PROPULSION SYSTEMS



Bendix* has long been a leader in supplying controls and fuel systems for all types of aircraft engines. Today, Bendix is proving to be a natural for new challenges in related missile fields—on ram jets, rockets, nuclear power, and other advanced propulsion systems. So, when it comes to controls, remember that Bendix has the background—and is anxious to share it in solving your problems. *REG. U.S. PAT. OFF.

BENDIX PRODUCTS DIVISION **SOUTH BEND, IND.**

Bendix AVIATION CORPORATION

Circle No. 12 on Subscriber Service Card.

ceived in time sequence, yet allows continuous nondestructive readout of information stored on the line so that a succession of events or a succession of bits of information can be simultaneously compared.

The line used in the DIGILOCK decoder has a nickel alloy ribbon as its magnetostrictive material. It has a characteristic propagation velocity of approximately five microseconds per inch, exhibits a linear input/output characteristic over approximately a 40 db range, and has a half-power bandwidth of approximately 400 kc centered at 500 kc. Typical lines are several feet in length and pickoffs or taps can be positioned several to the inch if desired. This element, therefore, provides a convenient means of correlating events separated in time by intervals up to several hundred microseconds.

• **Summing matrix**—A summing matrix associated with a set of systematically located taps can "recognize" a discrete pattern of pulses or otherwise coded information bits. Moreover, a large number of summing matrices properly "matched" with coded messages can individually recognize a large number of multiple-digit code transmissions. Hence, the magnetostriction delay line is a very versatile element for this application; it leads to variable data rate because if the pulse code transmission is "slowed down," this simply means adjusting the taps to be farther apart. It provides an extremely important characteristic common to most correlation detection systems—that of summing systematic events while tending to cancel random events.

This last effect is obviously of primary significance because a cancellation or decrease of random noise means a lower system threshold and, consequently, a greater communication range with a given amount of transmitter power.

• **Detector**—The best detector to use with a matched filter decoder is one that simultaneously compares all outputs and determines which filter output is greatest. This approach has been mechanized in the DIGILOCK system by connecting each filter output to a transistor operated in the emitter-follower configuration with all emitters tied to one common resistor. The transistor realizing the "greatest" signal at its input is turned on, developing a voltage across the common resistor which in turn causes all other transistors to be back-biased with resultant low conduction on all but the one "greatest-of" output bus.

Basic Reed-Muller Codes—(16-Bit)

UNITS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
4	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1
8	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1
16	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
E.G. CODE #27															
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
8	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1
16	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
	1	0	0	1	1	0	0	1	0	1	1	0	0	1	1	0

TO OBTAIN CODE FOR ANY 5-BIT DATA POINT, ADD APPROPRIATE CODES (BINARY ADDITION)

FIG. D—Summary binary scaler outputs.

After detection, the information can be directed to a conventional decommutator and analog display system, or it can be identified and stored as quantized information on magnetic tape in a format compatible with a digital computer.

• **Encoder**—The function of the encoder is simply to determine which of the codes from the set representing all possible data values best represents the value of a data sample—and to cause this particular code to be transmitted. The particular code group chosen for use with the DIGILOCK system is a "maximum redundancy Reed-Muller" group which, for this system, consists of 32 different codes, each 16 digits long.

This code set has orthogonal properties and can be formed by systematically summing the outputs of a binary scaler as shown in the table (Fig. D). Quantization to 32 levels must be accomplished by the analog-to-digital converter, which establishes a discrete set of commands controlling the generation of the code corresponding to the level established in the quantization process.

The 32-level quantization implies that each data sample contains five bits of information and that this information can be encoded in a 5-digit binary code. A simple binary code, however, does not possess orthogonal characteristics. The 16-digit code can be detected at a lower signal threshold than could the 5-digit code, even though both might be allotted equal transmission power and the 16-digit code would require 16/5 the bandwidth of the 5-digit code. This is an example of increased efficiency resulting from bandwidth expansion techniques.

• **Timing and rate control**—A timing and data rate control system, consisting of a crystal oscillator and a binary scaler of several stages, allows the timing system to be "slowed down" by factors of two simply by positio one switch. The analog-to-digital c verter uses a "stairstep" voltage ge ator and a comparator amplifier.

In operation, the timing system s a 5-stage binary scaler through 32 j sible states while a stairstep voltag being generated. When the compar amplifier indicates that the stair voltage first exceeds a data sample, inhibit signal stops the scaler, sto a binary measure of the data sam The specific on-or-off state of the st of the binary scaler is used as c mand information to simple digital l in the form of AND gates and CLUSIVE OR circuitry to generate one desired of the 32 possible co which can be formed by the bi addition of outputs from binary sc stages.

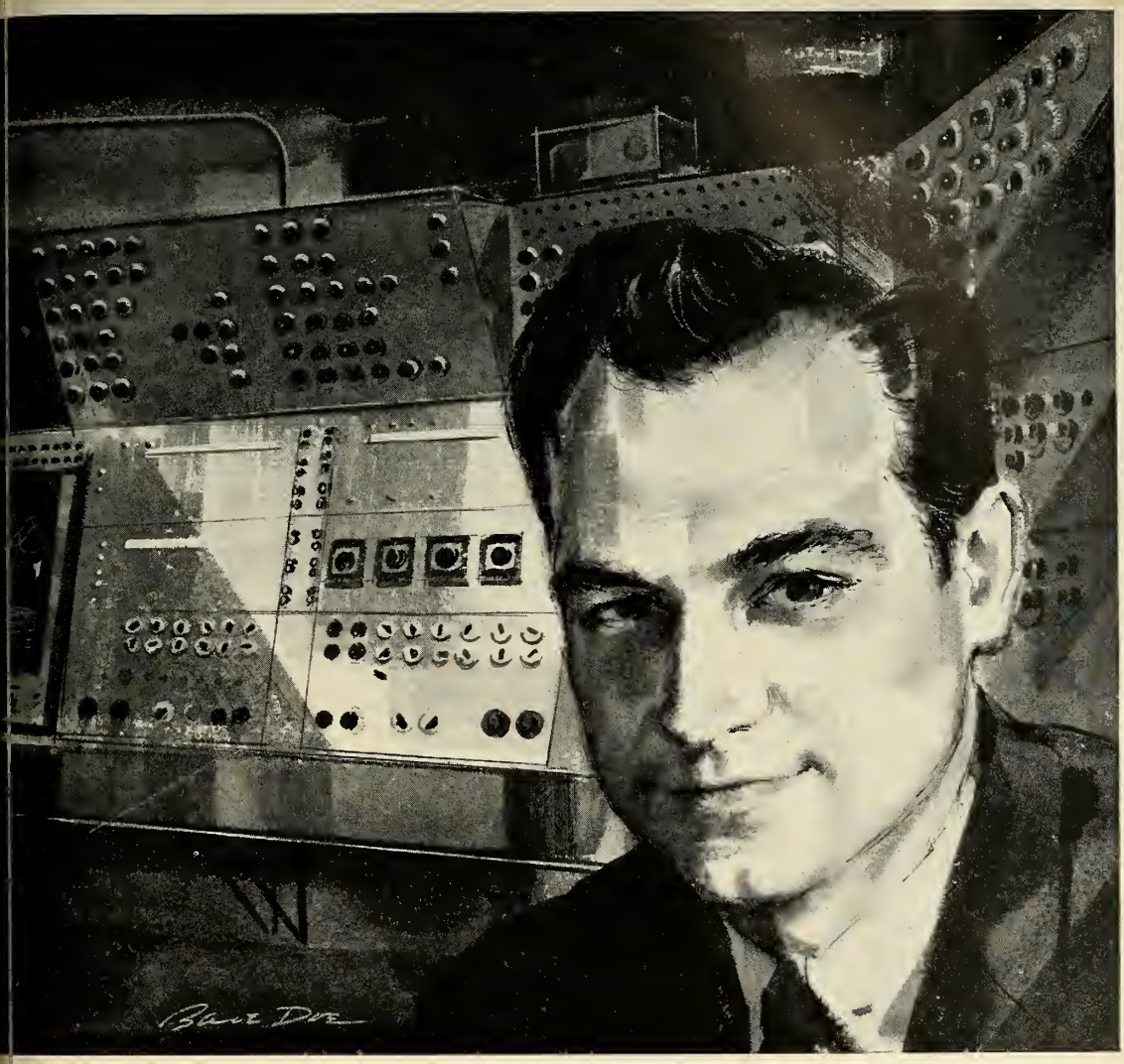
In operation, the system will use storage registers in the analog-to-dig conversion system; one will control code generator to transmit a code re senting a data sample quantized in preceding period while the second re ter is in process of storing a new q tized value. At the end of each w simple logic reverses the function the two storage registers. This appro results in nearly a 100% duty cycl transmitted information.

• **Synchronization**—System op tion depends of course on proper chronization of the decoder with airborne encoder. This is accomplis by a special code transmitted at s matic intervals, recognized by matched filter and detector and in a phase-locked flywheel sync sys to generate a gate signal. This si enables the "greatest-of" detector ing a short period surrounding match interval for each code t mitted.

• **Prototype evaluation**—First n surements of DIGILOCK operation portedly showed results within 3 dl that predicted. Several elements of system are not entirely new—in they are commercially available. means that application of the syste early missions would not require c plete replacement of all components for example, a world-wide ground tion network.

The airborne system particul lends itself to simple transistorized cuitry and extremely low opera power requirements. The complete borne system weight, excluding transmitter, is about 5 pounds.

Study of the system as designe dicates that maximum data rates such that one DIGILOCK system provide information bandwidth eq lent, for example, to several ty FM/FM systems and, therefore, be of extreme value in near-future missile system development progra



C. L. Hampton

Computer expert Chuck Hampton is a man with problems. As head of our Avionics Division's Computer Applications section, Hampton pits his analog and digital computers against the mathematical intricacies of infrared research, optics, spectral background studies, feedback control, and weapon system design.

At thirty, with a BSEE from the University of Illinois, Chuck Hampton is a Senior Engineer. He typifies the progress made at Aerojet by younger men of technical distinction, in electronics and many other areas.

We think the challenge is imposing, the opportunity impressive. May we see *your* resume? AEROJET-GENERAL CORPORATION, Box 296J, Azusa, California or Box 1947J, Sacramento, California. Attn: Director of Scientific and Engineering Personnel.

AEROJET-GENERAL CORP.®

THE GENERAL TIRE

AZUSA AND NEAR SACRAMENTO, CALIFORNIA · A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

Circle No. 13 on Subscriber Service Card.


RAUTH

J. Donald Rauth, 41-year-old general manager of The Martin Co.'s Nuclear Division, was elected vice president of the company, retaining his post as general manager of Martin-Nuclear. Rauth, who joined Martin in 1940 as a draftsman, served in turn as a group engineer, project engineer on the *Gorgon IV* drone program, assistant chief project engineer for the company, and as manager of the Engineering Projects Division. He holds several patents for engineering inventions.

The Marquardt Corp. has established a Marketing Div. and Administration Div. in its Power Systems Group. **Paul J. Papanek** has been appointed director of Marketing and **Richard A. Davis,** director of Administration.

The two new divisions join the other three that make up the Power Systems Group at Van Nuys plant—Propulsion, Controls and Accessories, and Test. Customer Relations, Contract Administration, Marketing Planning, Proposals and Publications fall under the New Marketing Div.

In other personnel changes, **L. E. Dunn,** former chief engineer, has been appointed Test Division director; **R. K. Wead** replaces Papanek as manager-Customer Relations; and **F. M. DeLaval** has been named manager-Marketing Planning.

The new divisions are part of a long-range organizational realignment which began in January.


BEAGLES

Robert Beagles has joined Packard Bell Electronics Corp. as chief engineer-advanced development, Technical Products Div. Beagles has been associated with RCA, Bendix and North American Aviation during the past 18 years in radar and missile electronics. He comes to Packard Bell after six years with RCA, where he was responsible for systems engineering activities in airborne radar, electronic warfare, and airborne communications and navigation.

Coleman Engineering Co., Inc., has formed a wholly owned subsidiary, Coleman Electronics, Inc., to manufacture the company's "Digitizer" and related automatic data handling and control systems. **T. E. Coalson** has been elected vice president and will serve as general manager of the new subsidiary. **T. C. Coleman** will act as president of both companies. Coleman has also promoted **C. A. Brosterhous** to chief engineer and named **R. D. Farnham,** former Eastern manager of the company, director of Customer Relations.

James R. Black has been appointed manager of the Microelectronics Laboratory in the Solid State Electronics Department of Motorola's Military Electronics Division. Formerly an associate professor in Electrical Engineering at the University of Michigan, Black will be responsible for research and development in microelectronics and applications to microminiaturized and integrated function circuitry.

William D. Caffin is contract administrator for the Electromechanical Division of Bowmar Instrument Corp. He was formerly assistant sales manager of Daystrom Transicoil Div., where he served in management and engineering capacities.


CAMPBELL

Transval Electronics Corp. has appointed **Jack Campbell** director of government contracts. The appointment reflects the broadening scope of the company's activities in past months in the field of missile, aircraft and drone electronics. Campbell came to Transval from Hayes Aircraft, Birmingham, Ala., where he was project engineer on the C-119 program.

James O. Seamans, new *Sparrow III* program manager for the Missile Systems Division of Raytheon Co., was formerly *Sparrow III* technical director at the Bedford Laboratories, where engineering of the weapon is carried on. Seamans joined Raytheon in 1951 as senior engineer responsible for flight testing after leaving the Western Electric Co. in Winston-Salem.

George S. Schairer was elected vice president for research and development at Boeing Airplane Co.


VLCEK

Adolph Vlcek, Jr., has been named director of manufacturing at Martin's Baltimore Division, succeeding **Vernon R. Rawlings,** general manager of Martin's newly created Activation Division. Vlcek joined Martin as a metal bench helper in 1930 at the age of 16 and worked his way up to Quality Control manager, tooling manager, and Manufacturing, Engineering and Research manager before promotion to his new position.

Benjamin O. Delaney has been na to the new position of assistant man for Missile Operations under the Techr Operations Manager at Vitro Laborato Silver Spring, Md. Delaney, form head of the Missile Projects departm held several engineering positions served with the rank of commander in U.S. Navy prior to joining Vitro in 1


SWINDELLS

Dr. Frank E. Swindells has been moted to man of research for p tosensitive dev and chemical search for the E tronic Tube Divi of Allen B. Mont Laborato Inc. He was merly manager chemical resea with emphasis transparent and black background sc phosphors, after coming to Du M from the Photo Products Dept. of E Du Pont de Nemours & Co.

Leang P. Yeh, telecommunications gineer specializing in communications missiles, satellites and space vehicles, joined Page Communications Engine Inc., as consultant to the vice presi and director of Engineering. Yeh also serve as technical advisor on Pa international projects now underway Libya, Greenland, Iceland, England, the Pacific Ocean area. Before joi Page, Yeh was with the General Ele Co., and previously spent three years Westinghouse Electric Corp.

John C. Pitchford, recently ret from the Air Force as a colonel, has b named project manager at Benson-Le Corporation, Los Angeles manufact of data processing equipment. He study future developments of the c pany's standard product line. Pitchfo last service assignment was Project Of for the deployment of IRBM's to NA

John B. Rittenhouse, Research Gr Supervisor in Chemistry at California stitute of Technology's Jet Propul Laboratory, was named recipient of award by the American Society for T ing Materials for a paper he wrote on chemical effects of certain acids on m used in rockets.

Monogram Precision Industries, has named **Victor Gehrig** and **Robert Lehman** senior vice presidents. Gel formerly vice president-production, i charge of Monogram's customer prod divisions in Culver City. Lehman, was general manager of the electro divisions in Los Gatos, Calif., now h the proprietary products divisions in company's San Fernando Valley facili

ida Electronic
loyment up 50%

Missile electronics are continuing om in Florida. A new State De- ment Commission survey shows ndustry now has 15,000 employees npared to 10,000 only a year ago. ory sales are estimated at upwards 200 million with annual payrolls ng about $60 million.

s one of the nation's fastest grow- lectronic centers, Florida during past 12 months added 10 new s and there were 10 major expan- The survey, incidentally, excludes of the work being done at Cape veral and Eglin AFB.

ptimistic officials are predicting expansion will continue and that tate's electronic output may triple ve years. **Martin-Orlando,** which g operations only a little over a ago, now has 6500 employees and state's largest single manufactur- mployer.

Force TIF
ig Distributed

he new Air Force missile/aircraft rt equipment "Technical Informa- File" is now being distributed to actors. First issue of TIF (M/R 15 p. 21 and M/R June 22 p. 13) more than 1500 items which can sed by missile system designers. t of the catalogue, which will panded, is to obtain maximum ardization and minimum duplica- of equipment. It may be fore- r of service-wide TIF.

ir National Guard Squadrons at on, Albuquerque and Windsor cs, Conn., are being equipped with *inder* air-to-air homing missiles. **Philco-General Electric**-produced on is being installed on F-100 sabres flown by the three squad- n

ow **Chemical** is producing 5000 ds of high-temperature lubricants e Air Force. The two polyphenyl hs—bis (phenoxyphenyl) ether and phenoxyphenoxy) benzene will be ated by Wright Air Development r for engine usage. Production is ows Midland, Mich., plant.

ioneering cryogenic manufacturer **Cambridge Co.,** Lowell, Mass.— een acquired by **Standard Steel** from the **Carrier Corp.** . . . For apco Group West Coast Division, **pson Ramo Wooldridge** is plan-



FULL-SCALE model of Project *Mercury* antenna fairing under test by Collins Radio engineers. Complete communication system, scheduled for delivery this month, is being built by Collins for McDonnell Aircraft. It consists of 14 electronic subsystems providing pilot voice communication during orbit; command functions within capsule for all phases; telemetry during all phases; tracking during orbit; voice communication and beacons for recovery/rescue; plus antennas.

ning a $2 million plant at Anaheim, Calif. Work will start in September on the facility which will produce hydraulic hardware and other precision missile/aircraft components. . . . Just opened—a 129,000-square foot addition to **Motorola's** Semiconductor Product Division in Phoenix. Company says its just the beginning of growth pattern for its Arizona operations. . . . In Mountainside, N.J., the **Cross Co.** of Detroit has acquired **Stephen F. Malaker Associates** and formed **Cross-Malaker Laboratories Inc.** to combine nuclear and electronic sciences "into an overall, integrated, automation concept." . . . On the West Coast: **Electric Steel Foundry,** a missile contractor supplier, has purchased **Pacific Alloy Engineering Corp.** . . . In *Polaris* speedup **Lockheed Aircraft** is setting up within its Missiles and Space Division a new unit headed by Arthur L. Hubbard. Purpose is to consolidate missile modification and checkout functions for test operations at Santa Cruz and Long Beach and for *Polaris* assembly at Sunnyvale. . . . **Hardesty Research and Development,** producer of filament-wound plastic rocket cases and pressure vessels, is expanding into a 100,000-foot plant at Santa Ana.

USAF Eyes *AA-5103*

An air-to-ground version of **Nord Aviation's** AA-5103, a two-stage solid-fueled missile controlled by radio link along its entire flight path, is reported under evaluation by USAF.

Nord Aviation has just made a deal with **Bolkow-Entwicklingen** of Germany to manufacture the air-to-air version of the 295-pound missile.

Astrodyne Control Shifts

North American Aviation is acquiring full ownership of **Astrodyne, Inc.,** McGregor, Tex., which it founded jointly with **Phillips Petroleum Co.,** in February, 1958, to produce, research and develop high-energy rocket fuels. Terms were not disclosed.

NASA's Novel Rocket



SIX-STAGE ROCKET designed by the National Aeronautics and Space Administration to test re-entry friction. Unlike other rockets, the stages are phased 1, 2, 3, 6, 5 and 4. The first three boosters send the vehicle up to about 200 miles, while the last three send the vehicle hurtling towards earth at 16,000 m.p.h. The re-entry trail—to the point where the final stage is consumed by friction with the air—is followed by radars and radio receivers.

Expanding the Frontiers of Space Technology in

GUIDANCE

■ As systems manager for such major projects as the Navy POLARIS FBM; DISCOVERER Satellite; Army KINGFISHER; Air Force Q-5, X-7 and X-17; Lockheed Missiles and Space Division is deeply involved in improving existing guidance systems and designing solutions to new problems.

ENGINEERS AND SCIENTISTS

The Division's projects and research and development programs reach far into the future and deal with unknown and stimulating environments. It is a rewarding future with a company that has an outstanding record of progress and achievement. There are inertial guidance positions now available at various Lockheed facilities and a particular need at our Vandenberg AFB location. If you are experienced in guidance work in one or more of the following areas, or in related fields, we invite your inquiry: circuit design; hydraulics; dynamic analysis; servo systems analysis and design; transistor circuit design or analog computer simulation.

Write: Research and Development Staff, Dept. G2-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed
MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO • HAWAII

propulsion engineering

Heat and mass transfer . . .

as they apply to missiles and aircraft are thoroughly covered in a new Air Force bibliography available from the Commerce Department's Office of Technical Services. The 172-page book is not only a bibliography of work in heat transfer and mass transfer, but also a volume of abstracts dealing with specific problems. W. J. Christian and T. H. Schiffman, Illinois Institute of Technology, compiled the volume for Wright Air Development Center. They split the volume into three parts: Local and average mass transfer from surfaces under isothermal and non-isothermal conditions; local and average heat transfer from pertinent airfoil surfaces; and correlations between heat and mass transfer. It's available from OTS at $3.00. (Order PB 151517.)

Low humidity storage containers . . .

can substitute for some types of dehumidified warehouse storage, says an Army Ordnance research team. Sprayable, strippable plastic containers in which it's possible to maintain low humidity statically or dynamically are reviewed in another Commerce Department, OTS, publication—"Standardization Study of Long-Term Storage Process: Strippable Film Containers," by W. J. Shields and W. F. McTeague, Frankford Arsenal. The 20-page study concludes that the plastic containers "are suitable substitutes for dehumidified warehouse storage of assembled, irregularly shaped material." Essentially, they are simply coatings sprayed on material requiring storage. Advantages: low cost of fabrication and maintenance, mobility of stored wheeled items, light weight, ease of removal.

Storage, without warehouse, up to two years . . .

is possible with the coatings. Storage of more than 10 years is possible with top coatings of mastic, or with mastic and aluminized paint. The report compares adhering and nonadhering film materials and discusses maintenance requirements, cost, and durability of one to three coats. Some industry people have been thinking about these coatings in terms of solid propellants. The report is available from OTS at 75 cents (order PB 151295.).

Astrodyne's insulation . . .

for solid-propellant motors may soon find some non-missile civilian uses. At least that's the hope of **Astrodyne** officials who say one firm already is interested. Astrodyne will not name the firm, its field of operations, or its possible use for the rubber and asbestos material described in this column July 6. Officials say that in the meantime prospective users of the material probably still have to be defense contractors, but "the situation hasn't come up yet." The insulation itself is not actually classified, but Astrodyne and the Navy are guarding details of its composition. Possible civilian uses—Astrodyne will neither confirm nor deny any of these—include insulation for high-temperature reacting vessels or combustion chambers; packaging; railroad refrigerator car and reefer truck liners.

Beryllium patent is available . . .

for public use. Patent number 2,872,363 has been released by the Atomic Energy Commission. It is for a "Method of Working Beryllium." A beryllium billet is sheathed with a jacket of copper or stainless steel. It can then be worked by drawing or similar means at 570°F to 750°F. Another patent just released by AEC (No. 2,872,310) is for producing a binary zirconium antimony alloy which is extremely hard and corrosion-resistant.

ls' 'Zoonik' Launching uses Calm Speculation

Vashington—Russia's announced e launching of two dogs and a it has raised more speculation than an.

Radio Moscow began excitedly and atedly to announce the launching he "zoonik" July 6—four days t it took place.

The Russians said the dogs—Otnaya and Snezhinka—and an unified rabbit were boosted to a at height" by an IRBM and successfully returned to earth.

The payload weighed more than 0 pounds. The Russians said it was



HSE dogs, shown training in rocket , may have taken latest flight.

heaviest ever hurled into space. e M/R Oct. 20, 1958)

No figures were released on how g the dogs and rabbit traveled.

The Russians said the launching ked Otvazhnaya's third trip into e. It came six weeks after the y launched Monkeys Able and r in the nose of a *Jupiter* and successfully recovered them more than 50 miles down the Atlantic Missile ge.

The Russians said instruments rd the dog and rabbit flight telered information on the ionosphere, treams and the ultraviolet part of solar spectrum.

The Russians attempted to make nost of the launching. Radio Mosov interrupted a broadcast of a footal match to announce the four-day news. The bulletin then was anced repeatedly and Soviet academians hailed the event as "another iph of Soviet science."

Soviet commentators declared that missile that launched the "zoonik" the most powerful single-stage booster ever launched to date. They said it was "much stronger than anything the Americans have."

However, the Russian boasts brought little of the alarm previously produced by Soviet space feats.

Despite the Soviet boasts of paving the way for space flight, the "zoonik" was nothing particularly new. Russia has announced repeated launching and recovery of dogs. The United States has recovered two monkeys.

Moreover, the announcement followed more than six months of Russian silence. Not since the sensational launching of *Lunik* have they indicated activity in space exploration. And U.S. scientists have been expecting the worst—an announcement that Russia has put a man into orbit.

The reaction is speculation as to whether Russia's space program may —for some unknown reason—have slipped.

Missile Designed for Firefighting

San Diego—**Solar Aircraft Company** has devised a new guided missile fire fighter that is launched like a rocket and hovers like a helicopter.

Conceived by Solar engineers, and dubbed the *"Firefly,"* it will reportedly fly anywhere within five miles in 40 seconds, just a fraction of the time required by conventional firefighting equipment. It is fired and guided by push buttons to its destination. an air crash or other site of potential fire.

After reaching a crash scene, the unmanned craft turns into a helicopter and hovers over the area. The remote operator can then flip a switch releasing more than a ton of extinguishing liquid over the danger area.

According to Solar engineers, the *Firefly* does not require any new technology, but can be built by perfecting existing systems.

With helicopter blades in its tail and a fire nozzle in its nose, the *Firefly* looks like a small jet aircraft. A solid propellant rocket under the fuselage shoots the missile into cruise altitude. When in flight, Solar reports, the bird operates as a fixed wing aircraft.

The three rotor blades are locked back to serve as tail surfaces. It is transformed into a helicopter by unlocking its rotors and firing up small rocket motors in each rotor blade tip.

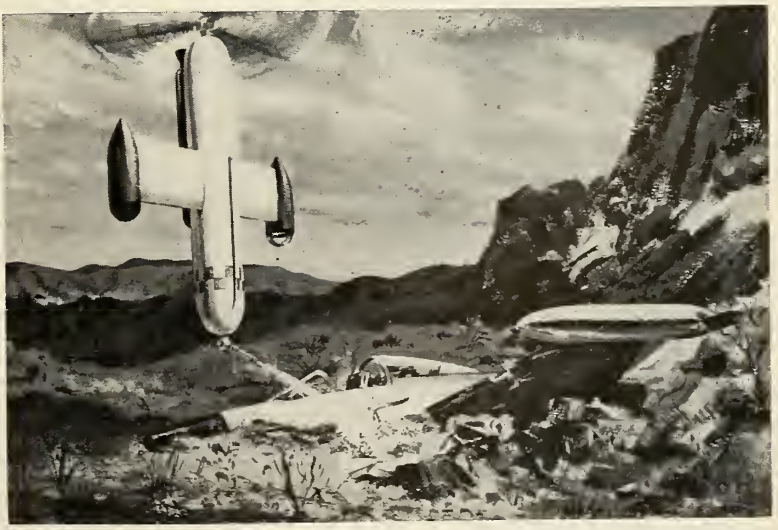
Solar engineers report that the missile-helicopter reaches its goal in three flight stages: 1) a ballistic trajectory, 2) powered level flight and glide and 3) deceleration and hovering.

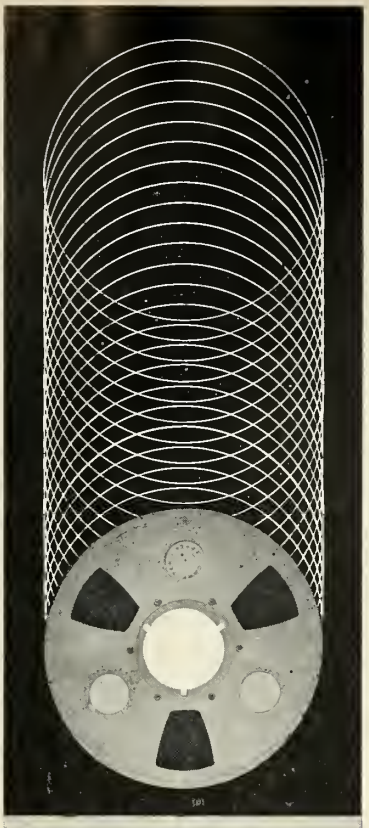
The bird picks up commands from a remote operator through an electronic "brain," and translates these into mechanical control of its devices. Radar and electronic sensing devices in the vehicle enable the operator to discover where and how severe a fire is and where and how much fire extinguishing fluid to release.

Mounted on a launcher which has a quick-opening metal-ribbed plastic housing for protection against inclement weather, the *Firefly* would be placed opposite a control tower near landing strips of an airfield.

Ground controls, consisting of a console and radar panel, would be located in the airfield's control tower. The radar can be tied in with equipment already present at most military and commercial airfields, Solar says.

The *Firefly's* body, exclusive of rotors and dispensing nozzle, is some 16 feet long, and its wing span is about the same. It weighs about 5000 pounds, including its payload of extinguishing fluid.





AMPEX PRECISION REELS:

Maximum Security with Minimum Clearances

Ever have trouble with the edge-track data on your magnetic tape? Possibly an Ampex Precision Reel could have prevented the difficulty. How? The secret is in the metal. Only Ampex makes precision reels of magnesium. It gives you thick, rigid, nontapered flanges that protect the tape. A strong hub, too, that doesn't distort under pack pressure. And because magnesium is light, Ampex achieves this extra strength within the weight limits your recorder is accustomed to. All this, together with a calculated design that means minimum clearances and tolerances, gives you a better tape pack—pass after pass. The security of Ampex Precision Reels is available in all conventional recording sizes.

AMPEX MAGNETIC TAPE

934 CHARTER STREET, REDWOOD CITY, CALIF.

Circle No. 14 on Subscriber Service Card.

west coast industry . . .

By FRED S. HUNTER

Someone said recently, "You can't fire unemployment statistics at the Russians." This seems to us to be a reasonably sagacious observation on the political byplay going on between the congressional delegations from New York and California over the distribution of defense contracts. There's no argument about California having a disproportionate share of present defense contracts. But there's also no argument about California having the research capabilities, the test centers, the manufacturing facilities, the trained personnel and the overall know-how to do the weapons job. You can't change these factors by legislation.

Keeping factory doors open in a phase . . .

of defense procurement which the various military services have to take into consideration. You'll recall the hue and cry that went up in California when the Air Force cancelled out the *Navaho* intercontinental missile and **North American Aviation** promptly began laying off employees. Then, a little later, North American picked up two juicy contracts, one for the F-108 and the other for the B-70, and a lot of people were surprised because the B-70 contract didn't go to **Boeing,** the Strategic Air Command's specialist in big bombers. So what happened? Boeing became a partner for development and assembly of the wing and is in the B-70 program in a big way.

Invitations to submit proposals for the missile . . .

carrier for the *Eagle* project have been issued by the Navy to several of its experienced prime contractors, such as **Chance-Vought, Douglas-El Segundo, Grumman, McDonnell** and **North American-Columbus.** We'll venture a prediction that the manufacturer capturing this plum will be Chance Vought. Our reasoning takes into consideration the cancellation of the *Regulus II* and the F8U-3. We're assuming, of course, that there will be little to choose between designs submitted and that all will meet requirements.

First blasts from the *X-15*'s rocket engines . . .

will be echoing in the upper altitudes over Utah and Nevada by the end of this month or early in August with the first powered flight of the research craft. Of comparable significance is the fact that the No. 3 aircraft has been turned over to the flight test group, completely finished as far as manufacturing is concerned. This is the vehicle in which the big 60,000-pound-thrust engine being specially developed by **Thiokol's Reaction Motors Division** will be installed first. Later on, the No. 1 and No. 2 planes will be retrofitted. North American has a group test engine at Edwards Air Force Base now and is scheduled to get a flight engine before long.

Research activities keep right on . . .

becoming more diverse and complex in the missiles and rockets industry. **North American's Rocketdyne Division** recently found it advisable to reorganize its research department into two groups, one a physical sciences section, the other an engineering sciences section. Under physical sciences come physics and mathematics, combustion and heat transfer, electrical propulsion and a chemical group comprising theoretical chemistry and chemical engineering. Under engineering sciences come propulsion devices and systems, experimental instrumentation, research design and a special-products group made up of igniters and special devices, igniter fabrication and solid propellant process development.

Peter Masefield, Bristol Aircraft managing director . . .

evoked an appreciative laugh at the recent IAS session with this observation: "The principal function of an advanced design department nowadays is to keep up with the public relations department."

NAVY

6,000—Newport News Shipbuilding and dock Co., Newport News, Va., for con-ıction of two nuclear-powered subma-es that will carry *Polaris* missiles.

1,541—Electric Boat Div., General Dy-nics Corp., N.Y., for construction of a lear-powered submarine that will y *Polaris* missiles.

01—Hazeltine Electronics Div., Hazel-Corp., Little Neck, L.I., N.Y., for gn, development, testing and produc-of one intercept tracking and con-group AN/SPA-43.

00—Massachusetts Institute of Tech-gy, Cambridge, for conducting a feasi-ty study encompassing those aspects fundamental and applied research re-ed for the evaluation of a high-speed puter system.

16—Heintz Div., Keisey Hayes Co., adelphia, for FFAR rocket head.

47—American Machine & Foundry Co., falo, for warhead, MK37-0.

86—Raytheon Manufacturing Co., Wal-n, Mass., for investigation of methods improving the operation of cross-field ntrant beam devices.

0—North American Aviation, Inc., Mis-Division, Downey, Calif., for conduct-an engineering study of the applica-of sandwich and/or other light-ght structural design and/or combina-thereof, to the hydrofoil and strut ion of Sketch PD 4374. Titanium skins l be used.

7—Philco Corp., Philadelphia, for vari-type oscilloscopes.

0—Cooke Engineering Co., San Mateo, f., for assembly and check-out of mo-missile tracking units.

0—Whirlpool Corp., Saint Joseph, n., for developing, testing and furnish-five Type I thermoelectric tempera-ture-controlled chambers including con-trol circuitry and power supplies.

$39,085—Sperry Rand Corp., Sperry Gyro-scope Co., Div., Sunnyvale, Calif., for re-search and development of missile-aircraft interference study.

$36,004—Nuclear Electronics Corp., Philadel-phia, for radiac computer-indicator (Scaler) CP-297.

AIR FORCE

$6,000,000—Avco Corp., Lycoming Div., Strat-ford, Conn., for production of missile rocket chambers for second- and third-stage chambers of "second generation" *Minuteman* ICBM.

$2,000,000—Westinghouse Electric Corp., for manufacture of experimental "hardware" for infrared, reconnaissance, communica-tions, telemetry, flight control and other military applications, using molecules as building blocks.

$1,500,000—Telecomputing Corporation, Los Angeles, for the manufacture of spare valve components.

$810,000—Massachusetts Institute of Tech-nology, Dept. of Aeronautical Engineering, Instrumentation Laboratory, Cambridge, for study, design, fabrication and test of advanced inertial navigation system.

$800,000—The W. L. Maxon Corporation, N.Y., for fabrication and testing of a fly-able model of the AN/APS-99 (XY-1) radar.

$796,664—Thiokoi Chemical Corp., Utah Div., Brigham City, for 88 M-16E-1 rocket en-gines for the *Mace* missile.

$500,000—American Electronics, Inc., Los Angeles, for design and manufacture of tactical ground support equipment for the B-58 "Hustler" jet bomber program (subcontract from Convair Div. General Dynamics Corp.).

$439,986—Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co., Ana-heim, Calif., for helium pressure regula-tors for use on the *Titan* ICBM (subcon-tract from The Martin Co., Denver).

$331,416—Sperry Rand Corp., Sperry Gyro-scope Co., Div., Great Neck, L.I., N.Y., for microwave command guidance system op-eration and support.

$192,000—Sperry Rand Corp., Sperry Phoenix Co., Div., Phoenix, Ariz., for guidance data transponder set.

$191,227—Motoroia, Inc., Chicago Military Electronics Center, for electron tubes.

$159,940—Wentworth Institute, Boston, for research directed toward physical and chemical properties of the upper atmos-phere.

$90,000—Stanford University, Stanford, Calif., for continuation of research on "Micro-wave Solar Radiation."

$50,301—Eitel-McCullough, Inc., San Carlos, Calif., for various electron tubes.

$42,079—Litton Industries of California, Beverly Hills, for continuation of research on "Electromagnetic Acceleration of Gas Plasmas."

$38,574—University of Illinois, Urbana, for investigation of the use of internal fric-tion techniques in the study of diffusion and phase changes in metals.

$35,000—The Catholic University of America, Washington, D.C., for continuation of re-search on "Studies of Molecular Physics."

$30,000—University of Western Ontario, Lon-don, Canada, for research on gas scintil-lations from ionizing radiations.

$28,980—Mass. Institute of Technology, Cambridge, for continuation of research on "Fracture under Plastic Flow."

ARMY

$60,159,214—Western Electric Co., N.Y., for work on the *Nike-Hercules* system, includ-ing missiles, ground equipment, repair parts, engineering services and improve-ments on the system (five contracts).



TOPFLIGHT RESULTS

. . . when you place your classified advertising in MISSILES AND ROCKETS Magazine. Every week you can reach about 30,000 top men in the booming missile and rocket industry. If you want to buy . . . sell . . . seek employment . . . send your classified message today to

MISSILES & ROCKETS

1001 Vermont Avenue, N. W., Washington 5, D. C.

BARCO

Flexible Joints for Handling Liquid Oxygen and other missile fuels

BARCO has the *specially designed* flexible joint which has passed the official "Qualification Test":

—Used in piping on fueling lines handling liquid oxygen, JP4 and JP5 fuel, white and red fuming nitric ocid, and other chemicals.

—Provides swivel motion to ollow for thermol exponsian ond contraction.

—High corrosion resistonce. Other speciol designs availoble. For temperotures from −320°F. to +1,000°F., ond higher. Also joints for gas and hydraulic service.



Potent Pending

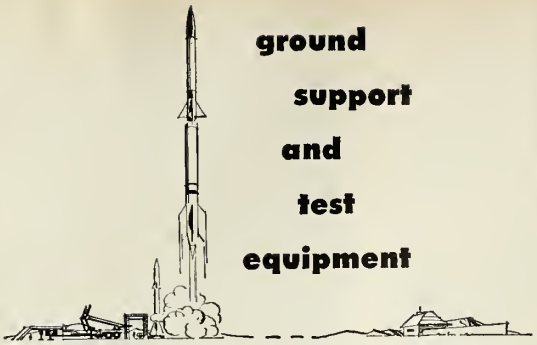
(Right) 6"—180° Flonged Barca Flexible Joint for use in fueling line handling liquid propellont. Also straight ond 90° designs.

AIRCRAFT DIVISION

BARCO MANUFACTURING CO., Serving Industry Since 1908

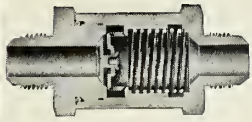
566H Hough St., Borrington, Illinois

Circle No. 15 on Subscriber Service Card.



ground support and test equipment

REPUBLIC VALVES



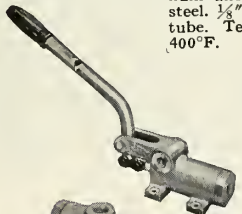
FREE-FLOW CHECK VALVES

No leakage. 3000 psi. Very low pressure drop. Can be furnished to open at ¼ to 35 psi. Brass, stainless steel, or aluminum alloy. ⅛" to 2" pipe or tube. Temp. range -65° to 200°F.

RELIEF VALVES

Quick unloading, smooth operation. Guided shut-off piston with stainless steel or Nylon seat. Pressure range to 4000 psi. Brass, aluminum alloy, or stainless steel. ⅛" to ¾" pipe or tube. Temp. range to 400°F.





HAND PUMP

For hydraulic applications on missile carrier and support equipment. Double-acting. 2 cu. in. displacement per cycle. 1000 psi. working pressure. Aluminum alloy body, stainless steel trim. -65° to 160°F.



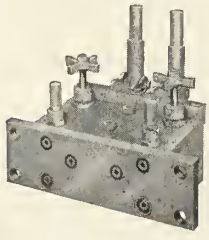
LEVELATOR VALVE

For automatically maintaining height and level condition in any vehicle with air spring suspension. Controls swaying in transit, and off-level position while standing. Applicable to trucks, buses, trailers, carriers, cranes, etc.

LO-TORQ SELECTOR VALVES

Smooth, easy operation, with low turning torque because of pressure balancing design. 0 to 6000 psi. Bronze, steel, or aluminum alloy. ⅛" to 2" pipe or tube. 2, 3, 4 ports.





DUAL HAND PUMP

2 pumps, 2 relief valves, and 2 needle shut-off valves, compactly manifolded for elevating mechanisms, hydraulic applications on ground support equipment, etc. Aluminum alloy body, stainless steel trim. -65° to 160°F.

Distributors in principal cities coast to coast



RM **REPUBLIC MANUFACTURING CO.**

15655 BROOKPARK ROAD • CLEVELAND 35, OHIO

Circle No. 16 on Subscriber Service Card.

contracts

$13,235,000—**Food Machinery & Chemical Corp.**, N.Y., for construction, and test operation of a Chemical Corps proc facility near Newport, Ind. (Prime contractor, The Li Company).

$13,141,192—**Chrysler Corp.**, Detroit, for repair parts on the missile program.

$8,295,767—**Raytheon Co.**, Waltham, Mass., for ground equi support equipment and engineering services for the missile (four contracts). Contractor has subcontract worl for the following and desires that subcontractors be loca the Northeast area: Drafting services, specifications v technical, manual preparation.

$6,938,450—**Blaw-Knox Company**, Pittsburgh, Pa., for consti of six *Atlas* launching complexes at Forbes AFB, Topeka

$4,800,000—**Western Electric Co.**, N.Y., for research and de ment study for a universal integrated communications (Unicom).

$1,572,334—**Independent Contractors & Engineers**, Dallas, fo struction of launch operations buildings, complexes A, B near Forbes AFB, Topeka, Kan. No subcontracts open.

$1,415,169—**Henry George & Sons**, Spokane, Wash., for operations buildings, site and utilities for SM-64 missile complexes A, B and C, near Fairchild AFB.

$1,000,000—**General Electric Co.**, for outdoor substations and gear for the AF Ballistic Missile Early Warning System near Thule, Greenland (subcontract from Greenland Co tors, Trenton, N.J.).

$430,080—**Ampex Corp.**, Los Angeles, for recorder/reproduce

$385,411—**C. H. Leavell & Co.**, El Paso, Texas, for missile as building at White Sands Missile Range, N.M.

$320,169—**Rheem Manufacturing Co.**, Downey, Calif., for desig development of warheads.

$254,460—**M.B. Electronics, Inc.**, New Haven, Conn., for an grated complex wave vibration testing system.

$219,652—**Western Electric Co., Inc.**, N.Y., for *Nike* spare and components (six contracts).

$170,632—**Consolidated Electrodynamics Corp.**, Pasadena, Cali oscillographs (two contracts).

$167,694—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., for parts and launching area items (three contracts).

$157,558—**B. B. Saxon**, Fort Walton Beach, Fla., for constr of two Model IV B launcher shelters for G/M launch f at EST site, Santa Rosa Island, Eglin AFB, Fla.

$105,728—**Douglas Aircraft Co., Inc.**, Charlotte, N.C., for spare parts and components (three contracts).

$84,289—**ARF Producers, Inc.**, Raton, N.M., for three miss di indicator ground stations.

$66,854—**Mandrell Industries**, Burbank, Calif., for airborne system.

$61,690—**Cooper Development Corp.**, Monrovia, Calif., for 32 motors, 32 window darts, 62 pyrotechnic fuses.

$50,893—**Dana Corp.**, Toledo, Ohio, for power take-off.

$46,800—**Dynamics Research, Inc.**, Los Angeles, for liquid ni converter.

$43,118—**Anderson-Nichols & Co.**, Boston, for development construction of one data recorder reproducer instrument.

$35,878—**Goodrich-High Voltage Astronautics, Inc.**, Burli Mass., for research on detailed technical scope of first demonstration of thrust.

$35,175—**Union Carbide Corp., National Carbon Co., Div.**, N.Y power pack Y-155 for *M31* rocket.

$25,726—**Beckman & Whitley Inc.**, San Carlos, Calif., fo streak camera with accessories.

BIDS

U.S. Army Engineering District, Detroit, Corps of Engi 1101 Washington Blvd., Detroit 31, Mich.—Construction of tower, including all related work necessary and appurt thereto at Selfridge Air Force Base, Mt. Clemens, Mich.— IFB Eng-20-064-59-99. Bid opening 16 July 1959.

Dayton Air Force Depot, Gentile Air Force Station, Dayton, Attn: Directorate of Procurement and Production. Tube el type 5957/E-37B in A/W Spec MIL-E1/1011A (sig) dated 1958 and MIL-E-1D dated 31 March 1958 S/N 5960-581-9956 each—IFB 33-604-59-779B. Bid opening 28 July 1959.

Directorate, Procurement and Production, Middletown Air Ma Area, Olmsted AFB, Pa. 9135-305-8199 (GSSF) propellan dimethyl hydrazine in accord with Spec MIL-D-25604B dat September 1958. Delivery to be made in contractor-furn returnable drums or Government-furnished drums at the o of the Government (to be packed 350 lbs. per 55-gal. dr Indefinite quantity. IFB 36-600-59-480. Bid opening 15 July

Electronics Supply Office, Great Lakes, Ill. Tube, electron: type 6249AA, MIL-E-1D, QPL, FSN N5960-543-1143—200 Alternate A—300 each; alternate B—400 each. Estimatec each. IFB 126-1283-59B. Bid opening 21 July 1959.

—when and where—

JULY

o Technical Commission for Aeronautics and Los Angeles Section of the nstitute of Radio Engineers, Third iennial Joint Meeting, Ambassador otel, Los Angeles, July 16-17.

American Rocket Society, Propellants nd Combustion Committee, "Propelnts, Thermodynamics and Handling onference," Ohio Union, Ohio State niversity, Columbus, July 20-21.

id Annual Institute on Missile Techology, Chief of Research and Delopment, U.S. Army, University of onnecticut, Storrs, July 26-Aug. 7.

Denver Research Institute of the niversity of Denver, 6th Annual ymposium on Computers and Data rocessing, Stanley Hotel, Estes Park, olo., July 30-31.

AUGUST

Institution of Investigation of Biological Sciences, Sponsor: Air Force Office of Scientific Research, Aeromedical Div., World Health Organization, Montevedio, Uruguay, Aug. 2-7.

Association of the U.S. Army, Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Aug. 3-5.

American Astronautical Society, Second Annual Western Regional Meeting, Ambassador Hotel, Los Angeles, Aug. 4-5.

William Frederick Durand Centennial Conference, The Problems of Hypersonic And Space Flight, Stanford University, Stanford, Calif., Aug. 5-7.

Institute of Radio Engineer's Professional Group on Ultrasonics Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

Institute of Radio Engineers, Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 18-21.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare, (classified), San Diego, Aug. 24-26.

Army-Navy Instrumentation Program, Annual Meeting, Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Aug. 31-Sept. 2.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkley, Calif., Sept. 2-4.

Air Force Association and Panorama: send Reservations to AFA Housing Bureau, P. O. Box 1511, Miami Beach, Sept. 3-6.

AFOSR/Directorate of Aeronautical Sciences, Office of Naval Research, National Science Foundation, Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Sept. 9-11.

Institute of the Aeronautical Sciences, Western Regional Meeting on Frontiers on Science and Engineering, Los Angeles, Sept. 16-17.

Standards Engineering Society, Boston Section Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, Conference and Exhibit, Chicago, Sept. 21-25.

Industrial Nuclear Technology Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology, Nucleonics Magazine, and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

Advertisers' Index

ejet-General Corp., Sub.-General Tire Rubber Co. 41
ency—D'Arcy Adv. Co.
rican Bosch Arma Corp. 2
ency—Doyle, Kitchen & McCormick, Inc.
nax Corp. 46
ency—McCann-Erickson, Inc.
n Mfg. Co. 47
ency—Armstrong Adv. Agency, Inc.
man & Whitley, Inc. 24
ency—Gerth, Brown, Clark & Elkus of an Francisco, Inc.
ix Aviation Corp., Bendix Products 39
ency—MacManus, John & Adams, Inc.
ro Instruments, Inc. 52
ency—Clyde D. Graham Adv.
Goodrich Aviation Products, a Div.— B. F. Goodrich Co. 6
ency—Batten, Barton, Durstine & Osborn, Inc.
Goodich Co., The, Sponge Products 20
Agency—Cunningham & Walsh, Inc.
o year Tire & Rubber Co., Inc., The .. 3
Agency—Kudner Agency
-ear Rivet Tool Co. 27
ird Corp., Div. of Siegler Corp. 51
Agency—Cole, Fischer & Rogow, Inc.
es Aircraft Co. 8
Agency—Foote, Cone & Belding
ir Mfg. Co. 33
Agency—Meermans, Inc.
National Business Machines Corp. ..34, 35
Agency—Benton & Bowles, Inc.
eed Aircraft Corp
California Div. 28
se System Div. 44
Agency—Hal Stebbins, Inc.
ole-Heppenstall Co. 23
Agency—A. E. Aldridge Associates
nsota Mining & Mfg. Co., Mincom D 31
Agency—Reach, McClinton & Co., Inc.
nsota Mining & Mfg. Co., Missile Indry Liaison 19
Agency—Batten, Barton, Durstine & Osborn, Inc.
op Corp. 10
Agency—Edwin Wasey, Ruthrauff & Ryan, Inc.
lic Mfg. Co. 48
Agency—J. N. Paterson & Associates
S.White Dental Mfg. Co., Industrial Div. 4
Agency—W. L. Towne Co., Inc.

EMPLOYMENT SECTION
eral Electric Co. 49
Agency—Deutsch & Shea, Inc.

CLASSIFIED

FIDELITY components, tape recorders, ...pes at wholesale prices. Send for ...E catalogue. **CARSTON 215-RM, East ...N.C. 28.**

■ ENGINEERS—SCIENTISTS ■

Work on

TOTAL SOLUTIONS

to Major Defense Problems

at General Electric's Defense Systems Department

You'll find greater opportunities in Systems Engineering in an organization whose charter has a breadth and scope seldom met in industry:

...to find total solutions to specific large scale defense problems requiring the integration of diverse fields of knowledge and equipments. These problems will be of sufficient magnitude and duration to justify the allocation by General Electric of considerable numbers of highly qualified scientists and engineers to contribute *systems program management* and *systems engineering support*—on programs such as:

ATLAS • DYNA-SOAR • SENTRY

...and other highly classified systems which cannot be listed here.

Immediate Opportunities for:

Systems Program Engineers
Systems Management Engineers
Guidance Equation Engineers
Data Processing Engineers
Electronic Systems Management Engrs.
Operation Analysts
Systems Logistics Engineers
Engineering Psychologists

Forward your confidential resume at an early date. Whereas growth potential here is evident—both for DSD and the engineers who join us—the posirions filled during these early months will carry significant "ground-floor" benefits.

Write fully to Mr. E. A. Smith
Dept. 7-G.



DEFENSE SYSTEMS DEPARTMENT
A Department of the Defense Electronics Division

GENERAL ELECTRIC

300 South Geddes Street
Syracuse, New York

Components Reliability: What's Needed?

The velocity of change in the exploding fields of missiles and their related technology is so great that each day's effort brings new concepts, new designs and new developments.

Still there apparently never seems to be a lack of such choice phrases as: "Let's advance the state-of-the-art," or "We have to beat them to . . ." (and you name the astronautical position), etc.

This is all well and good because this nation advances when there's a sense of urgency in the prodding. But it occurs that there's still lethargy in one important area; components reliability.

On page 14 of this issue of M/R, a guest writer makes the point that "too much engineering time and attention has been devoted to perfecting an *assembly* of complicated components, and not enough to perfecting individual parts and—even more important—the basic materials themselves." He says that a by-product of this misplaced emphasis is that much R&D effort is expended not in the laboratory but on the shop or factory floor—*the least efficient and most expensive place for R&D.*

To this we would like to add another tragic fact: Too many thousands of components going into missile systems are *not designed specifically* for the particular missile involved. In far too many instances they're off-the-shelf components usually designed for a variety of applications which too often are either modified or put beyond their performance parameters to fit into a missile system. Missile failures frequently are the costly result.

Let's cite some statistics pertaining to the *Nike-Hercules.* The system consists of approximately 1,500,000 individual parts, ranging in weight from the smallest fraction of an ounce to hundreds of pounds. It contains one quarter of a million feet of wire, two thousand vacuum tubes, and a host of functional components, such as gyroscopes, servomechanisms, and electronic computers. Approximately 80,000 engineering drawings are required to depict the system on paper. The prime contractor utilizes 3300 subcontractors and suppliers scattered across the country. The system alone uses—directly or indirectly—practically every raw material used by American industry, and provides work to some extent for nearly every type of industry in the country.

With so many subcontractors and suppliers it is virtually impossible for the prime, military or major subs, to specify in precise detail the performance parameters for *each* component. What usually happens is that in known critical systems areas, great reliability attention is paid to some components, while other components that might be subjected to the same vibration, shock and g-forces go practically unnoticed. The choice phrase—"random" failure is then offered to the public.

There is the argument that missile systems would be priced out of the pocketbook of the American taxpayer if each component were designed for a *specific* missile application. Components manufacturers themselves are reluctant to fire up assembly lines and produce for a *specific* application. "Why should we," many say, "when we can make one item and sell it to *many* customers?"

But as man prepares for space, government and industry are becoming more cognizant that he is too valuable a commodity to risk on a 98.2% reliability factor. More will be required to satisfy an American public which will become irate and aroused when the first life is lost.

Won't it be a little bit too late then to explain why more emphasis was not placed on this field? This fact should be told now: the reliability standards necessary for man in space will entail far more government action and fund support than has ever been evidenced in the past decade of missile development.

To say that it will be costly is an understatement. But you don't build a high-speed racing car that wins high-performance races by revamping an existing 65 hp engine. In the same way, you don't develop highly reliable spacecraft by using the same parts that are in the home television set.

What do we do about all this? First, it will be up to government to strengthen its present, mostly inadequate reliability requirements to such a par—as the enviable standards being achieved with fuzing and arming. Next, government must furnish the financial incentive for components manufacturers to start designing parts from the ground up. We must insure that components are given the most thorough testing in the laboratory—not in the shop or at a firing range—before they are wedded into the subsystems picture.

Then and only then will we see a *marked* improvement in reliability. Maybe then the scientists can quit sending up missiles with just prayers and hopes. We'll have something we *know* will work. This is as the science of rocketry should be.

Don Perry

Circle No. 17 on Subscriber Service Card. —>

SUBSCRIBER SERVICE
missiles and rockets

or additional information about any product or service advertised entioned in the editorial pages of this issue of Missiles and ts:

Jse the attached prepaid reply cards. Circle numbers shown on eply card that correspond with numbers appearing beneath items bed. If no circle number accompanies the article or advertise- give page number (and advertiser's name) on line provided at n of the card.

our requests for information will be forwarded promptly to the anies concerned.

NEW PRODUCT BRIEFS

I TUBE. An advanced type of itensifier tube that can "see" ng atom or the faintest star e developed by the Westing- ectric Corp.'s electronic tube r The new tube amplifies the ering at one end to produce an much as 3000 times brighter orescent screen at the opposite st important use of the new expected to be in the nuclear vere it will permit photographic f atomic particle reactions. Two y of Michigan Physicists, Mar- l and Lawrence W. Jones, have used the tube in a luminescent system to produce photographs from the path of a single perticle. Pictures can be taken tube of the minute light scin- that occur when certain ma- re struck by nuclear particles l by "atom smashers." The na- these fleeting scintillations gives formation on the nuclear re- ing observed. In astronomy, the ube cen further intensify the f giant telescopes when viewing et stars, or it could be used in to obtain pictures of far dis- s and galaxies. The tube can y its own output simply by the light output back through with a system of mirrors. Four ubes feeding into each other es would be able to produce of e single photoelectron.

N 225 on Subscriber Service Card.

N:R TUBE. A new high-sensitivity nal counter tube, WL-7243, de- o detect thermal neutrons in range from 8×10^{-3} to 8×10^{5} r/cm²/ second is now available th Westinghouse Electric Corpora- Ctaining an aluminum body, the 24 consists of three individual nal counters; each one inch in et and $10\frac{5}{8}$ inches long and vh BF, enriched to 96 per cent B on-10 isotopy. Operating et ves, the sensitivity of the WL-7243 pximately 13 counts/neutrons/ T pulses arising from incident na photons are sufficiently small based out by suitable discrimina- ir try.

N 226 on Subscriber Service Card.

PULSE GENERATOR. A completely transistorized battery or ac operated pulse generator has been announced by Solidyne. The unit features a design allowing versatile operating characteristics without the penalty of size, weight and heavy power drain usually associated with such units. Compactness and low power drain (less than 2 watts) are accomplished by unique transistorized circuitry. Short-circuit proof 15-volt positive and negative pulse outputs are provided with separately controlled emplitudes. Pulse width can be varied from 0.5 to 100 microseconds with a rise time less than 0.1 microsecond. Repetition rate can be continuously varied between 20 end 5000 pps and provision for en external sync. source is featured. Output pulse delays of up to 100 microseconds and anticipation up to 10 microseconds, relative to sync. output, are also included.

Circle No. 227 on Subscriber Service Card.

MIDGET RELAYS. Kurman Electric Company, a subsidiary of Crescent Petroleum Corp. has introduced the Series 51C Midget Relay; the smallest, lightest plate circuit relay offering self-wiping contacts, dc operation only. Standard adjustment—10 milliwatts. (51CB44D factory adjusted for 5 milliwatt operetion—others can be field adjusted—1 amp contact rating.) Adjustable 2 amp SPDT screw contacts. New rigid front pile-up. Variations—including 5 amp contact, H. S. Military relays coils to 20,000 ohms available. Mounting 2 #6-32 tapped holes on 0.437" centers.

Circle No. 228 on Subscriber Service Card.

OHMMETER. A new technique for accurately measuring low resistances (milliohms) has been devised by Electro Instruments, Inc. Possible applications include measuring the resistance of fuses, conductors and transformer windings. The new instrument will measure resistance to an accuracy or ± 1 milliohm over the full range of 1 milliohm to 9999 milliohms. Sensitivities of 100 microhms are available at slightly reduced accuracy. Scanning and print out modules can be added to form automatic component testing systems.

Circle No. 229 on Subscriber Service Card.

MISSILES AND ROCKETS
July 13, 1959
Expires Three Weeks After Above Date

NAME
TITLE/POSITION
COMPANY
Product Mfg./Service Offered
ADDRESS
CITY ZONE STATE

Card cannot be processed unless all information is given. Please limit requests to ten items.

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements																									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
• • Missile Literature																									
200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	
• • New Missile Products																									
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	

For Other Information Give Page Numbers: _____

POSTAGE WILL BE PAID BY ADDRESSEE

BUSINESS REPLY CARD
First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

MISSILES and ROCKETS
17 EAST 48th STREET
NEW YORK 17, N.Y.
SUBSCRIBER SERVICE DEPT.

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

MISSILE LITERATURE

PRESSURE SWITCHES. Consolidated Controls Corporation, a subsidiary of Consolidated Diesel Electric Corporation, has issued a new condensed catalog covering airborne pressure switches. The catalog lists general-purpose pressure switches, including pneumatic and hydraulic types, high vibration models and differential pressure units. In addition, special application units, such as altitude switches, high-temperature (650-degree Fahrenheit) models and pressure ratio switches, and aircraft gauges are discussed.

Circle No. 200 on Subscriber Service Card.

FERRITE DEVICES. Two new catalog sheets summarizing data on coaxial ferrite isolators and "Tee" ferrite circulators have been made available by Sylvania Electric Products Inc. Sylvania is a wholly-owned subsidiary of General Telephone & Electronics Corporation. Twenty-three types of coaxial ferrite isolators are shown on one of the sheets, covering frequencies from 1 to 11 kilomegacycles. Available units cover an octave of bandwidth over this range. The units offer isolation between 10 and 35 db with 1 db of insertion loss. Any of them can be delivered with up to 80 db isolation, according to Thomas D. Fuller, marketing manager of Sylvania's Special Tube Operations. "Tee" ferrite circulators as small as one-fourth the size of conventional circulators are described on the other sheet. The miniaturization has been achieved in part by designing the units in a shunt T configuration. One of the new units described, the broadband FD-TC501, offers 20 db isolation at 0.3 db insertion loss from 5.925 to 6.425 kilomegacycles.

Circle No. 201 on Subscriber Service Card.

THYRATRON. A new technical bulletin from CBS-Hytron, tells how Thyratron tubes differ from conventional amplifier types. In it, author Bud Tomer explains the mechanism of ionization, describes the "critical characteristic" curve, and discusses the effects of temperature on ionization time and tube life. Installation precautions are also given.

Circle No. 202 on Subscriber Service Card.

GENERAL CATALOG. The Electro Mechanical Instrument Division of Consolidated Electrodynamics Corp. announces the availability of its new General Catalog. The divisions's entire line of dynamic-measuring and recording instruments including oscillographs, data amplifiers and bridge balances; vibration measuring equipment; and power supplies is described. A summary of specifications for CEC standard galvanometers is also included.

Circle No. 203 on Subscriber Service Card.

BROCHURE. A brochure has been released by M. Ten Bosch, Inc. describing three basic Force Balance Pressure Transducers; Static Pressure, Pressure Ratio, and Pressure Difference. Transmission of computed quantities by means of electrical servo loops permits remote indication and tie-in with navigational computers, autopilots and other systems for aircraft and missile control are described.

Circle No. 204 on Subscriber Service Card.

WELDING MANUAL. The A
Welding Society has announ
publication of an Arc Welding
Manual specifically designed f
ers and instructors of manual n
welding. Contents include weldi
esses and recommended safet
tices, the metal-arc process, acc
exercises in arc welding, arc
equipment, identification of met
metals and their structure. Prol
lustrated, the manual contains
drawings, halftones and tables.
terial was prepared in respons
quests from schools and indu
a training manual of basic arc
information which would be a
instructors and a reference to
Fifty pages are devoted to arc
exercises and the various technic
be mastered by following the
tions.

Circle No. 205 on Subscriber Serv

CATALOG. Will Corp.'s latest
supplement describes the new
"StereoZoom" microscopes wit
terrupted, continuously variable,
fication and the 1959 Precisio
Ovens with electronic temperat
trol and higher heat range. Of
interest is the newly-designed
constant Temperature Circulator
rer, pump and temperature c
in one unit. The CTC is housed
compact and shock resistant cha
is equipped with a transistor re
cuit for precise control of ba
peratures. Other items include
ture determination, direct-readi
ance that simplifies dry'n wei
tines, and flexible, waterproof,
tapes which won't burn out end a
for heating large bulky contain
conducting pipes.

Circle No. 206 on Subscriber Servi

RECTIFIERS. A handbook on
rectifiers has been issued by
Electric Co. This book, which sh
of interest to all design enginee
such rectifiers, contains consi
basic information on the producti
and design characteristics. It d
all rectifier components manuf
by GE, contains application work
circuit information, cooling, anc
cation techniques.

Circle No. 207 on Subscriber Servi

BULLETIN. A new four-page t
bulletin, No. 2024, describing a
range frequency converter for 15
000 cps inputs is now availabl
Cox Instruments Division of Ge
Nankervis Company. The Cox T
Frequency Converter described
literature is designed to meet
requirements in laboratory and
applications. It is readily adapt
all types of pulse generating tr
ers. Applications include recorde
puters, digital indicators, milli
and data handling equipment. C
application specifications are pr
in the bulletin discussion and
data, including frequency rang
linearities at various output ratio
signals required; output current
ious linearities; accuracies; f
time constants; power requireme
closures; and price list for stand
modified versions.

Circle No. 208 on Subscriber Servi

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD

First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

MISSILES and ROCKETS

17 EAST 48th STREET

NEW YORK 17, N.Y.

SUBSCRIBER SERVICE DEPT.

POSTAGE WILL BE PAID BY ADDRESSEE

NAME.....

TITLE/POSITION.....

COMPANY.....

Product Mfg./Service Offered.....

ADDRESS.....

CITY.....ZONE.....STATE.....

Card cannot be processed unless all information is given. Please limit requests to ten items.

MISSILES AND ROCKETS

July 13, 1959

Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

- **Advertisements**

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

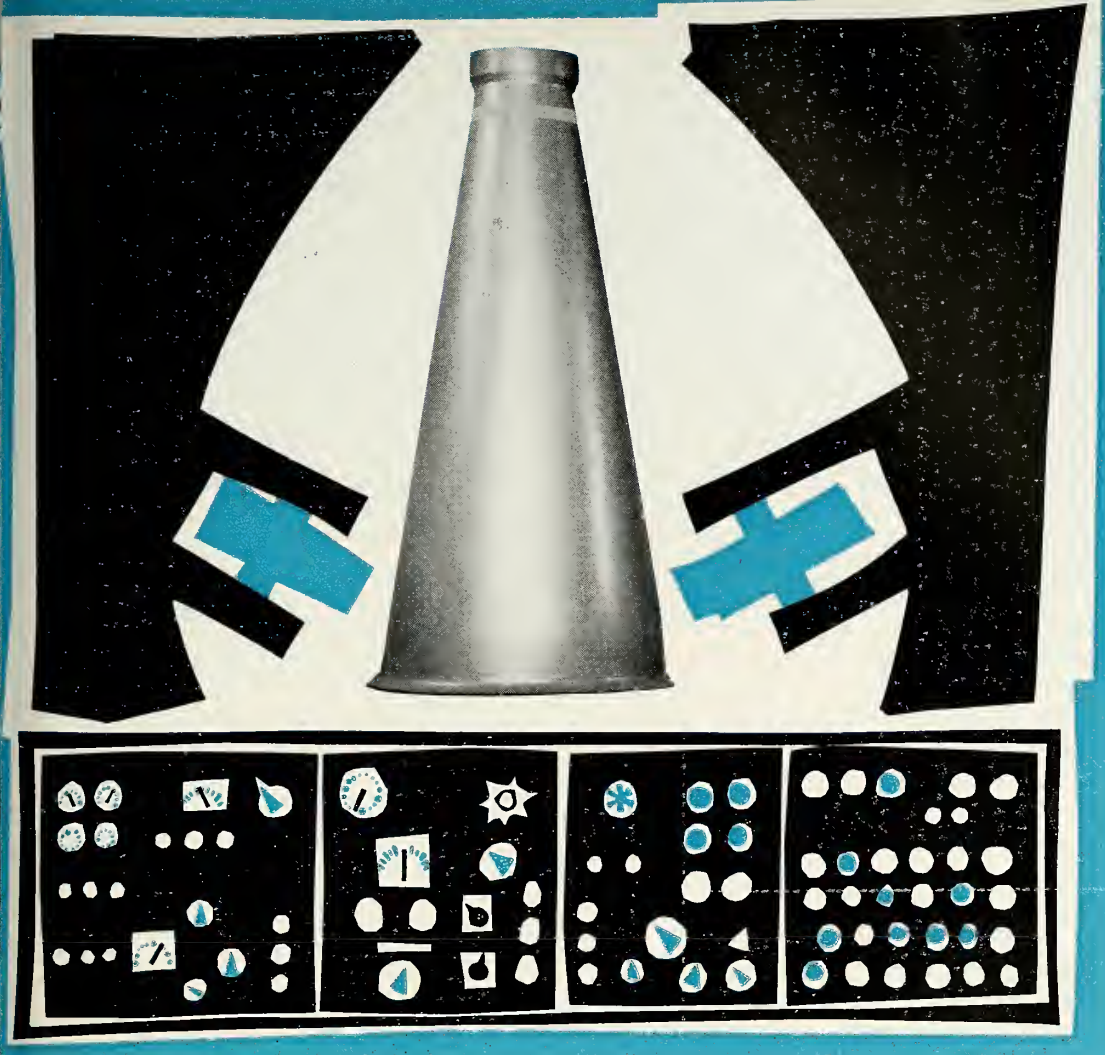
- **Missile Literature**

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

- **New Missile Products**

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274
275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299

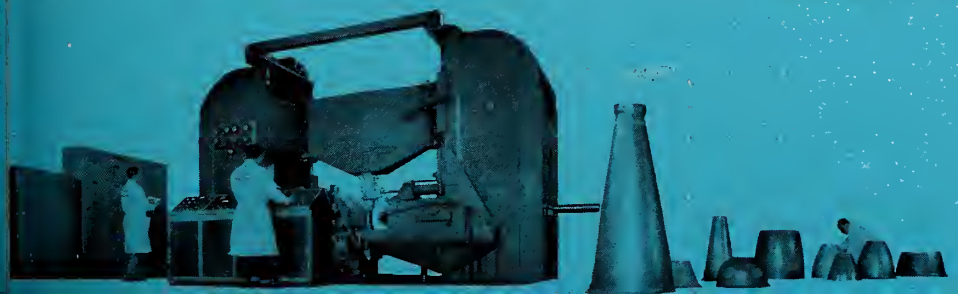
For Other Information Give Page Numbers: .....



LECTRONIC "MEMORY" SPIN FORGES IDENTICAL PARTS

Dial in" essential engineering data. Hufford Spin Forge forms up to ½ ton of hardest metal ne or a thousand times, without reliance upon human memory or artisanry. Because input is lectronically applied, the effect is "a machine with a memory." Time between tool completion nd delivery of a perfect part is brought to a minimum, because the machine "reports" to ngineering precisely. Given approved data, each new start produces an identical part. Iaterial savings and product uniformity become automatic. Complete automation, never before pplied to machinery of this type, is the important "reason why." For information concern-ng the application of Hufford Spin Forging to your require-ients, write: The Hufford Corporation, 1700 E. Grand Avenue, l Segundo, California...a division of The Siegler Corporation.

HUFFORD



Model A12's pass rugged military environmental tests for altitude, shock, temperature, humidity and electro interference.

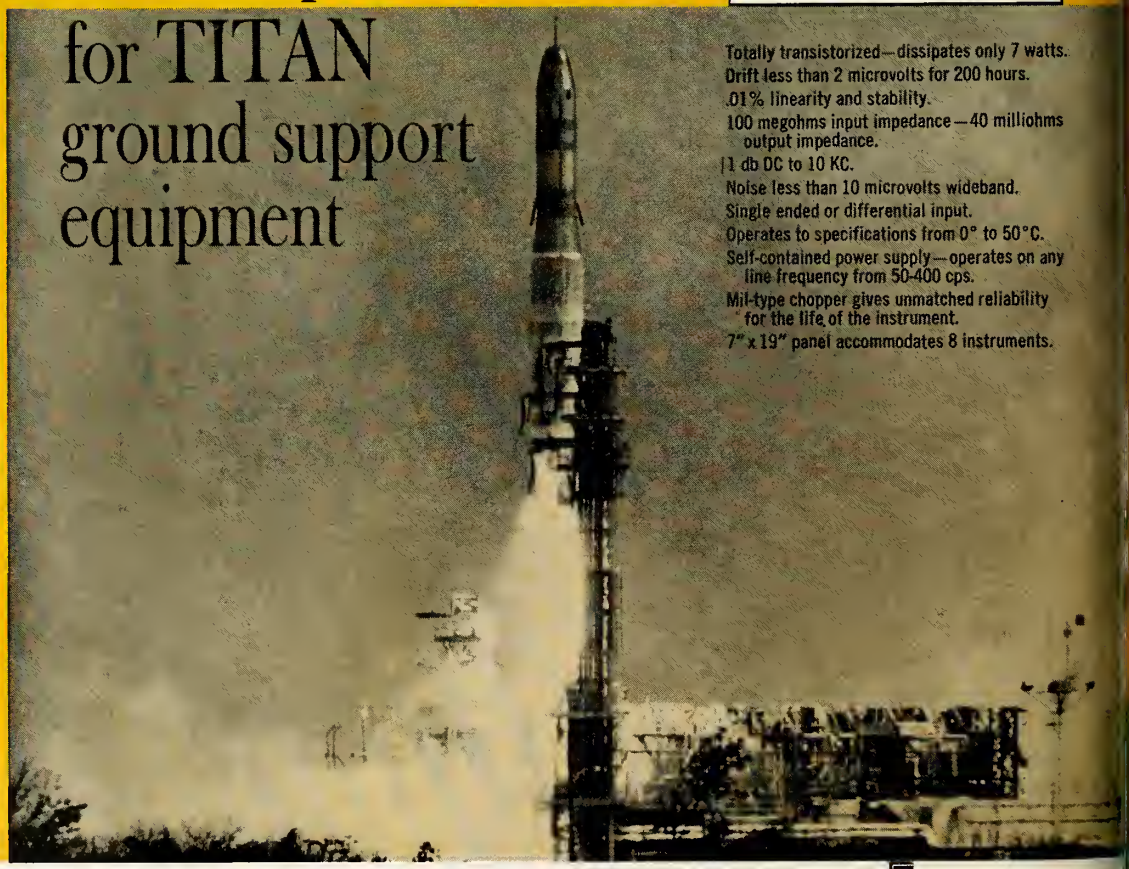
Design and construction techniques used in the Model A12 amplifier are fully two years ahead of the field! These advanced techniques enabled the Model A12 to meet stiff environmental qualification tests which resulted in their being selected by Martin engineers for use in the *Titan* ground support equipment.

Use of totally transistorized circuits gives the A12 unmatched reliability and performance, and minimizes heat dissipation problems inherent in vacuum tube instruments. Plug-in etched circuit boards and modular internal construction make servicing and maintenance checks easy—the amplifier can be disassembled and reassembled in less than 10 minutes. *Your E-I representatives can give you complete information.*

Martin picks Electro Instruments D.C. Amplifiers for TITAN ground support equipment



Plug-in attenuators of the A12 provide convenience, flexibility, economy. Special variations, gain settings, etc., can be tailored to your system at no extra cost.



Totally transistorized—dissipates only 7 watts.
Drift less than 2 microvolts for 200 hours.
.01% linearity and stability.
100 megohms input impedance—40 milliohms output impedance.
1 db DC to 10 KC.
Noise less than 10 microvolts wideband.
Single ended or differential input.
Operates to specifications from 0° to 50°C.
Self-contained power supply—operates on any line frequency from 50-400 cps.
Mil-type chopper gives unmatched reliability for the life of the instrument.
7" x 19" panel accommodates 8 instruments.

Electro Instruments, Inc.

3540 AERO COURT
SAN DIEGO 11, CALIF.

JULY 20 1959

JUL 1959
HOUSTON PUBLIC
LIBRARY
Houston, Texas



LEWIS LAB WIND TUNNEL

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

IRD ANNUAL

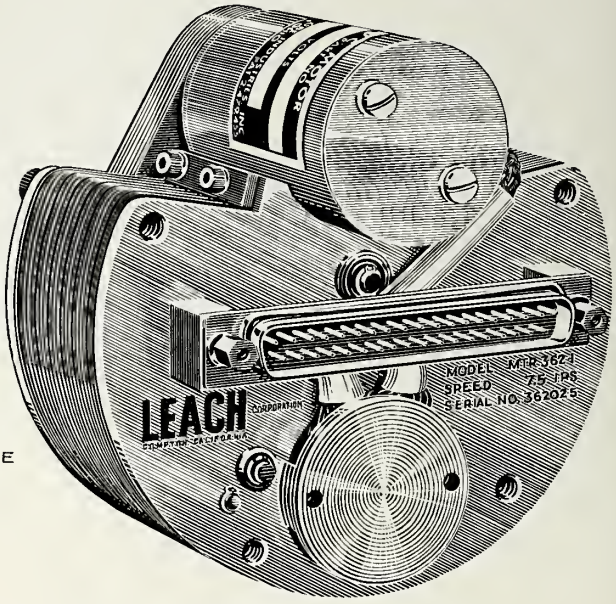
ngineering Progress Issue

nd World Guided Missile Encyclopedia

AN AMERICAN AVIATION PUBLICATION

tells the whole story...with impact!

miniature tape recorder



ACTUAL SIZE

newest new product from Inet!

Testing under severe environments . . . in extremely limited space? Inet's rugged new Miniature Tape Recorder simultaneously records data on 1 to 14 in-line channels, never loses a record because it's built to survive high impacts.

Here are the features to look for: precision in-line recording head; adjustable motor speed and tape tension; molded rubber pressure roller and driver wheels; and precision ball bearings at both ends to support all revolving parts.

Weighs just 24 ounces and operates at tape speeds of from ¼ to 15 inches per second in a temperature range of —50°F. to +200°F. Among its applications: in-flight and static tests; atmospheric, blast, explosion, and wind tunnel studies; and acceleration and actuation tests. *Write today for complete specifications.*

RELIABILITY

LOOK TO LEACH

INET DIVISION . . . LEACH CORPORATIO

18435 SUSANA ROAD, COMPTON, CALIFORNI

DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U. S. AND CANADA • EXPORT: LEACH CORP., INTERNATIONAL DIVISIO

Circle No. 2 on Subscriber Service Card.



Crosley helps put the "Sunday Punch" in POLARIS

Making sure the Navy's *Polaris* missile detonates at the right time and at the right place is a prime responsibility of Avco's Crosley Division.

A long record of success in the arming and fuzing of many different types of ordnance brought Crosley the Navy Ordnance Laboratory's prime contract for this difficult assignment.

Since first undertaking the task, Crosley has expanded its *Polaris* development work, without once losing step in the demanding *Polaris* timetable.

Arming and fuzing is just one area in which Crosley contributes to the development and performance of missiles. It is the country's leading producer of Command Receivers for missile-range safety applications and for high-performance drones and decoys. It is an important subcontractor to Hughes Aircraft on the *Falcon* missile. Crosley also has contributed to the development of the *Jupiter*, *Sergeant* and *Redstone* missiles.

Crosley's technical competence, dependability, and coordinated project administration are ready to serve the Free World's defense requirements wherever needed most.

For more information, write to: Vice-President, Marketing— Defense Products, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.

Avco / Crosley

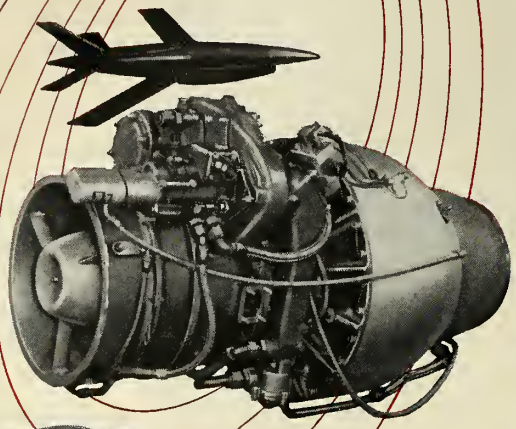


ENGINEERS!

Creative research and development engineers experienced in electronics, mechanics, weapons systems, and ordnance warheads are urged to investigate the wide range of opportunity at Crosley. Write to: Director, Technical and Scientific Personnel, Dept. M-79E, Avco/Crosley, 1329 Arlington Street, Cincinnati 25, Ohio.

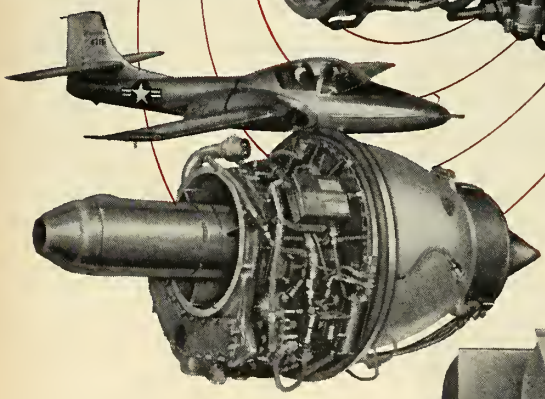
CAE...

PRODUCERS OF SPECIALIZED POWER



J69-T-29A

1,700 lb.-thrust model far drone applications. The new engine has 60% mare thrust with anly a 6% increase in weight. It is presently pawering the Ryan Q-2C target drone which recently underwent successful flight tests.



J69-T-25

Latest pawer plant far the Air Farce T-37A twin-jet trainer manufactured by Cessna, the J69-T-25 has increased thrust to 1,025 lbs.



Cantinental's TC-106 turbine air campressar, develaped in canjunctian with the United States Air Force, is naw available far ground support af jet age aircraft. The unit, supplying low pressure air, is especially suited ta engine starting, cabin air canditianing and actuatian af electrical generating equipment far graund aperatians af the aircraft.

CONTINENTAL AVIATION & ENGINEERING CORPORATION

12700 KERCHEVAL AVENUE, DETROIT 15, MICHIGAN

SUBSIDIARY OF CONTINENTAL MOTORS CORPORATION

Executive Editor .....CLARKE NEWL
Managing Editor ....DONALD E. PEI

NEWS STAFF
News Editor .....REED BU
Defense and Legislative .....BETTY OSV
JAMES 1
West Coast .....RICHARD VAN OS
Copy Editor .....ERICA P
Editorial Assistant .....DAVID NEWI

ASTRIONICS
Guidance and Control ....CHARLES D. LAF
Support Equipment .....HAL GETT

ASTRONAUTICS ENGINEERING
Chemistry & Propulsion .....JAY HOL
Astrodynamics .....PAUL MI

MISSILE SUPPORT
Installations and Equipment
East Coast .....WILLIAM E. HOV
West Coast .....FRANK MCG

BUREAUS
Los Angeles .....FRED HUI
Paris .....JEAN-MARIE R
Geneva .....ANTHONY VAND

CONTRIBUTORS
British Astronautics .....G. V. E. THOMP
Propulsion .....MICHAEL LOR
Industry .....JAMES J. HAGGERTY,
Soviet Affairs .....DR. ALBERT P.
Space Medicine .....DR. HUBERTUS STRUG
Astrophysics .....DR. I. M. LE
Research .....HEYWARD CANNEY,

ADVISORY BOARD
DR. WERNHER VON BRAUN . ROBERT P. HAVI
DR. PETER CASTRUCCIO DR. ARTHUR KANTRO
KRAFFT EHRICKE DR. EUGEN SAE
R. F. GOMPERTZ ALEXANDER S

PRODUCTION AND ART
Art Director .....WILLIAM MA
Assistant Art Director .....BACIL GU
Production Manager .....J. F. W
Ass't Production Manager .....ELSIE C

BUSINESS STAFF
Assistant Publisher .....E. D. MUHL
Advertising Sales Manager .....W. E. BR
Circulation Director .....L. L. BRET
Promotion Manager .....J. E. MU
Advtg. Service Manager ..MRS. GLADYS BUS
New York
Eastern Advtg. Mgr. .....P. B. KIN

ADVERTISING OFFICES
New York ..(17 East 48th St.) P. N. ANDE
A. B. SCHEF
Detroit ...(201 Stephenson Bldg.) K. J. W
Chicago .....(139 N. Clark St.) G. E. YO
Los Angeles .(8929 Wilshire Blvd.) J. W. C
C. R. MARTZ
Miami .....(208 Almeria Avenue) R. D. H
Toronto (12 Richmond St. E.) ALLIN ASSOC
London .....(28 Bruton St.) NORALL & L
Paris .....11 Rue Cond
Geneva .....10 Rue Gr

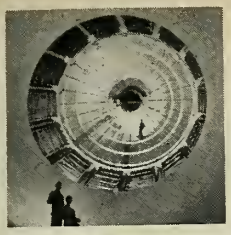
Missiles and Rockets Volume 5 Number

Published each Monday by American Avia
Publications, Inc., 1001 Vermont Ave., N
Washington 5, D.C.

WAYNE W. PARRISH ....*President & Publi*
LEONARD A. EISERER *Executive Vice Presi*
& General Man
A. H. STACKPOLE .....*Vice Presi*
FRED HUNTER .....*Vice Presi*
ERIC BRAMLEY .....*Vice Presi*
ROBERT R. PARRISH .....*Vice Presi*

Printed at the Telegraph Press, Harrisburg
Second class postage paid at Washington,
and at additional mailing offices. Copyr
1959, American Aviation Publications, Inc.

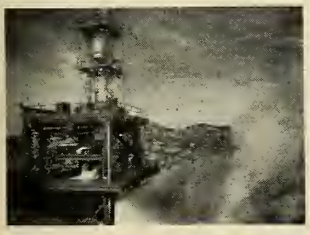
Subscription rates: U.S., Canada and Pos
Union Nations—1 year, $8.00; 2 years, $12.
3 years, $14.00. Foreign—1 year, $10.00;
years, $18.00; 3 years, $26.00. Single co
rate—$.75. Subscriptions are solicited o
from persons with identifiable commerc
or professional interests in missiles a
rockets. Subscription orders and changes
address should be referred to Circulati
Fulfillment Mgr., M/R, 1001 Vermont A
Washington 5, D.C. Please allow 4 we
for change to become effective and encl
recent address label if possible.



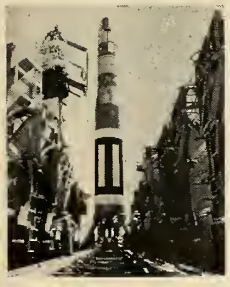
COVER: upstream view of the No. 2 cooler of the Unitary Plan Wind Tunnel at the Lewis Flight Propulsion Laboratory, NASA facility at Cleveland, Ohio.



EARTH'S inner and outer radiation belts, named for Van Allen, are shown in a new artist's conception. (See the Astrophysics report, p. 43.)



TEST firing of individual H-1 engines is carried out at Rocketdyne's Propulsion Field Laboratory in the Santa Susana Mountains. (See the report on liquid engines, p. 53.)



POWERFUL *Titan* ICBM is readied for static testing at one of Martin-Denver's four static test stands. (M/R's annual missile encyclopedia is included in this issue—see p. 137.)

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

ANNUAL ENGINEERING PROGRESS ISSUE

Astrophysics: The Van Allen Belts Discovery Most Important
U.S. has obtained more fundamental scientific information from its satellites than the Soviets have gained with heavier payloads. By Dr. Robert Jastrow, NASA 43

Missile Support: The Bigger Problems Coming with Larger Vehicles
Army Corps of Engineers has the responsibility for solving most of the engineering difficulties ahead. An interview with Maj. Gen. E. C. Itschner, Chief of Engineers 48

Instrumentation: A Fertile Field for New Applications
Promising areas include microminiaturization, solid-state physics and communications technology. By Robert J. Jeffries, President, Data-Control Systems, Inc. 51

Liquid Engines: Emphasis Remains on Power, Simplification and Reliability
Cheaper oxygen-jet fuels will be dominant for some time because of tremendous consumption of rockets being designed. By Roy Healy, Rocketdyne 53

Astrometry: A Vital Program Is Still Lacking Support
Continuous location of spacecraft will demand more equipment and development of new methods for using it. By Dr. Douglas Duke, Radiation, Inc. 56

Control, Guidance and Navigation: Propulsion Imposes Design
Inventiveness is needed most in prime problem areas of components hardware. By S. S. Edwards, W. C. Griffith and J. I. Osborne, Lockheed Aircraft Corp. 63

Space Medicine: Not Keeping Pace With Engineering
Several new sciences must be developed before man can travel safely through great distances in space. By Dr. T. C. Helvey, Radiation, Inc. 68

Astrionics: A Host of Tough Challenges
A survey of strides made by the electronics industry to meet its Space Age assignment—and how they will bring new markets. By David R. Hull, vice president, Raytheon Manufacturing Co., and president, Electronic Industries Association 76

Electric Propulsion: Much Theoretical Work Is Started
Although experiments are still in early stages, results so far are encouraging. By Dr. Ernst Stuhlinger, ABMA 83

Materials: Heat Remains the Major Problem
An examination of the broad environmental criteria which underline the need for comprehensive R&D. By Lt. Col. Frederick C. Krug, ARDC 90

ANNUAL MISSILE ENCYCLOPEDIA

A comprehensive illustrated listing of U.S., allied and Soviet missiles 137

NEW MISSILE PRODUCTS

Reynold's New Aluminum Back-up for Aluminum Welding 107

THE MISSILE WEEK

Washington Countdown 21
Industry Countdown 29
More About the Missile Week 105

DEPARTMENTS

Contract Awards 127
Propulsion Engineering ... 128
Letters 129
When and Where 135
People 179
Guest Editorial 184



SKY HIGH

integrated hurricane hunting

A sky-high vantage point will be the key to the detection of spawning hurricanes over vast ocean areas such as the Caribbean Sea. Weather satellites equipped with special sensing devices will be able to report cloud patterns and rising columns of warm moist air which indicate the formation of these tropical storms.

Alerted by satellite information, weather reconnaissance aircraft will be dispatched to investigate the hurricane area. These aircraft, with the Bendix AN/AMQ-15 system, will employ high altitude rocketsondes, dropsondes, aircraft sensors, and cloud and storm radars to measure the meteorological and geophysical parameters that make it possible to predict storm intensity and motion.

Measurements of weather phenomena relayed from the AN/AMQ-15 system will be combined with data from land-based weather stations and upper air sites. These data will be integrated and processed by advanced weather computing centers to yield forecasts essential to military operations, commercial aviation and our civilian life.

Advanced weather and geophysical forecasting is the ultimate objective of the AN/AMQ-15 system and related projects being carried out at the Bendix Systems Division. These programs, air defense projects and the EAGLE Air-to-Air Missile program, will provide the integrated systems of tomorrow. Opportunities are available for better engineers and scientists also looking to the future.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

Circle No. 4 on Subscriber Service Card.

Reeves INSTRUMENT CORPORATION *is part of the picture on front page projects of today.*

A HIGHLIGHT ON CREATIVE SYSTEMS ENGINEERING AT Reeves



PRECISION...ON A SPACE-HIGH PEDESTAL

Reeves has pioneered in the development of extremely high precision two- and three-axis antenna pedestals for fire control, guidance and tracking systems. Reeves-engineered pedestals and related electronic assemblies, including servo systems and computers, are production-ready in types for both land-based and shipboard applications. The pedestals provide continuous rotation in azimuth, with angular travel in the remaining two axes designed to meet particular requirements. Accuracies in the order of 0.1 milliradians can be achieved, with rates of 10 degrees per second, or higher.

REEVES INSTRUMENT CORPORATION

A Subsidiory of Dynomics Corporotion of America

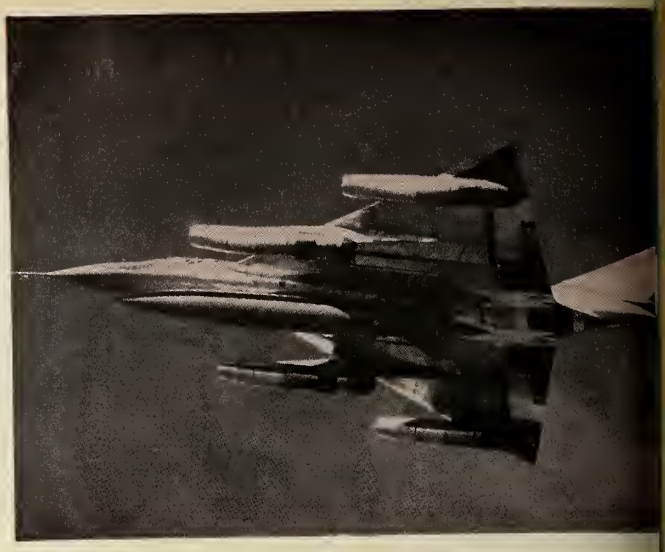
Roosevelt Field, Garden City, New York

Qualified engineers who are seeking rewarding opportunities for their talents in this and related fields are invited to get in touch with us.

Font page projects of tomorrow are part of the picture at Reeves INSTRUMENT CORPORATION

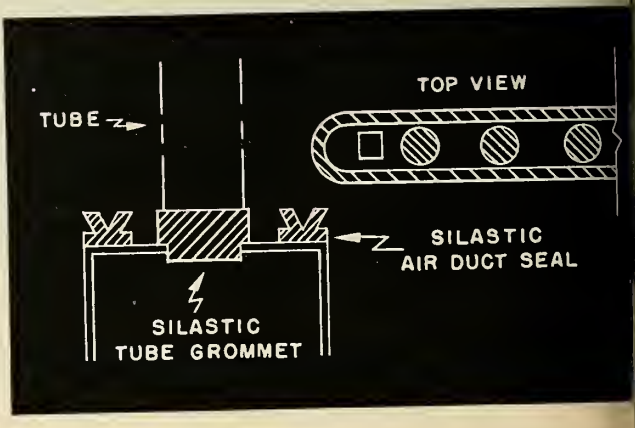
The PLANE

America's newest production bomber, the Convair B58 Hustler. This delta-wing jet employs an area-ruled fuselage for supersonic regime efficiency, and has reportedly been flown in excess of Mach 2 at 50,000 feet. Engines are four J 79's, in pods below the wings.



The PROBLEM

Sealing and cushioning vacuum tubes in cooling air ducts for the B58 Fire Control System, designed and produced by The Emerson Electric Manufacturing Company. Difficulties involved include heat —the sub-miniature tubes operate as high as 350 F— and severe cold when the units are inactive during flight. Protective material must stay resilient despite these extremes.



The PART

SILASTIC
SILICONE RUBBER

Tubes and other electronic equipment in the B 58 are cushioned by molded parts of Silastic®, the Dow Corning silicone rubber. Silastic stays rubbery, has excellent electrical properties.

TYPICAL PROPERTIES OF SILASTIC MOLDED PARTS

Temperature range, °F	—130 to 500
Tensile strength, psi	600 to 1400
Elongation, %	150 to 500
Electric strength, volts/mil	300 to 500

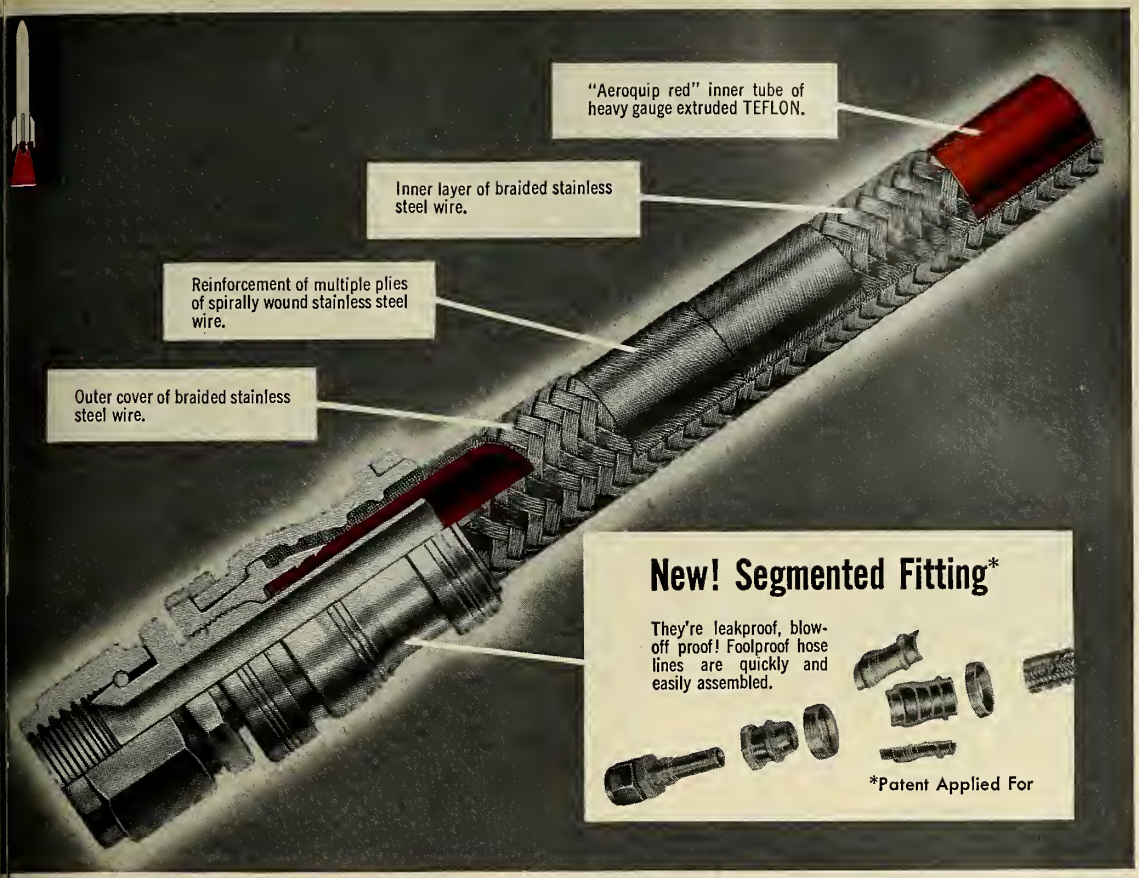
For further information write Dept. 7619.



first in silicones

Dow Corning
CORPORATION
MIDLAND, MICHIGAN

Circle No. 14 on Subscriber Service Card.



BURST PRESSURE

24,000 psi.!

OPERATING PRESSURE: 6000 psi.

AEROQUIP ANNOUNCES VERY HIGH PRESSURE 678 PNEUMATIC HOSE LINES OF TEFLON

Aeroquip makes a major contribution to safety in the handling of very high pressure air, helium, nitrogen and other gases for missile charging systems. Newly developed and now available is rugged 678 Hose of TEFLON, rated for 6000 psi. service . . . *with a 4-to-1 safety factor!*

With an inner tube of TEFLON, which has zero moisture absorption and an anti-adhesive surface, Aeroquip 678 Hose allows fast, easy purging and dehydration. The hose has superior resistance to vibration, low volumetric expansion and high temperature resistance. Return the coupon for complete information.

Aeroquip 678 Pneumatic Hose of Teflon		
Hose part number	678-6	678-8
Hose size I.D.	.312	.437
Hose size O.D.	.609	.812
Oper. press., psi.	6,000	6,000
Burst press., psi.	24,000	24,000
Bend radius at pressure	5	10

All dimensions in inches

Aeroquip Corporation, Jackson, Michigan
Please send me a copy of Engineering Bulletin AE8-23. MR-7

Name_____

Title_____

Company_____

Address_____

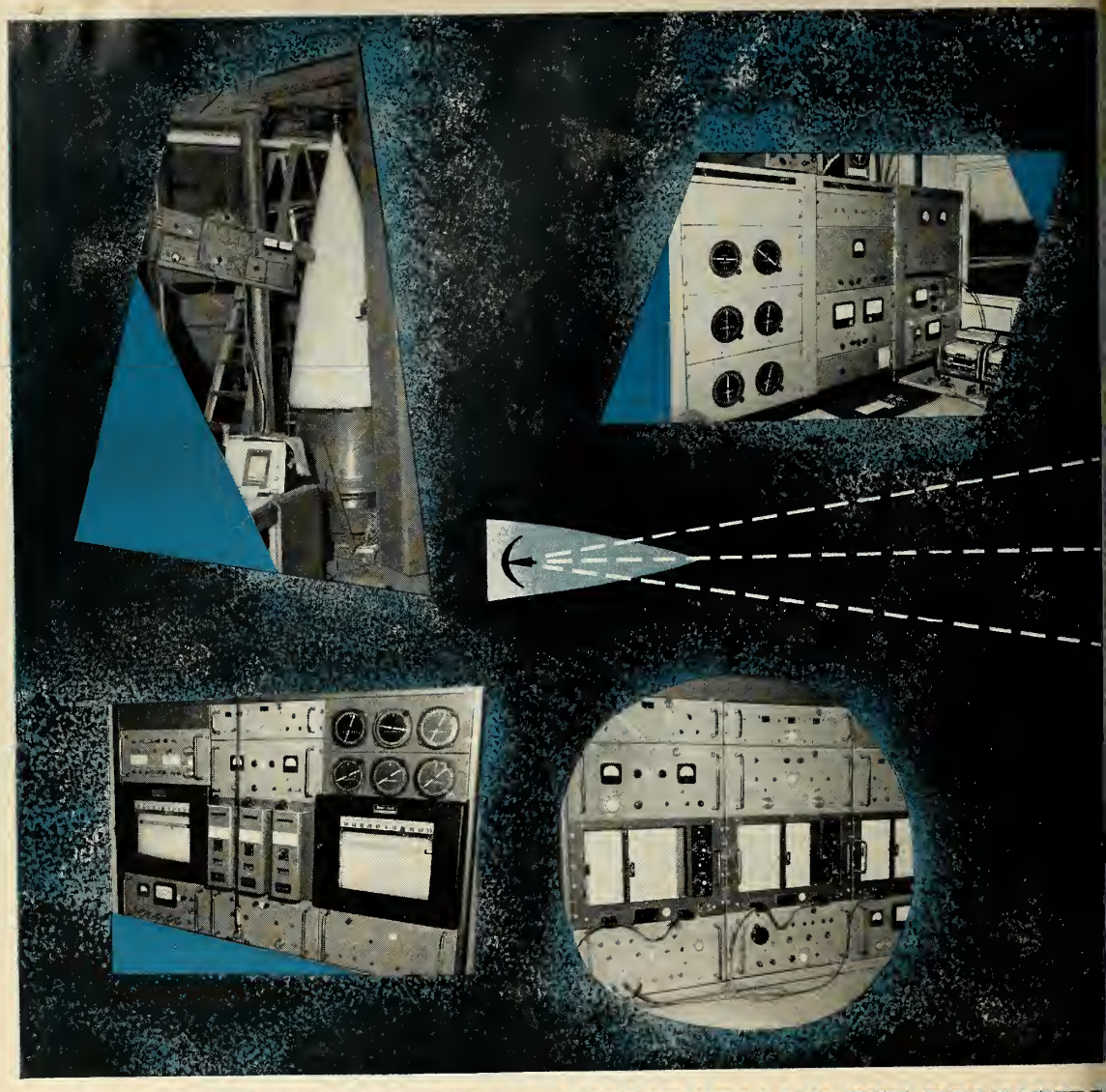
City_____ Zone____ State_____

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN
AEROQUIP CORPORATION, WESTERN DIVISION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN CANADA, U.S.A. & ABROAD
Teflon is DuPont's trade name for its tetrafluoroethylene resin



BORESIGHT ACCURACY TO 1/15 MILLIRADIAN? SEE BRUNSWIC

Brunswick-built radomes are setting new highs not only for strength-to-weight ratios, but accuracy as well. The reasons for the accuracy are simple: Brunswick has the test facilities and know-how that are without peer in the industry. Three radome ranges which automatically detect boresight error to an accuracy of 1/12 to 1/15 milliradian are now in full operation at Brunswick.

Soon to be in operation: two 1,000-foot ranges, manually operated, that will assure even more refined accuracy, detecting errors as small as 5 seconds of arc. Also, as an aid to design, quality control and maintenance of electrical tolerances, Brunswick is currently utilizing a one-horn interferometer for accurate IPD measurements and corrections before final range testing.

Behind these extensive test faci ties operates an engineering tea skilled in both detecting and c *recting* boresight error. To lea how this combination of facilit and engineers can give you unique accurate, tough and lightweight domes, write to: Brunswick-Ball Collender Company, Defense Pr ucts Division Sales Manager, 17 Messler St., Muskegon, Michiga

BRUNSWICK

MAKES YOUR IDEAS *WOR*

Circle No. 8 on Subscriber Service Card.



AIR FORCE ROCKET POWER

with pressure vessels by Butterworth in the instrumentation and launching systems

In the launching system for the Air Force's Bomarc, pressure vessels custom-designed and custom-built by Butterworth assure precise volumetric control of liquid nitrogen.

Pressure vessels by Butterworth meet the most rigid requirements for high and low temperature operation. Butterworth experience in the design and building of molds for Naval solid propellants is also available to prime contractors in the missile and rocket field.

Talk to a Butterworth engineer. Or write for "The Butterworth Story", a quick-tour of our complete metalworking facilities.

BUTTERWORTH

Division of VAN NORMAN Industries, Inc.

Metalworking for Industry Since 1820

H. W. BUTTERWORTH & SONS CO. • BETHAYRES, PA.

Circle No. 9 on Subscriber Service Card.



Now! Cool through the thermal barrier with FLAMEMASTIC!

The high-heat insulating material proved in actual production for 5 years

Now, provide positive protection and high-heat insulation for metal surfaces with FLAMEMASTIC. For five years, FLAMEMASTIC has been used exclusively on one of the major production missiles. Also applied extensively on allied test and launching equipment. Protects against high-velocity combustion heats, ranging from 3000°F upward. Gives positive protection for electronic equipment. Readily applied by conventional methods.

NEW! L-154 CERAMIC CONVERSION COATING

High temperature protection. High dielectric. Spray, brush or dip with conventional equipment.

For additional information on Flamemastic, write or wire:

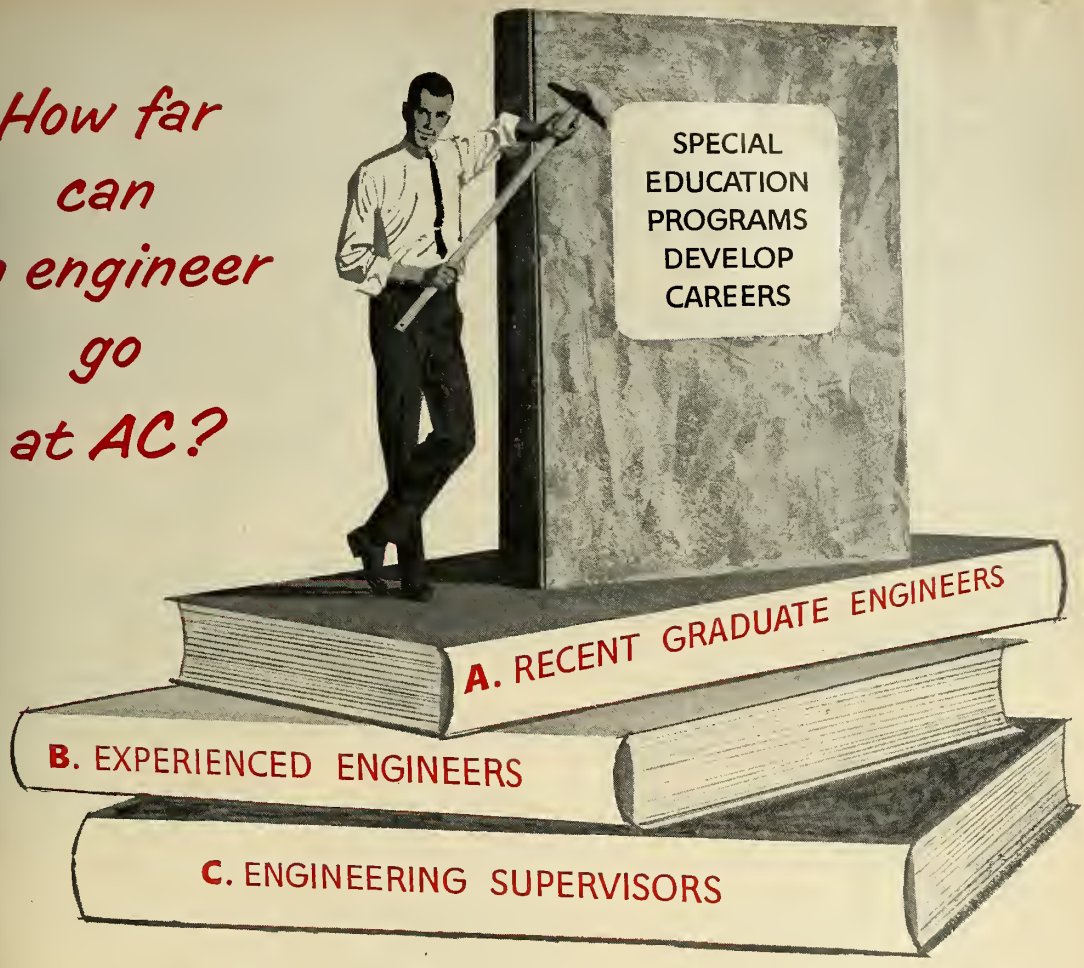
DYNA-THERM Chemical Corp.

Culver City, California



Circle No. 10 on Subscriber Service Card.

How far can an engineer go at AC?



Finest "in house" programs anywhere

When you work in AC's instrumentation business, AC offers free comprehensive training programs that will help you graw professianally and enhance your status. Just laok at these opportunities . . .

Program A—far recent graduate engineers—gives you a salid foundation in the theory and application of inertial guidance systems and servamechanisms. You attend classes three haurs per day for four months, all on company time.

Program B—for experienced engineers—consists of upgrading studies in inertial guidance, servamechanisms, environmental problems, engineering math and physics, plus advanced state-af-the-art caurses. Time—during working hours or evenings.

Program C—for all engineering supervisors—involves management training developed by a team af AC executives and University of Chicago industrial relations experts. Sixty ane-half-hour sessions give you a solid grounding in management techniques.

These tharoughly practical courses—taught by university prafessars ar recagnized AC specialists—constitute AC educational "extras." AC offers them in addition ta their educational assistance programs for men who wish ta study far degrees in nearby universities.

You may be eligible for training

If you are a graduate engineer in the electronics, electrical or mechanical fields, ar if yau have an advanced degree in mathematics ar physics, you may be able to participate in these programs while you work on AC's famaus AChiever inertial guidance system or a wide variety af ather electromechanical, aptical and infra-red devices.

Far mare details, just write the Director af Scientific and Prafessianal Employment: Mr. Rabert Allen, Oak Creek Plant, Dept. H, Box 746, Sauth Milwaukee, Wisconsin.

Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers • Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes Speed Sensitive Switches • Speed Sensors • Torquemeters • Vibacall • Skyphone

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Circle No. 11 on Subscriber Service Card.

LAVELLE

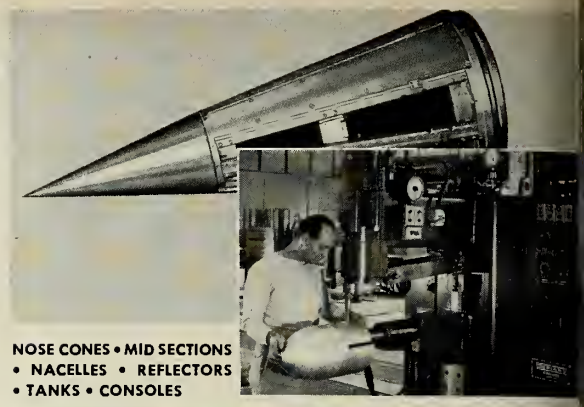
SPECIALISTS IN ROCKET, MISSILE, JET ENGINE, AIRFRAME AND ELECTRONIC COMPONENT FABRICATION

Sheet metal parts and assemblies precision welded, machined, and processed to your specifications by certified men, methods and machines . . . of stainless steel, titanium, aluminum, and heat resistant, high strength nickel alloys.

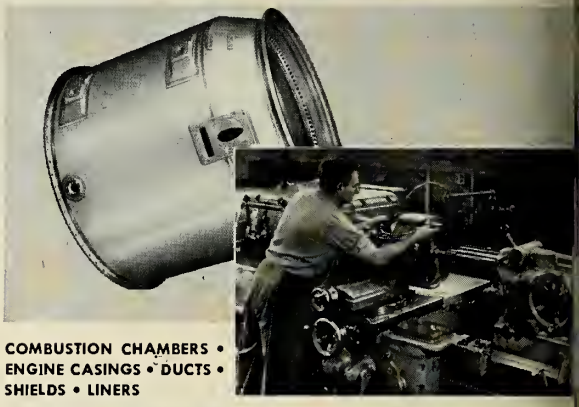
Weldments fabricated by resistance, inert gas shielded arc, metallic arc and oxyacetylene welding. X-ray, Zyglo and Magnaflux methods of non-destructive inspection are used to establish and control weld quality.

Services include engineering, production planning, tool making, sheet metal fabricating facilities, machine shop, anodizing, painting and quality control.

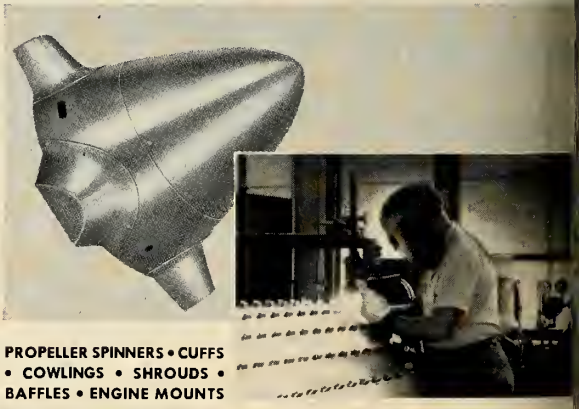
For components requiring precision fabrication, quality workmanship, dependable delivery . . . at reasonable cost . . . contact Lavelle.



NOSE CONES • MID SECTIONS • NACELLES • REFLECTORS • TANKS • CONSOLES



COMBUSTION CHAMBERS • ENGINE CASINGS • DUCTS • SHIELDS • LINERS



PROPELLER SPINNERS • CUFFS • COWLINGS • SHROUDS • BAFFLES • ENGINE MOUNTS



FLAME HOLDERS • EXHAUST NOZZLES • TAIL PIPES • FUEL MANIFOLDS



Write for illustrated brochure describing Lavelle's services in detail.

Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.
Between Philadelphia, Pa., and Trenton, N.J.

Circle No. 12 on Subscriber Service Card.

Circle No. 13 on Subscriber Service Card. ⟶

conax®

EXPLOSIVE VALVES

..in mass production for over 5 years!



More than 150 proven explosive valve designs ready for production and 26 models now in mass production provide Conax with the greatest accumulation of experience in this type of hardware.

Aluminum or stainless steel, Conax Explosive Valves operate by firing a small, completely self-contained explosive squib.

Light weight, minimum envelope, "normally closed" Conax Explosive Valves provide dead-tight shut-off before firing and are used for indefinite storage of gases or liquids up to 10,000 psi. Upon firing, flow passage is completely opened in .002 seconds.

"Normally opened" Conax Explosive Valves, when fired, completely stop flow of gases or liquids.

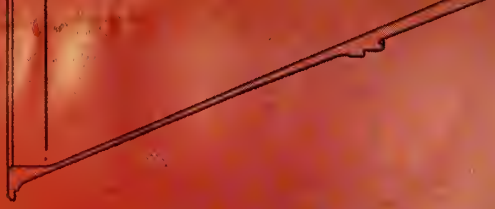
Write for FREE DATA BOOK 5808-XV



Retouched photographs above show a few of the thousands of Conax Explosive Valves that have been made to highest aircraft standards and put into operation on missiles.

conax® corporation

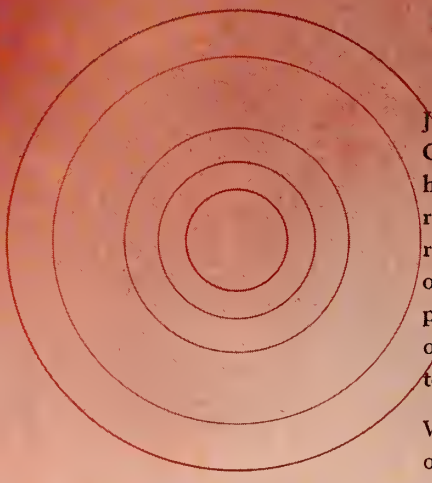
U. S. Patent No. 2,815,882.



A NEW HIGH

IN METALLURGICAL PROPERTIES FROM EXOTIC METALS



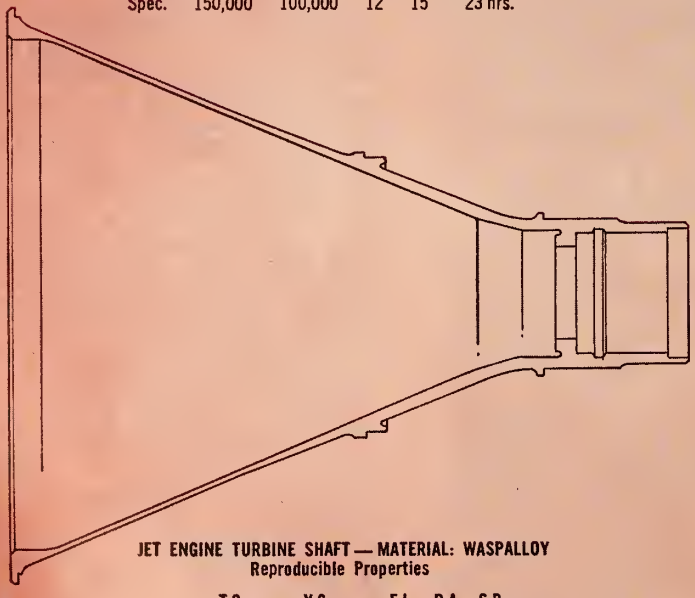


JET ENGINE TURBINE DISC — MATERIAL: INCO 901

	T.S.	Y.S. .2%	E.L.	R.A.	S.R. 1200° F. 80,000 lb./sq. in.
	175,000	128,000	20	23	225 hrs.
Spec.	150,000	100,000	12	15	23 hrs.

Jet engine components made from Cameron forgings have hit a new high in forming and in metallurgical refinements, developing not only room temperature properties 20% over specifications but, more importantly, producing these same over-specification values at elevated temperatures.

With our special forging techniques, one heat and one push produce uniform properties from surface to center, and from hub end to flange end. Even in high density alloys, interesting economy is effected. Favorable billet to finished forging weight ratio means less of the expensive material is used in each operation. Because of improved grain structure and close controls throughout the entire process, machining qualities are excellent.

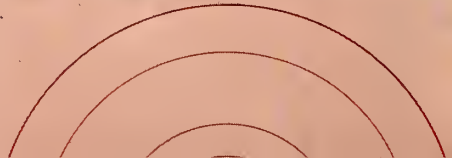


JET ENGINE TURBINE SHAFT — MATERIAL: WASPALLOY
Reproducible Properties

	T.S.	Y.S. .02%	E.L.	R.A.	S.R. 1350° F. 70,000 lb./sq. in.
	196,200	131,700	23	32	71 hrs.
Spec.	160,000	90,000	15	18	23 hrs.

All this, of course, gives our customers a better component functionally and economically. Check the accompanying comparison of the specification values and obtained values on the two jet turbine rotating components shown—let us show you what we can do with your problem forgings—just CALL, WRITE, or COME BY





Cameron

IRON WORKS, INC.

SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas



PRODUCT SUPPORT ENGINEERS

Urgency–Speed–Reliability. These words describe Convair-Astronautics' top-priority program of activating Atlas ICBM bases throughout the United States. Included in this immense task is the job of training Air Force personnel, developing and producing hundreds of technical manuals and providing technical assistance to the Air Force. The Product Support department at Astronautics is responsible for this assignment and to fulfill it must double in size within the next two years. Engineers qualified to participate in this long-range program will find excellent growth opportunities in the following areas:

CUSTOMER TRAINING – Service Training Instructors—Engineers with degrees in ME, AE or EE, or equivalent hardware experience are needed to prepare and conduct continuing 4-6 month courses to Air Force personnel on the Atlas ICBM. This training will include classroom theory and hardware manipulative skills to a high level of proficiency.

Service Training Planners – Men with 2-5 years experience in the planning of industrial and/or armed services training programs are needed for the planning, preparation, editing and publishing of training material for the Air Force. This assignment will also include training standards, syllabuses, lesson plans and training projects.

TRAINER DESIGN – Trainer design engineers (electronic and mechanical) with degrees in ME, AE or EE are needed to design simulators to be used in the training of Air Force personnel on the Atlas weapon system.

FIELD SERVICE – Engineers, preferably with degrees in ME, AE or EE, and field or in-plant hardware experience are needed to act as technical representatives to the Air Force on the Atlas ICBM. Most assignments will be at Vandenberg AFB, Santa Maria, Calif. There will be other assignments as additional Atlas bases become operational. A limited number of San Diego openings also exist in the areas of Field Service Support. A field service bonus of $210.00 per month is authorized for field assignments in excess of six months. Per diem paid for assignments under six months.

TECHNICAL WRITING – Engineering degree preferred, plus 1-3 years of technical writing experience. Assignments include the writing of engineering reports, maintenance manuals and operation manuals.

Our engineering representatives will be conducting

INTERVIEWS

in these cities soon:

Schenectady • Utica • Syracuse • Albuquerque • El Paso • Los Angeles • Dayton • Rockford • South Bend • Salt Lake City • Cleveland • Denver • Washington • Chicago • New Orleans Hagerstown • Milwaukee • Indianapolis • St. Louis • Fort Wayne • San Francisco • Philadelphia • Boston • Oklahoma City • Pittsburgh • Youngstown

Call our permanent recruiting offices – in Detroit, LI 9-3038; in New York, EL 5-3330.

Qualified Product Support Engineers are urged to send a detailed resume at once so advance arrangements can be made for a confidential interview. Write to Mr. T. W. Wills, Engineering Personnel Administrator, Department 130-90.

CONVAIR/ASTRONAUTICS

CONVAIR DIVISION OF

GENERAL DYNAMICS

5519 KEARNY VILLA ROAD, SAN DIEGO, CALIFORNIA



STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

I've been asked whether non-aeronautical engineers have good prospects for advancement in the aviation industry.

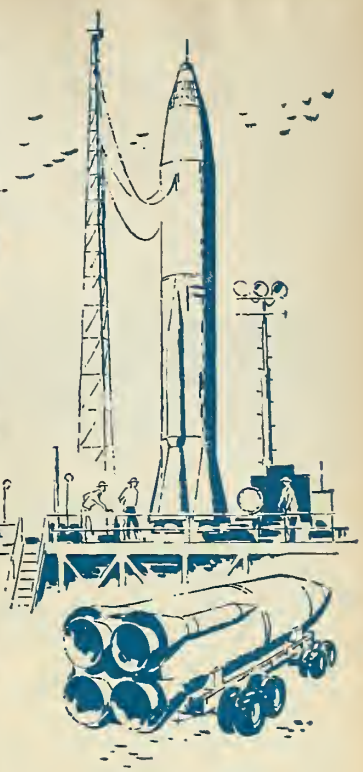
The answer is *yes, definitely!* At Douglas many of our top supervisory people have moved up from other engineering specialties. The complexity of modern aircraft and missiles requires the greatest variety of engineering skills known to industry.

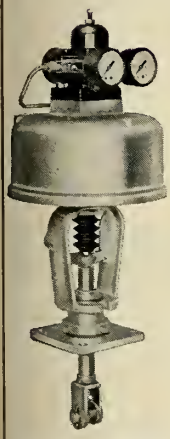
For example, we now have pressing needs for mechanical, structural, electrical and electronics engineers in addition to aerodynamicists, physicists and mathematicians. Whatever your background in the engineering profession may be, there are prime opportunities in the stimulating aircraft and missiles field.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box 620-R
Santa Monica, California

Annin OFFERS YOU MORE IN ACTUATORS

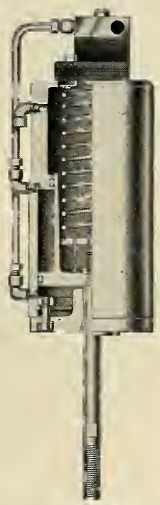
Your choice OF ADVANCED DESIGNS WITH MORE PRECISE POSITIONING AND DYNAMIC RESPONSE CHARACTERISTICS





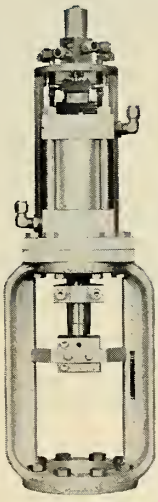
1542 & 1544 SERIES DOMOTOR POWERED ACTUATORS

Two types, "Direct Thrust" (illustrated) or "Lever" units are available for any application requiring accurate positioning in response to a pneumatic signal, such as butterfly valves, dampers, turbines and engine governors. Guaranteed positioning accuracy of better than 0.001" per inch of stroke over the complete range of piston travel is combined with a smooth operating action that provides an accurate, stable output force.



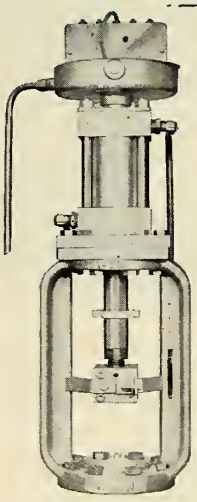
600 SERIES STROKE POSITIONING ACTUATORS

Offered primarily for the control of variable speed drives, rheostats, pumps and cams, as well as control valves, with strokes up to 6 inches and forces up to 2510 pounds of thrust. Compact and rugged, for easy mounting on existing equipment. May be operated from a standard 3-15 psi instrument signal, with a positional accuracy within 0.001" per inch of stroke.



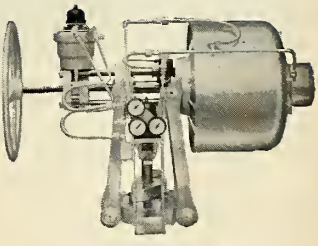
10,000 SERIES PNEUMATIC-HYDRAULIC ACTUATORS

For valves requiring strokes to 6 inches and thrusts to 100,000 lbs. Furnished on body assemblies where process conditions require very fine valve response, hi-speed and stability. Operate on 1500 psi oil supply system from any common instrument air signal.



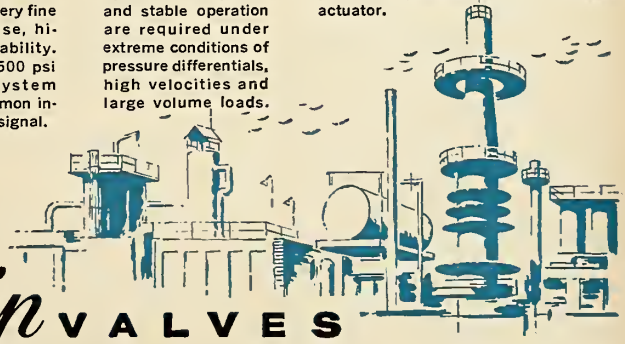
20,000 SERIES ELECTRO-HYDRAULIC ACTUATORS

Provide a means of converting an electrical signal to a powerful hydraulic positioning force, where high speed of response and stable operation are required under extreme conditions of pressure differentials, high velocities and large volume loads.



TOGGLE ACTUATORS

For process requirements where the unbalanced forces are extremely high, or where large through-puts are required. Three types are offered: pneumatic positioning, pneumatic on-off, and manual control, all embodying the toggle actuator; or a manual control arrangement can be combined with the pneumatic positioning or on-off toggle actuator.



Annin VALVES

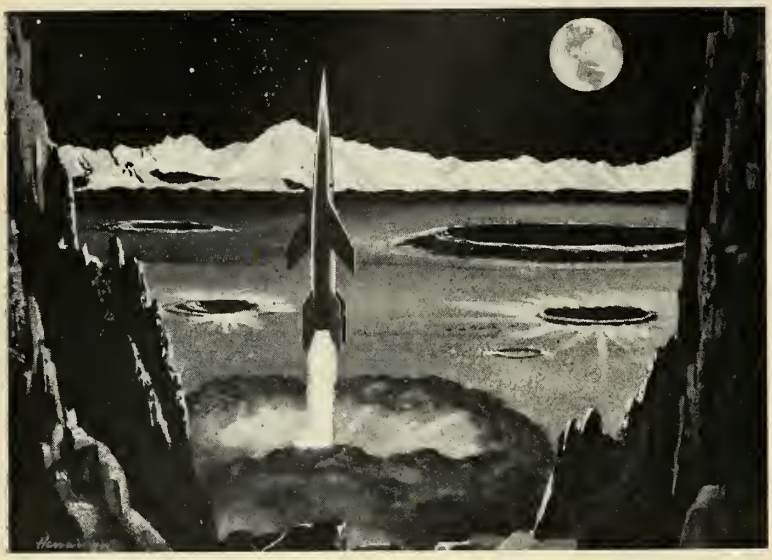
Write for Bulletin 1236-ST

THE ANNIN COMPANY
1040 S. Vail Avenue, Montebello, California

Circle No. 16 on Subscriber Service Card.

COUNT DOWN

for the conquest of space



"MISSION ACCOMPLISHED: DEPARTING LUNA 2205 ZEBRA"

This message, flashed across a quarter-million miles to Washington, D.C., will be awaited anxiously by millions.

But even then our first expedition to the moon will still face its most crucial test—the journey home to earth.

The success of that trip will depend in large part on rocket propellants—fuels and oxidizers that will have been stored for days in the tanks of the expeditionary vehicle and yet will respond instantly when needed.

Storable liquid propellants is one of the fields in which Rocketdyne has anticipated the future. For more than ten years, its propellant chemists have been studying, engineering, and testing combinations of storable fuels and oxidizers for greater storability and higher energy.

Storability PLUS high energy

Rocketdyne has tested these combinations in all production and experimental engines. The results prove that today's storable fuels and oxidizers have these important capabilities:

(1) High performance, even after months or years of storage; (2) Stability over a wide temperature range, permitting storage in missile tanks without rigid environmental controls; (3) Dependable performance, predictable even at extremes of heat and cold; (4) Instant readiness for firing at any time during the storage period; (5) Energy yields equal to or higher than those of conventional propellant combinations.

Second-generation missiles

The tests also prove that engines developed for conventional propellants can be converted to storable combinations rapidly and inexpensively—a significant consideration in the development of second and third generation strategic, tactical, and air defense missiles.

Significant, too, is the *potential* performance of storable combinations. Research points to energy yields as high as 400 seconds of altitude specific impulse—performance 20 percent higher than that of today's combinations. These high-energy yields will offer new capabilities and greater flexibility for America's scientific and military programs.

Stepping stones to Space

Rocketdyne has designed and built much of today's operating hardware in the high-thrust rocket field. Engines by Rocketdyne power most of the military and scientific projects sponsored by Air Force, Army, and NASA. This experience now becomes the point-of-departure for tomorrow's journeys into the unknown.



POWER FOR AMERICA'S MISSILES

Thrust chamber production line for Thor and Jupiter at Rocketdyne's Neosho, Mo., facility moves smoothly.

FIRST WITH POWER FOR OUTER SPACE

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

Washington Countdown

IN THE PENTAGON

Which military service will run . . .

the new satellite detection fence is up for decision at the Pentagon's top levels. The command could encompass all U.S. military tracking facilities around the world. All three services want the job.

• • •

Recent Soviet 'Zooniks' . . .

may have soared some 1000 miles into space before returning to earth. The Russians aren't saying, but this is the educated guess of a number of U.S. experts. The flights obviously are aimed at collecting data on survival in space.

• • •

Pentagon sources complain . . .

that the GAO—Congress' fiscal watchdog—is stepping out of bounds in checking up on military expenditures. They say GAO is not only checking up on fiscal matters but also making judgments on the reliability of weapons.

• • •

No extensive delays . . .

in the *Discoverer* satellite schedule are now expected to result from recent failures. ARPA and the Air Force had planned to launch *Discoverer V* about the end of July. The shot is expected to be a full equipment checkout. No wildlife.

• • •

Behind the scenes an AF fight . . .

is shaping up over handling of weapon systems development. The trend appears to be moving toward greater centralization. A top-level AF committee is studying the question.

ON CAPITOL HILL

The House-cut NASA budget . . .

probably will stay cut—at least in part. But NASA appears to have little to worry about. Whatever dollars are lost in the first round are fairly certain to be regained by slipping them into a FY '60 supplemental appropriations bill later on.

The Hébert Subcommittee investigation . . .

into hiring of ex-military officers by defense contractors is scheduled to get down to specifics in its new round of hearings. Among other things, the subcommittee wants definitions of such activities as "selling," "promoting," and "negotiating."

At NASA

Would an astronaut die . . .

if the **Convair** *Atlas* designed to boost him into space exploded on the launching pad and the *Mercury* escape system failed to blast him free? NASA experts say no. The heat-resistant escape capsule would save him anyway.

• • •

But, incidentally, the strain . . .

of the ride to safety in an escape capsule is nothing to look forward to. If the *Mercury* capsule is blasted free from ground level, the astronaut will have to sustain as much as 20 g's for about one second.

• • •

Testing of Big Joe . . .

the boiler plated capsule mounted on top of an *Atlas*, will begin in late summer. The shots, which will test the capsule's heat shield on re-entry, have been delayed because of the recent defects discovered in the *Atlas* vehicle.

• • •

Chrysler's *Jupiter* may be put back . . .

in the *Mercury* program for budgetary reasons. NASA would like to use *Atlases* for the early *Mercury* tests. But cheaper *Jupiters* may have to be used because of congressional cuts in NASA's budget.

AROUND TOWN

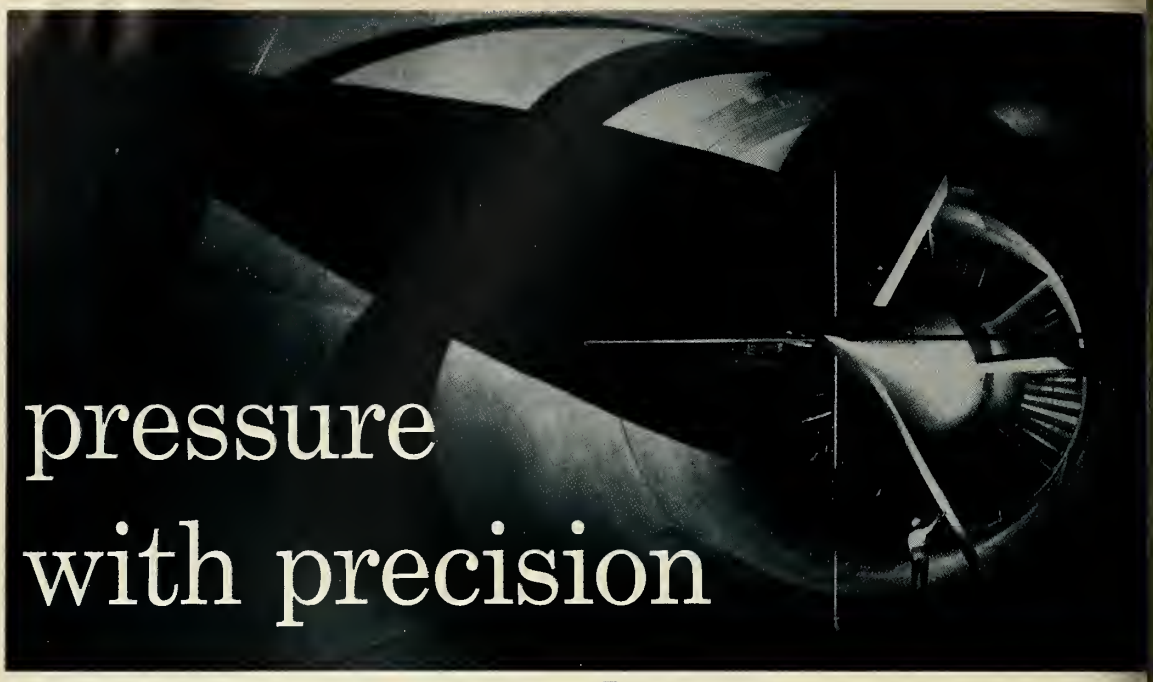
Some of the reports . . .

that are being passed as the "latest" in the nation's capital:

. . . The French will explode their first A-bomb in a matter of months and begin developing nuclear warheads for missiles.

. . . Officials are worrying about a new Red power play in troubled Latin America's Possible Soviet goal: missile bases at America's back door.

. . . Top civilian scientists fear they see a trend back toward starving civilian federal research programs in favor of military research.



pressure with precision

When critical pressures must be delivered or measured, Consolidated Systems are on the job, surpassing design specifications. Digital pressure measurement for windtunnels, automatic calibration of pressure transducers, missile propellant systems checkout with accuracies of one part in 2,000... these are being accomplished day-in and day-out, with precise pressures delivered at the turn of a dial. This type of performance is available for your application. Write for the complete story in Bulletin 3018-X5.

Consolidated Systems CEC

CONSOLIDATED ELECTRODYNAMICS *300 N. Sierra Madre Villa, Pasadena, Calif.*

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

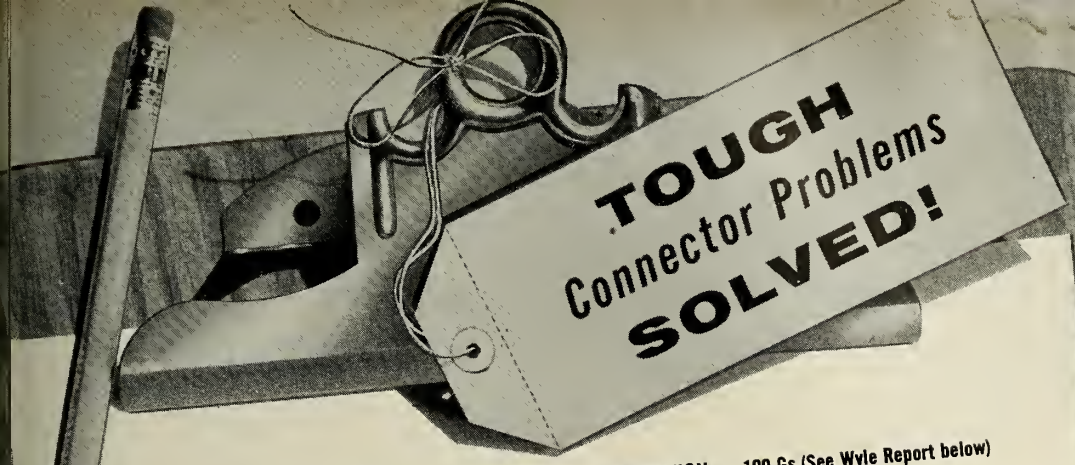
Pressure transducer calibration system controls and measures pressures from 25 pickups in ranges from 1.5 to 500 psi. Linearity, hysteresis, zero, and sensitivity characteristics are determined at a specified temperature in 2½ minutes.



Propellant Utilization System Exerciser checks missile system performance by generating precise pressures for fuel and oxidizer channels at preselected points. Twenty-one similar systems are now in use at missile test sites.

Circle No. 17 on Subscriber Service Card.

Circle No. 18 on Subscriber Service Card. ——→



- ✔ SELF-ALIGNING
- ✔ 1000 CONNECTIONS
- ✔ PRODUCIBLE in large or small quantities
- ✔ LOW PRESSURES for insertion and extraction
- ✔ HUMIDITY . . . 0% to 100%
- ✔ ATMOSPHERE . . . air, water, salt water, jet fuel, exhaust gases, oil, hydraulic fluid
- ✔ PRESSURE . . . 0 to 30 p.s.i.a.
- ✔ OPERABLE by mechanical manipulator
- * TEMPERATURE . . . —65°F to 1000°F
- ✔ VIBRATION . . . 100 Gs (See Wyle Report below)
- ✔ POSITIVE LOCK-UP and trip-free disconnect
- * RADIATION LEVEL . . . 1,000,000 Roentgens per hr.
- ✔ EXPLOSION PROOF
- ✔ DEAD FRONT
- ✔ SEQUENCE SWITCHING
- ✔ LIGHT WEIGHT
- ✔ HERMETICALLY SEALED
- ✔ TROUBLE FREE
- ✔ LOW TOOLING COST
- ✔ HIGH VOLTAGE

*Under development

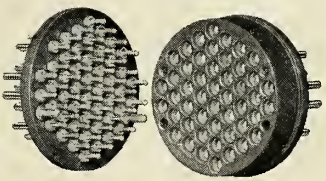
Many tough electrical connector problems have been submitted to Cole Electric Co. in recent months. Because of the ability of revolutionary new Cole self-aligning ball-and-socket connector pins to operate under extreme conditions, all of these problems have been or are being solved. Special Cole Connectors with up to 1000 contacts have been developed to meet difficult environmental and operational requirements for aircraft, missiles, ground support, computers, nuclear, electronic and electrical equipment.

Whatever your connector problem might be, a special Cole Self-Aligning Connector may provide the practical solution. Virtually any size or configuration with any number of contacts can be made. Four pin capacities: 15, 30, 75 and 300 amp. Highly specialized fittings in stainless, phenolics, fiber glass, nylon, ceramic or other materials.

Our complete research and development facilities are at your disposal. Write or phone today.

Cole ELECTRIC CO.

8439 Steller Dr., Culver City, Calif. • UP 0-4701



Tested to 100 Gs

In recent tests conducted by Wyle Laboratories of El Segundo, Calif., Model B-3106 Cole Connectors were subjected to vibration scan from 5 to 2000 cps. Each connector contained 15 contacts, wired in series. At vibrations up to 100 Gs amplitude there was no evidence of contact opening. Noise levels were exceedingly low. Full test report available on request.



Ability of energy to do work?

A mathematical convenience?

Gibbs' Free Energy?

What does it mean in isothermal electrochemistry?

The concept of energy availability in all its ramifications is becoming ever more important to Allison's energy conversion mission.

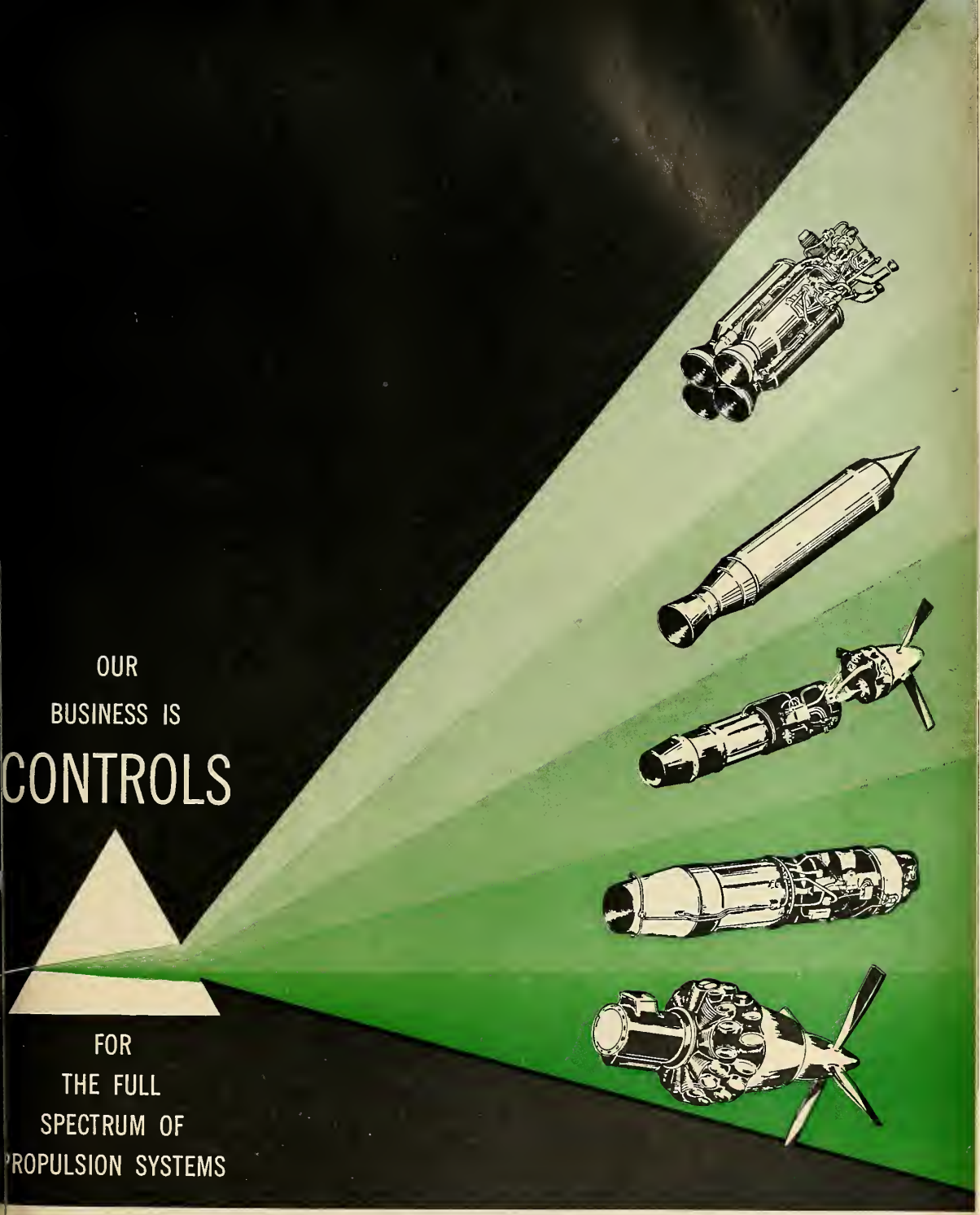
Current projects involving this concept include electrochemical conversion systems (for satellites, space systems, and perhaps even your future automobile), heat regenerator systems and photolysis regenerators.

In our inquiries we rely not only on our own resources but also on the talents of General Motors Corporation, its Divisions, and other organizations and individuals. By applying this systems engineering concept to new research projects we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business

ALLISON

Division of General Motors, Indianapolis, Indiana



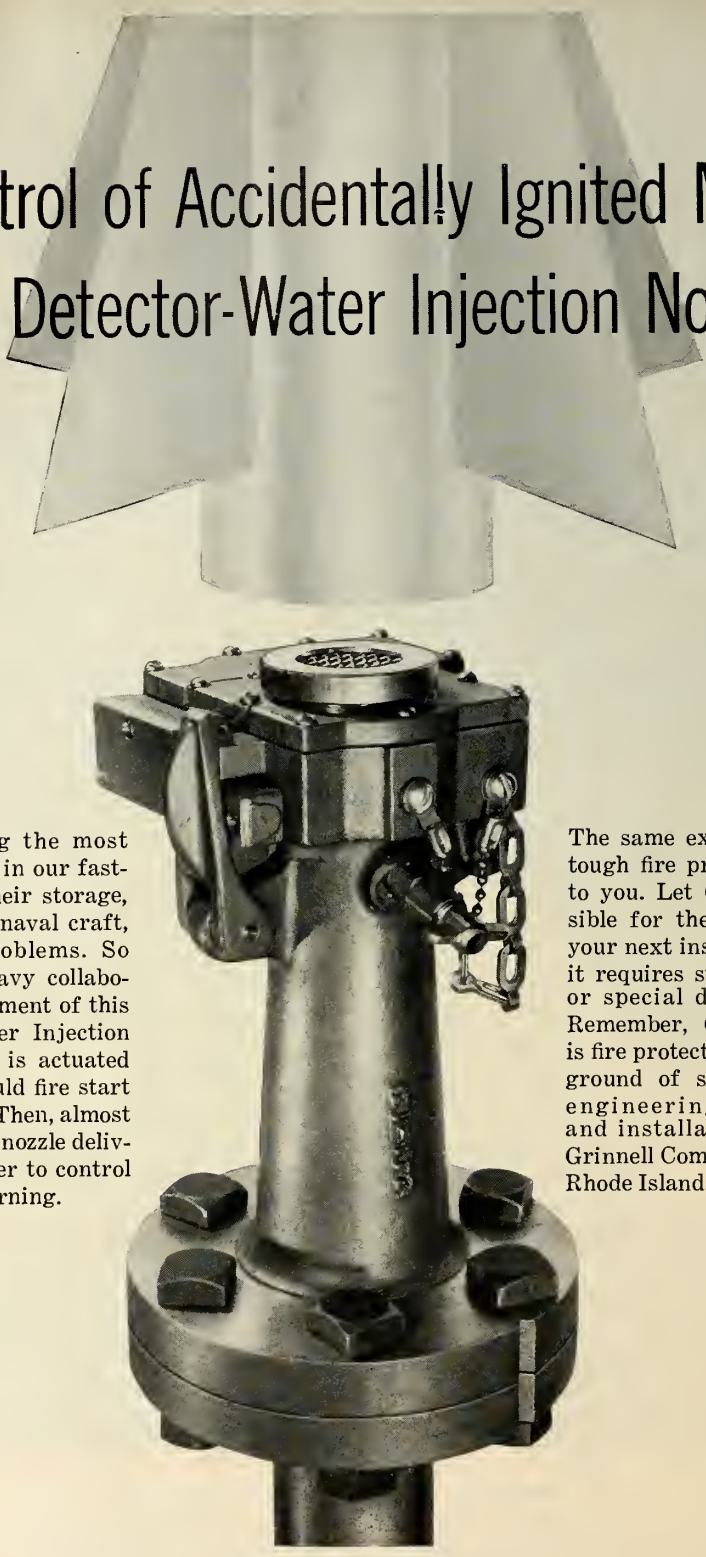
Bendix * has long been a leader in supplying controls and fuel systems for all types of aircraft engines. Today, Bendix is proving to be a natural for new challenges in related missile fields—on ram jets, rockets, nuclear power, and other advanced propulsion systems. So, when it comes to controls, remember that Bendix has the background—and is anxious to share it in solving your problems. *REG. U.S. PAT. OFF.

BENDIX PRODUCTS DIVISION **SOUTH BEND, IND.**

Bendix AVIATION CORPORATION

Circle No. 19 on Subscriber Service Card.

For Control of Accidentally Ignited Missiles ... Fire Detector-Water Injection Nozzle



Missiles are among the most destructive weapons in our fast-growing arsenal. Their storage, particularly aboard naval craft, creates critical problems. So Grinnell and the Navy collaborated on the development of this Fire Detector - Water Injection Nozzle. This device is actuated by shock waves should fire start in a missile booster. Then, almost instantaneously, the nozzle delivers a stream of water to control or extinguish the burning.

The same experience in solving tough fire problems is available to you. Let Grinnell be responsible for the fire protection on your next installation—whether it requires standard equipment, or special development work. Remember, Grinnell's specialty is fire protection . . . with a background of successful research, engineering, manufacturing and installation for 89 years. Grinnell Company, Providence 1, Rhode Island.

GRINNELL

Research, Engineering, Manufacturing and Installation of Fire Protection Systems since 1870

Circle No. 20 on Subscriber Service Card.



When man first steps into the vehicle that will carry him into outer space, it will be with complete confidence.

He knows that he can rely on the extensive testing and preparations that have gone before. Flexonics has played a vital part in these preparations—engineering, designing, and manufacturing metal and synthetic components and systems for hydraulic, pneumatic, liquid oxygen, and fuel applications on America's best-proved missiles and aircraft.

You can draw on this unequalled experience, too, by contacting your Flexonics sales engineer.

Thin wall ducting • Flexible hose: metal, synthetic, Flexon-T (Teflon) • Gimbal, pin, and link joints
Metal bellows and expansion joints • Special-formed stainless steel parts

A-410

TOMORROW'S ENGINEERING TODAY

Flexonics

AERONAUTICAL DIVISION

FLEXONICS CORPORATION • 1414 SOUTH THIRD AVENUE • MAYWOOD, ILLINOIS

Divisions

INDUSTRIAL HOSE • EXPANSION JOINT • BELLOWS • AERONAUTICAL • AUTOMOTIVE

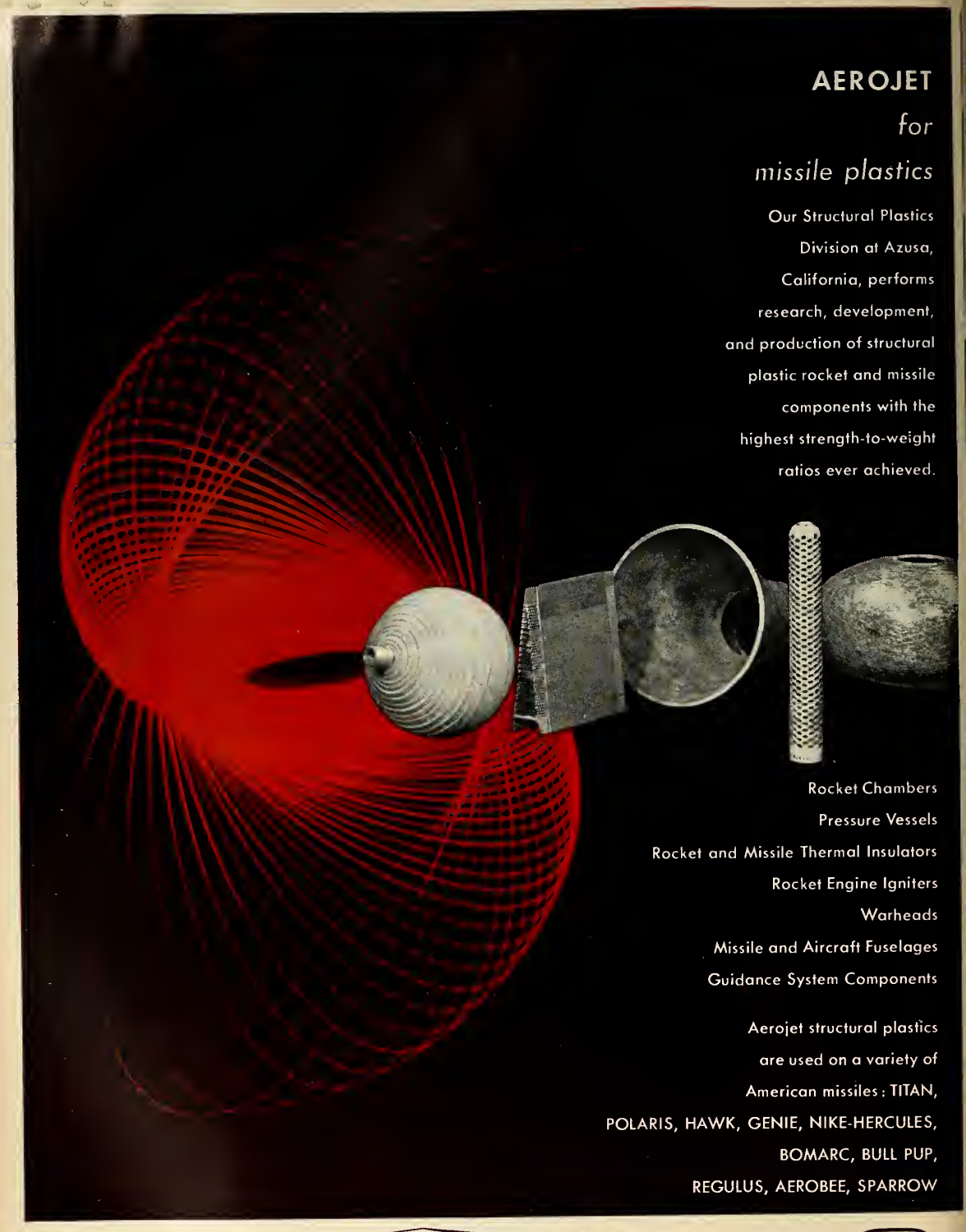
Flexonics Research Laboratories, Elgin, Illinois

In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario

Circle No. 21 on Subscriber Service Card.

AEROJET
for
missile plastics

Our Structural Plastics Division at Azusa, California, performs research, development, and production of structural plastic rocket and missile components with the highest strength-to-weight ratios ever achieved.



Rocket Chambers
Pressure Vessels
Rocket and Missile Thermal Insulators
Rocket Engine Igniters
Warheads
Missile and Aircraft Fuselages
Guidance System Components

Aerojet structural plastics are used on a variety of American missiles: TITAN, POLARIS, HAWK, GENIE, NIKE-HERCULES, BOMARC, BULL PUP, REGULUS, AEROBEE, SPARROW

AEROJET-GENERAL CORP.

THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE & RUBBER COMPANY

Engineers, scientists—investigate outstanding opportunities at Aerojet. (Plants at Azusa and near Sacramento, Calif.)

Circle No. 22 on Subscriber Service Card.

Industry Countdown

STRUCTURES

Satellite rendezvous . . .

system is being researched by **Norair Division** of **Northrop Corp.** Concept is to permit maneuverable manned satellite to couple in space with life support satellite in permanent orbit. Hook-on would be effected through target satellite controlled approach (TSCA)—space version of aircraft ground controlled approach, or through maneuverable satellite landing system. MSLS would utilize search-and-track radar beacon aboard target satellite with pilot performing terminal phase guidance and coupling through visual observation.

• • •

'Super' *Hawk* . . .

is under research and development by the Army. On the operational **Raytheon**-built *Hawk* low-flying anti-aircraft missile, the Army is planning to spend an additional $127 million in FY 1960. Plans call for 15 *Hawk* battalions—13 operational in mid-1961.

• • •

Reports are current in France . . .

that De Gaulle hopes to get help from **Boeing** in producing a solid-fuel IRBM of his own. Advisors have told him that the cost, plus production of an atomic warhead would be a prohibitive 18 billion francs (about $3½ billion) or more. The French almost-ready atomic bomb is presently uncomfortably large for an aircraft, let alone a missile warhead.

• • •

Government recognition . . .

of the missile industry won't be possible for at least two years. It takes that long to make the change in the Standard Industrial Classification of the Census Bureau. Argument is under way now whether missiles should be classed as ammo/ordnance, lumped together with aircraft or treated separately in the 1958 census of manufacturers listing dollar value of contracts. This will be published in 1960.

• • •

Total of $384 million . . .

so far has been awarded **The Martin Co. Denver Division** for design, fabrication and test of *Titan* ICBM. Recently, ARPA chose modified first stage of *Titan* as second stage of 200-foot, 1.3 million pound thrust *Saturn* space vehicle.

• • •

Timetable for missile cruiser . . .

Long Beach to be ready for action is early 1961. The *Talos*- and advanced *Terrier*-carrying nuclear-powered warship was launched at the **Bethlehem Steel Co.** shipyard in Quincy, Mass., on July 14. Outfitting will take until late next year.

PROPULSION

Dynasoar propulsion . . .

systems proposals are being reviewed by Source Selection Board composed of AMC, ARDC and SAC officials. **Boeing** concept would use *Atlas* or *Titan* to blast off the boost-glide space vehicle, while **Martin-Bell** proposes using *Titan* only.

• • •

Saturn at lift-off . . .

will weigh about 580 tons—500 of it fuel. Booster for the 1.3 million pound thrust vehicle is cluster of eight H-1 **Rocketdyne** engines.

• • •

In pop-up tests . . .

of full-scale mockup *Polaris* at San Clemente Island, Calif., **Lockheed** is using 186-foot barge-mounted crane to catch the instrumented missile in the air. Operation is called "fish-hook."

ELECTRONICS

Western Electric has won . . .

the $25 million-plus NASA contract to construct the Project *Mercury* world-wide tracking range. On the **Western Electric** team are **Bell Telephone Laboratories, International Business Machines, Bendix Aviation Corp.** and **Burns and Roe, Inc.** Formal contract negotiations will begin this week.

• • •

Improved Azusa Mark II . . .

tracking system is being readied by **Convair Astronautics** for installation soon at Cape Canaveral under $1.7 million contract. Azusa circuits presently are aboard *Thor, Jupiter, Polaris, Atlas* and *Titan*. Mark II, which employs continuous microwave signal showing velocity and position, will be installed in second generation missiles and space vehicles.

ASTROPHYSICS

The Czechs are setting up . . .

an astronautics commission in the country's Academy of Sciences. But reports from the Iron Curtain country say the commission will not participate in any satellite or rocket launchings. Activity will be confined to optical, photographic and radio observation of cosmic activity.

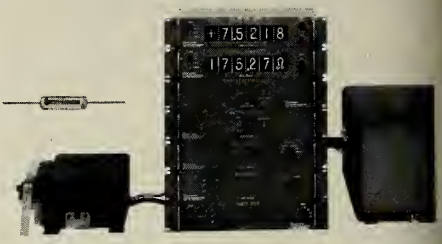
• • •

"Moon garden" of snap beans . . .

carrots and turnips is being grown in pressurized vessels by **Republic Aviation** researchers. Project is aimed at determining the feasibility of growing crops to support a lunar base. Results so far indicate that little germination results in seeds planted in simulated altitude of 46,000 feet.

Low cost, versatile DIGITAL SYSTEMS

for automatic testing of transistors resistors diodes and capacitors



Small E-I automatic digital systems provide many advantages. First, they cost less. This is primarily the result of large-quantity manufacture of modules which make up the E-I system. Cost is almost a linear function of performance capabilities desired in the system.

Second, they are exceptionally versatile. The E-I system can be expanded simply by adding appropriate modules. Typical systems presently in use measure resistance, capacitance, DC and AC voltages, DC/DC ratios, AC/DC ratios, AC/AC ratios and combinations of these. Measurements to four or five digits can be visually displayed and printed out at rates up to five readings per second. Operation can be semi- or totally automatic with go/no go comparison of values and programmed readout at periodic intervals. Scanners can be provided for scanning thousands of single and multi-wire input channels. In brief, the E-I system has an extensive scope of operating capability.

Third, E-I systems provide unmatched reliability. Where practicable, circuits are totally transistorized. The use of etched, plug-in circuit boards, and modular internal construction make maintenance checks and in-plant repairs easy.

Typical E-I system for evaluating components—includes 100 channel input signal scanner. Can digitize DC voltage, resistance, AC voltage and DC/DC voltage ratio analogs. Digital equivalents are recorded on strip printer for "quick look" data and on punch paper tape for additional data reduction by digital computer.

Lower cost, maximum versatility and greater reliability—if you want these advantages in your component test system, contact your nearest E-I representative. He can give you complete information or answer any specific questions you may have.



Electro Instruments, Inc.

3540 AERO COURT
SAN DIEGO 11, CALIF.

Circle No. 23 on Subscriber Service Card.

Circle No. 24 on Subscriber Service Card.



he 28" diameter Scoife missile motor cose shown bove wos laborotory-tested to 230,000 p.s.i. minimum ield without permonent deformotion. Here is another riking example of how Scaife's missile metol ports know-how", combined with the most modern monu-acturing techniques—such as the fomed Reverse-Drow rocess—have advanced missile frontiers over the past decode. Todoy, os higher specific impulse propellants goin wider use, Scoife's progress in developing the right "hordwore" becomes even more important to your R & D ond Production progroms. For full information on what Scoife is doing right now to ochieve even higher yields, and how this importont break-through con benefit you, telephone EMerson 2-2100, or write today.

SCAIFE

OUNDED IN 1802 • OAKMONT (PITTSBURGH), PA. • A DIVISION OF WILSON BROTHERS

RODUCER OF THE GREATEST NUMBER OF HIGH PERFORMANCE* MISSILE MOTOR CASES IN AMERICA

PMR Outlines Plans To Spend $30 Million

by Robert Mount
Special M/R Correspondent

OXNARD, CALIF.—Pacific Missile Range development of downrange and coastal facilities moves into high gear this fiscal year with $30 million in expenditures authorized.

Island facilities at Eniwetok, Wake, Kaneohe Bay, Midway and Kwajalein are under way, and some modification of the tracking station at Ka Lae, South Point, Hawaii, may also be in the cards.

In addition, PMR will develop new instrumentation facilities at Point Montara, near San Francisco; Granite Canyon, on the Monterey Peninsula; Piedras Blancas, west of Paso Robles; Point Pillar, south of Point Montara; and at Laguna Peak, next to Pacific Missile Range Headquarters, Point Mugu.

Expenditures at PMR headquarters itself this year will total about $18 million, with nearly $10 million more earmarked for Point Arguello development. Launching pads for the Air Force project, WS-117L (Project *Sentry*) are under construction at a contract cost of over $5 million at Point Arguello. *Sentry* is the advanced reconnaissance satellite, still listed in Air Force releases under that name. It will utilize **Convair's** *Atlas* for a booster and a **Lockheed**-developed satellite stage.

• **For the islands**—Island development planned this year includes:

• Eniwetok—Communications data link with Wake Island, to handle missile impaction location data, $317,000. SOFAR MILS (Sound Frequency and Ranging/Missile Impact Location System) installation, $435,000. Sounding rocket facility to obtain high-altitude meteorology data, $22,000. Such data are essential for operations involving nose cone re-entry and missile impact data collection.

• Wake Island—Expansion of Federal Aviation Agency transmitter building, $93,000, needed because ICBM target area is near Wake Island and impact data must be transmitted. Wake is one of several PMR stations in what eventually will become Naval Missile Facility Western Pacific. Another $190,000 will be spent here for civilian bachelor quarters this year.

• Midway—SOFAR MILS installation, $435,000.

• Kaneohe Bay—SOFAR MILS installation, $486,000. PMR Hawaiian Islands communications center located at this Marine Corps Air Station will cost another $123,000.

• Ka Lee, South Point, Hawaii—Although no money is explicitly earmarked for this site, recently acquired from the Air Force in a transfer, it has been reported that this deep space tracking station may be modified to increase its ICBM tracking capabilities.

• **On the coast**—Instrumentation along the West Coast budgeted for this year includes:

Instrumentation stations with portable communications and tracking equipment at Point Montara, Granite Canyon and Piedras Blancas, to cost a total of $423,000.

At Point Pillar, the Navy will construct permanent instrumentation facilities costing $545,000, and $63,000 more in photographic and calibration instrumentation for air-to-air and air-to-surface missiles.

A new remote monitoring building atop Laguna Peak, near PMR headquarters at Point Mugu, will extend monitoring coverage to the Los Angeles Basin, presumably to refine current capabilities for frequency screening and interference control.

At Point Mugu, the following major construction is planned:

Roads, $3 million; missile project building, $2.9 million; armament test project building, $2.4 million, which may herald transfer of some armament system studies from Patuxent River, Md., to Mugu; PMR headquarters building, $1.8 million, to house about 600 administrative and operations personnel by 1961; parking facilities and flight aprons, $1.1 million; instrumentation facilities $750,000; frequency control facilities $580,000.

At Point Arguello, planned inter-service and inter-agency launch site for PMR, the following are approved:

Roads and facilities, $5 million; security facilities, $955,000; central launch control building and missile assembly building, each costing $873,000; multipurpose Marine detachment quarters $410,000; range users' engineering building, $400,000; second unit of radio receiver station, $238,000; operational computer center, $233,000; ordnance assembly building, $200,000; public works shop, $150,000; launch site support, $65,000.

Beryllium Heat Sink Is Forged for *Mercury*

CLEVELAND—An 80-inch saucer-shaped beryllium disc has been forged for heat-sink service in the Project *Mercury* space capsule.

A 50,000-ton press at the **Alcoa** plant here squeezed a steel-jacketed beryllium billet into the shape desired at a temperature of 2000° F. **Brush Beryllium Co.** hot-pressed the 62-inch billet by a patented process involving simultaneous application of vacuum, heat and pressure.

After preliminary machining by Brush, Alcoa heated the billet in a special furnace. Then a huge manipulator placed it on a pre-heated die and pressed it to 3 inches thick. The forged part goes back to Brush for precision finish machining, after which Alcoa will perform ultrasonic inspection.

The shield will form part of the outside covering of the capsule, for which **McDonnell Aircraft Corp.** is prime contractor. The shield will be the leading face of the chamber on the return to earth. The piece is one of a series of beryllium forgings Brush and Alcoa will produce for *Mercury*. Beryllium was chosen because it is only a fifth the weight of steel and is an excellent heat absorber.



Only MARMAN makes all four!

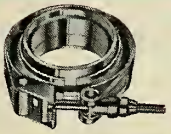
DUCTING...BELLOWS...JOINTS...VALVES



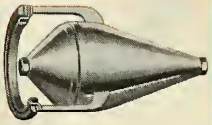
Stainless steel and aluminum ducting in any configuration.



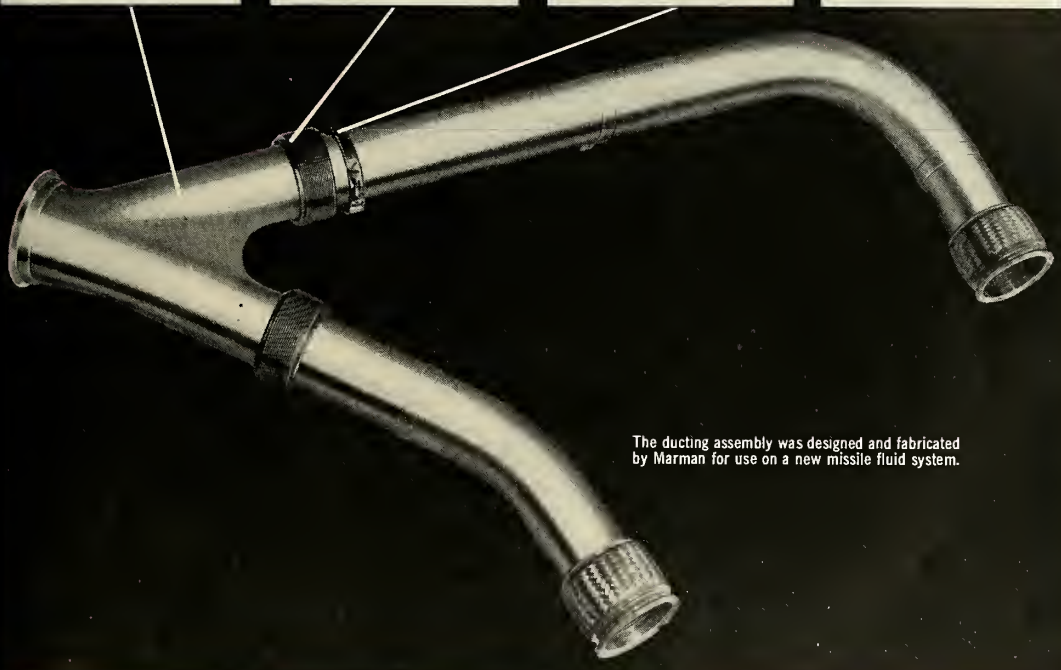
Straight, link and gimbal type bellows assemblies.



High performance tube joints for all pressures and temperatures.



In-line check valves to meet bleed air requirements.



The ducting assembly was designed and fabricated by Marman for use on a new missile fluid system.

NOW YOU GET COORDINATED ENGINEERING AND MANUFACTURING FROM ONE SOURCE

Let Marman simplify your problems of designing and procuring duct assemblies for missile fluid systems. Marman provides highly competent, start-to-finish engineering assistance. And, only Marman manufactures the full range of components required to produce complete duct assemblies for low, medium and high performance systems.

Marman's wide experience and extensive facilities assure expert fabrication of ducting, bellows, joints and valves into precision assemblies. Engineering and manufacturing facilities are coordinated to meet your lead time requirements. To get full information, return the coupon below.

MARMAN DIVISION
Aeroquip Corporation

11214 EXPOSITION BLVD., LOS ANGELES, CALIFORNIA
IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO
Marman Products are Covered by U.S. and Foreign Patents and Other Patents Pending

MR-7

Aircraft Sales Department
MARMAN DIVISION, Aeroquip Corporation
11214 Exposition Blvd., Los Angeles 64, California

Please send me full details on Marman Duct Assemblies.

Name_____

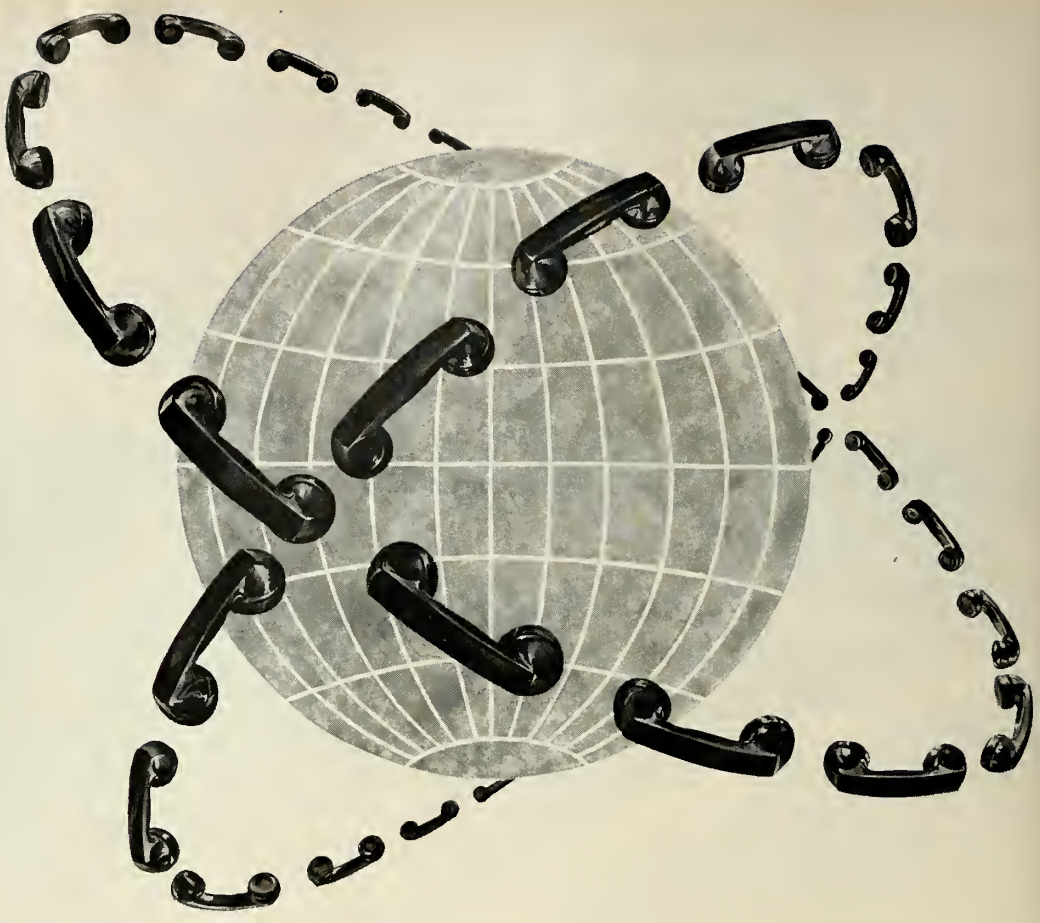
Title_____

Company_____

Address_____

City_____ Zone_____ State_____

Circle No. 6 on Subscriber Service Card.



Tomorrow's dialing will be out of this world

Global telephone calls via satellites brought nearer by a new ITT electron tube

From the nation-wide resources of ITT Laboratories has come the ultimate development in a unique electronic amplifying device called the *traveling wave tube.*

A four-foot version pioneered by ITT for the Armed Forces can transmit as many as 100,000 telephone messages *simultaneously!*

Telephone Exchanges in the Sky

Now a miniaturized type is to be produced by ITT Components Division—small enough for satellites, where its amazing message capacity could be utilized to relay *thousands* of dial telephone calls to points around the globe.

ITT traveling wave tubes of many sizes are already in use in major areas of telecommunications, and in radar, missile guidance, electronic countermeasures, microwave radio, and television.

Pioneers in Electron Tubes

ITT Components Division, backed by experience almost as old as the electron tube industry itself, also manufactures *Iatron*® tubes that can display information, store it for days, erase it at will; photo multiplier tubes that convert light into an electrical signal and amplify it millions of times; image converter tubes for infrared applications, and tubes that give sharp eyes to our radar warning systems.

Other ITT tubes include types for industrial power, rectification, and radio-TV broadcast transmission.

In the free world today, nine ITT System companies are developing and building electron tubes for hundreds of essential and sophisticated tasks—in laboratories, industry, global communications, and national defense. For information, write ITT Components Division, Clifton, New Jersey.

ITT

. . . the largest American-owned world-wide electronic and telecommunication enterprise, with 101 research and manufacturing units, 14 operating companies and 130,000 employees.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION 67 Broad Street, New York 4, N.Y.

ITT COMPONENTS DIVISION • ITT FEDERAL DIVISION • ITT INDUSTRIAL PRODUCTS DIVISION • ITT LABORATORIES • INTELEX SYSTEMS INCORPORATED
AIRMATIC SYSTEMS CORPORATION • KELLOGG SWITCHBOARD AND SUPPLY COMPANY • ROYAL ELECTRIC CORPORATION • AMERICAN CABLE & RADIO
CORPORATION • FEDERAL ELECTRIC CORPORATION • ITT COMMUNICATION SYSTEMS, INC. • INTERNATIONAL ELECTRIC CORPORATION • INTERNATIONAL
STANDARD ELECTRIC CORPORATION • LABORATORIES AND MANUFACTURING PLANTS IN 20 FREE-WORLD COUNTRIES

Circle No. 26 on Subscriber Service Card.



giving the "breath of life" to solid propellants!

TRONA® ...first and foremost source of supply for **AMMONIUM PERCHLORATE**

Advances in solid propellant technology have depended on AMMONIUM PERCHLORATE from American Potash & Chemical Corporation since the very beginning. First in the field with this essential oxidant, AP&CC was for many years the only domestic producer of ordnance-grade NH_4ClO_4. Today, with a growing network of strategically located plants and increased technical knowledge, Trona still leads the industry. Supporting the big tonnage production of AMMONIUM PERCHLORATE at Henderson, Nevada is the new SODIUM CHLORATE plant at Aberdeen, Mississippi, making AP&CC the free world's largest producer of $NaClO_3$. If a guaranteed source for AMMONIUM PERCHLORATE and the very latest in technical developments, gained through years of experience in this field, are important to your process and products, contact your nearest AP&CC sales office today.

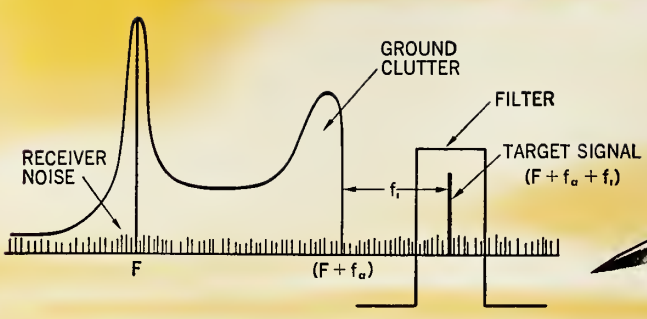
American Potash & Chemical Corporation

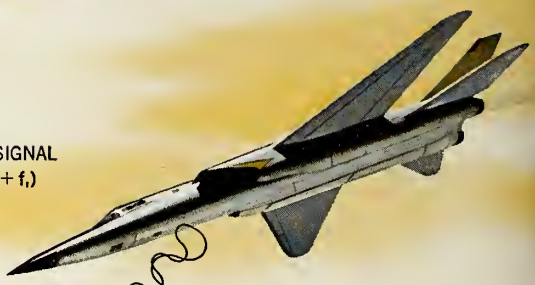
3000 WEST SIXTH STREET, LOS ANGELES 54, CALIFORNIA

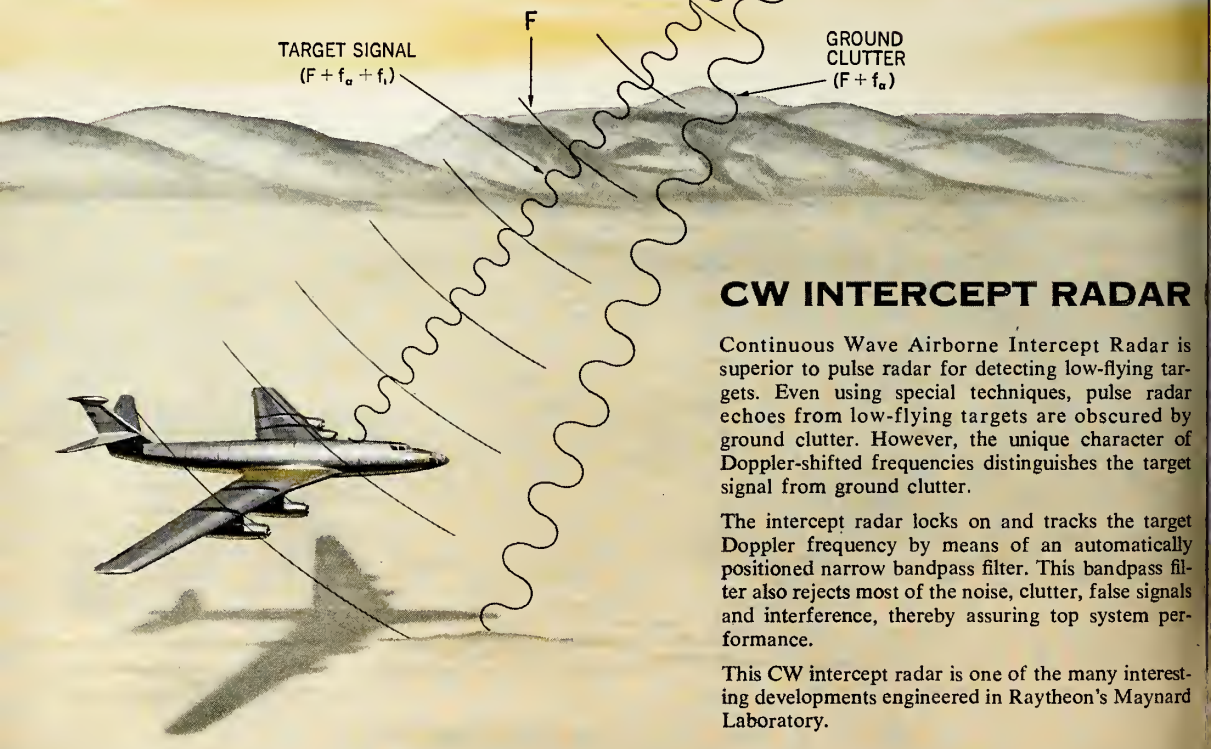
99 PARK AVENUE, NEW YORK 16, NEW YORK

SALES OFFICES: Los Angeles • New York • San Francisco • Portland (Ore.) Chicago • Atlanta • Shreveport • Columbus (O.)

Circle No. 27 on Subscriber Service Card.







CW INTERCEPT RADAR

Continuous Wave Airborne Intercept Radar is superior to pulse radar for detecting low-flying targets. Even using special techniques, pulse radar echoes from low-flying targets are obscured by ground clutter. However, the unique character of Doppler-shifted frequencies distinguishes the target signal from ground clutter.

The intercept radar locks on and tracks the target Doppler frequency by means of an automatically positioned narrow bandpass filter. This bandpass filter also rejects most of the noise, clutter, false signals and interference, thereby assuring top system performance.

This CW intercept radar is one of the many interesting developments engineered in Raytheon's Maynard Laboratory.

PROFESSIONAL ASSOCIATION WITH A FUTURE

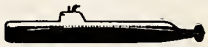
Raytheon has excellent openings for qualified engineers and physical scientists with BS or advanced degrees. Positions are available in systems, development, design or manufacturing engineering of complex electronic equipments. Please write Donald H. Sweet, Government Equipment Division, Raytheon Company, 624 Worcester Rd., Framingham, Mass.

Engineering Laboratories: *Wayland, Maynard, Sudbury, Mass.; Santa Barbara, Calif.*
Manufacturing Facilities: *North Dighton, Waltham, Mass.*

RAYTHEON

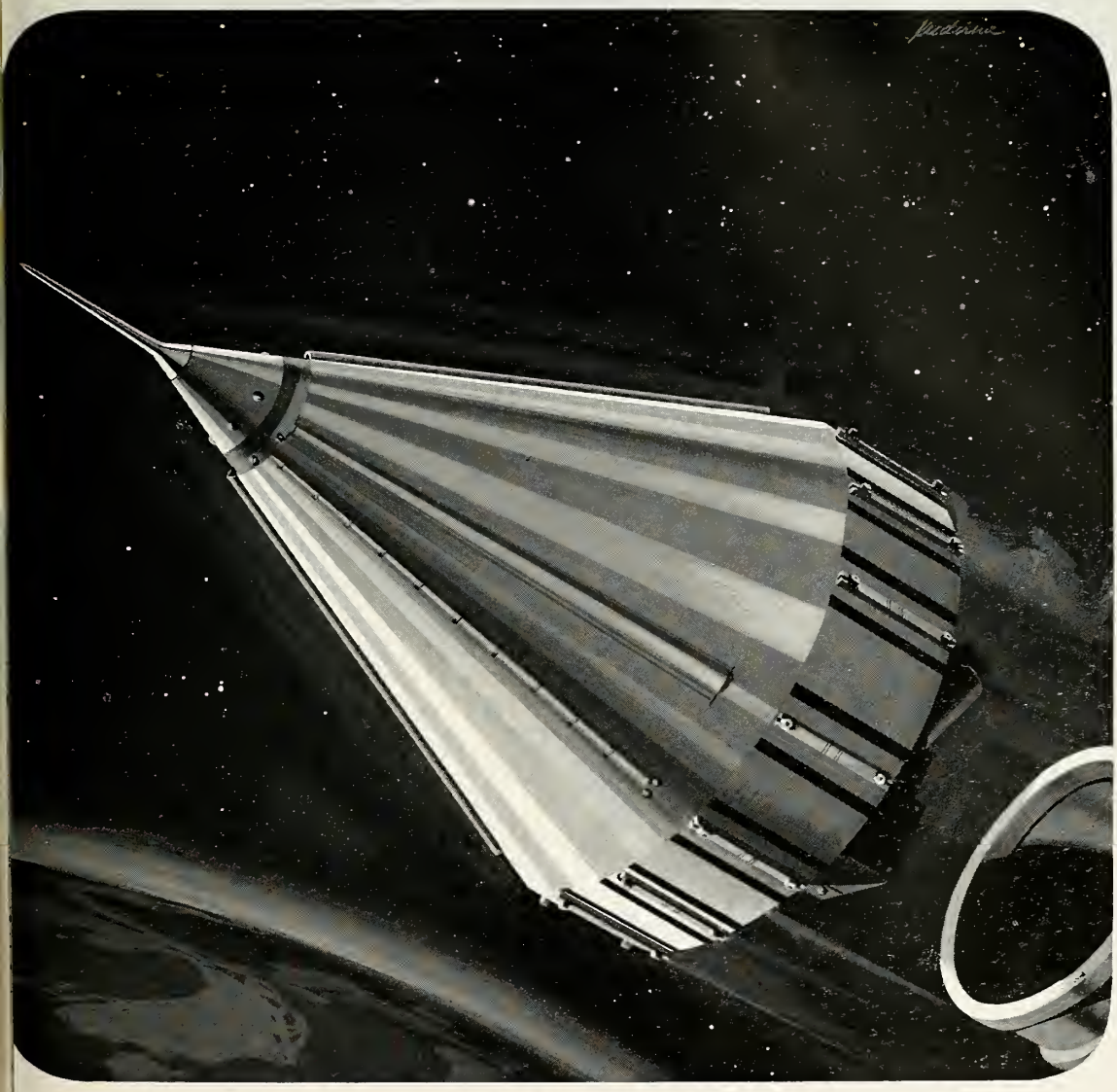
Excellence in Electronics

GOVERNMENT EQUIPMENT DIVISION


LAND SEA AEROSPACE

NOTABLE ACHIEVEMENTS AT JPL...



PIONEERING IN SPACE RESEARCH

Another important advance in man's owledge of outer space was provided Pioneer III. This, like many others of a ntinuing series of space probes, was signed and launched by Jet Propulsion boratory for the National Aeronautics d Space Administration. JPL is admin- tered by the California Institute of chnology for NASA.

During its flight of 38 hours, Pioneer III was tracked by JPL tracking stations for 25 hours, the maximum time it was above the horizon for these stations.

The primary scientific experiment was the measurement of the radiation environment at distances far from the Earth and telemetering data of fundamental scientific value was recorded for 22 hours. Analysis of this data revealed, at 10,000 miles from the Earth, the existence of a belt of high radiation intensity greater than that observed by the Explorer satellites.

This discovery is of vital importance as it poses new problems affecting the dispatch of future vehicles into space. The study and solution of such problems compose a large part of the research and development programs now in extensive operation at the Laboratory.

jpl

CALIFORNIA INSTITUTE OF TECHNOLOGY

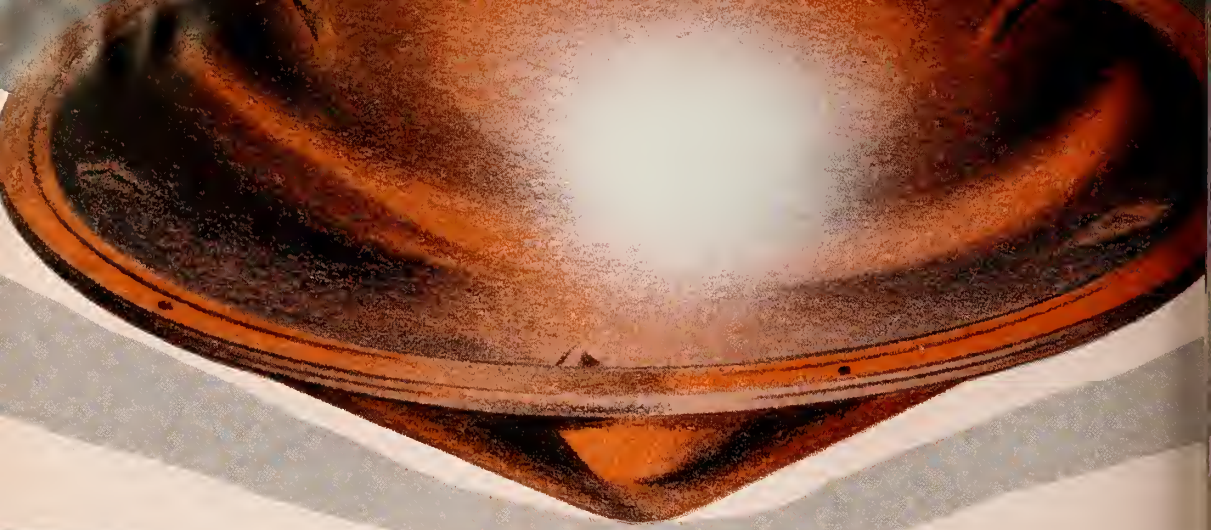
JET PROPULSION LABORATORY

A Reseorch Facility operoted for the Notional Aeronautics and Space Administration

PASADENA, CALIFORNIA

PORTUNITIES NOW OPEN ▶ APPLIED MATHEMATICIANS . ENGINEERING PHYSICISTS . COMPUTER ANALYSTS . IBM-704 PROGRAMMERS
THESE CLASSIFICATIONS ▶ AERONAUTICAL ENGINEERS . RESEARCH ANALYSTS . DESIGN ENGINEERS . STRUCTURES AND DEVELOPMENT ENGINEERS

Circle No. 28 on Subscriber Service Card.



RE-ENTRY SHIELDS

WYMAN-GORDON IS FORGING RE-ENTRY SHIELDS

- Copper in production
- Beryllium in limited production
- Reinforced plastics in development

WYMAN-GORDON

FORGING

ALUMINUM MAGNESIUM STEEL TITANIUM BERYLLIUM MOLYBDENUM COLUMBIUM
AND OTHER UNCOMMON MATERIALS

WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS
DETROIT, MICHIGAN
GRAFTON, MASSACHUSETTS
FORT WORTH, TEXAS
FRANKLIN PARK, ILLINOIS
LOS ANGELES, CALIFORNIA

Circle No. 29 on Subscriber Service Card.

METALS FOR MISSILES...

Armco PH Stainless Steels—
PH 15-7 Mo
17-7 PH
17-4 PH

New steels are born at Armco

These special Armco Stainless Steels, developed specifically for aircraft and missiles, are used for missile airframes, tanks, power plants and accessories because they:

- possess high strength-weight ratios up to 900-1000 F.
- can be readily fabricated by standard methods.
- resist corrosion without plating or painting.
- are commercially available in all forms.
- can be hardened by simple heat treatments.
- have been proved by performance.

For complete information on the properties and fabrication of Armco's Precipitation-Hardening Stainless Steels, write to Armco Steel Corporation, 1499 Curtis Street, Middletown, Ohio.

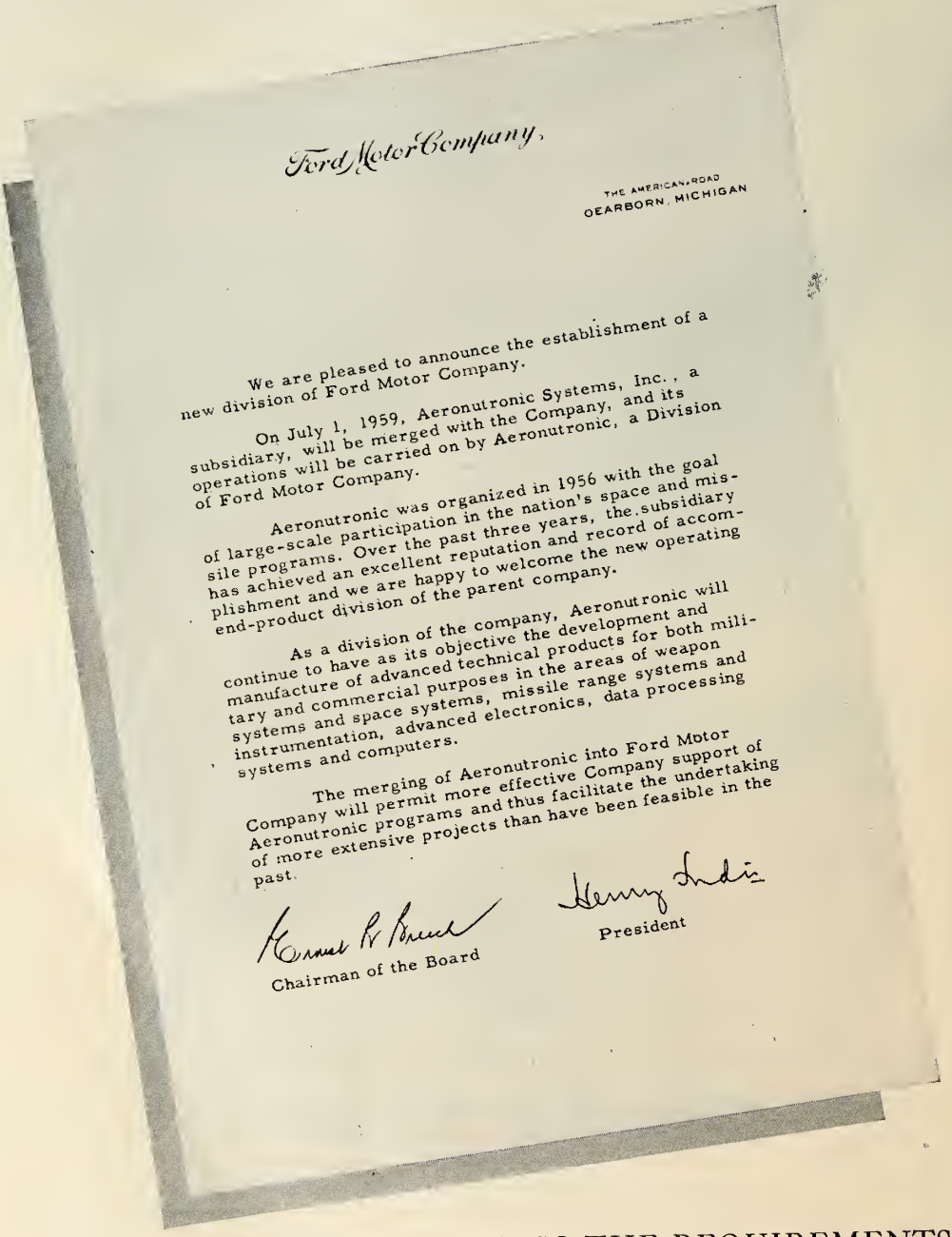


ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Circle No. 30 on Subscriber Service Card.

FORD MOTOR COMPAN
DIVISION–AERONUTRONI
FOR TH



Ford Motor Company,

THE AMERICAN ROAD
DEARBORN, MICHIGAN

We are pleased to announce the establishment of a new division of Ford Motor Company.

On July 1, 1959, Aeronutronic Systems, Inc., a subsidiary, will be merged with the Company, and its operations will be carried on by Aeronutronic, a Division of Ford Motor Company.

Aeronutronic was organized in 1956 with the goal of large-scale participation in the nation's space and missile programs. Over the past three years, the subsidiary has achieved an excellent reputation and record of accomplishment and we are happy to welcome the new operating end-product division of the parent company.

As a division of the company, Aeronutronic will continue to have as its objective the development and manufacture of advanced technical products for both military and commercial purposes in the areas of weapon systems and space systems, missile range systems and instrumentation, advanced electronics, data processing systems and computers.

The merging of Aeronutronic into Ford Motor Company will permit more effective Company support of Aeronutronic programs and thus facilitate the undertaking of more extensive projects than have been feasible in the past.

Ernest R. Breech
Chairman of the Board

Henry Ford II
President

AERONUTRONIC – MEETING THE REQUIREMENTS OF

missiles and rockets, July 20, 1

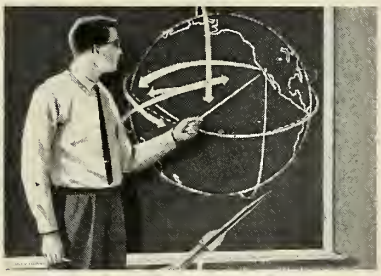
NNOUNCES A NEW
PECIALIZING IN PRODUCTS
PACE AGE



NEW 200-ACRE ENGINEERING AND RESEARCH CENTER. An artists' concept of Aeronutronic's new 20-million dollar Research Center under construction at Newport Beach in Southern California. Here, Ford resources provide the finest facilities for carrying out complete engineering, research and prototype manufacturing operations on advanced projects. Over 40 government and commercial programs are now underway at the new Center and at other Aeronutronic facilities nearby.



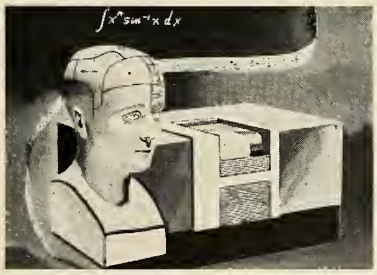
OFFICE OF ADVANCED RESEARCH. Basic research is conducted in areas of long-range company interests, with special emphasis in the fields of atomic and molecular physics, physical chemistry and atmospheric physics.



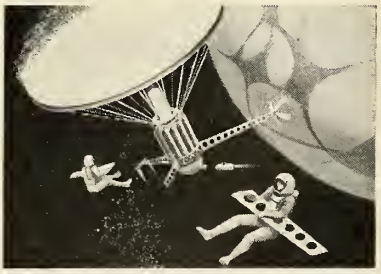
RANGE SYSTEMS OPERATIONS provides total capability to study and plan missile range instrumentation and to staff and manage complete missile range operations for U. S. military and civilian agencies.



AL WEAPON SYSTEMS OPERATIONS. The of TWSO is to research, develop and ucture tactical weapons for the military ics. Under development now is the Army's lion SHILLELAGH surface-to-surface missile system.



COMPUTER OPERATIONS is engaged in research, development, manufacturing and marketing of computer components and communications systems for military and commercial use. New products developed are revolutionizing present data processing techniques.



SPACE TECHNOLOGY OPERATIONS is devoted to solving problems dealing with man's new frontier. Typical development programs include satellite communication, ICBM detection, space vehicle design and research rockets, such as Project Far Side.

For information regarding interests, ilities, products or positions, write to Aeronutronic, a Division of Ford Motor Company, oad, Newport Beach, California.

Ford Motor Company

LITARY AND INDUSTRY IN SCIENCE AND TECHNOLOGY

Circle No. 31 on Subscriber Service Card.



Excellent opportunities for growth are available to qualified Engineers and Scientists, who can contribute to the fulfillment of recently awarded long term contracts in the

Development of Space and Armament Systems

Openings in many fields, including:
ADVANCED BOMBING SYSTEMS
SPACE FLIGHT CONTROL SYSTEMS
MISSILE GUIDANCE SYSTEMS
SPACE COMPUTERS

These Space Age Projects will be of particular interest to Engineers and Scientists with professional training and interest in: Space Flight Mechanics • Weapon Systems Evaluation • Analysis Of Performance Requirements • Operations Analysis • Advanced Digital Computer Development • Advanced Inertial Systems Development • Study Of Advanced Sensors • Missile Trajectory Analysis • Synthesis Of Aerospace Systems



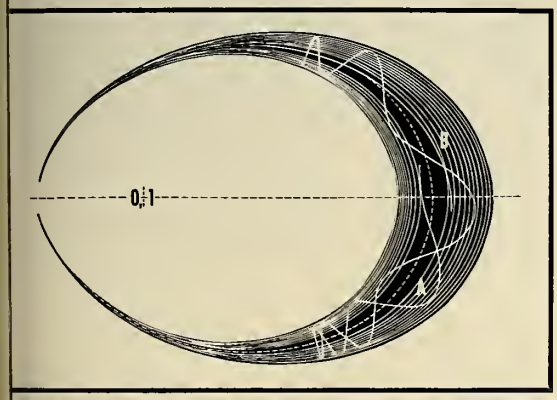
For Further Details
Please Contact
MR. J. W. DWYER,
Employment Manager

SPERRY
GYROSCOPE COMPANY
Division of Sperry Rand Corp.
GREAT NECK,
LONG ISLAND, N.Y.
FIELDSTONE 7-3665

Circle No. 32 on Subscriber Service Card.

Van Allen Discovery Most Important

U.S. has obtained more fundamental scientific information from its satellites than the USSR from its instruments in heavier payloads



RBITS OF trapped particles, from the paper published by oermer in 1913: Orbit A shows a particle injected into the diation belt at a large angle to direction of the local magtic field; Orbit B, particle injected at small angle. (Fig. 1)



INNER AND outer radiation belts in space. Outer belt penetrates into the atmosphere at the latitudes of the auroral zones. Zones are indicated by light bands across the surface of the earth. (Fig. 2)

by Dr. Robert Jastrow

WASHINGTON—The first step toward e exploration of space occurred apoximately 22 months ago as a part of ie International Geophysical Year. In ie short interval since October, 1957, te new tools of research, the satellite d the space rocket, have produced o unexpected results of fundamental ientific importance.

First, instruments placed in the *Exprer* satellites by James A. Van Allen lve revealed the existence of layers energetic particles in the outer atmosphere. This discovery constitutes the most significant research achievement of the IGY satellite program. The layers may provide the explanation for the aurora and other geophysical phenomena, and they will also influence the design of vehicles for manned space flight, whose occupants must be shielded against their harmful biological effects.

Second, the shape of the earth has been determined very accurately with the aid of data from the first *Vanguard* satellite. As a result of this investigation, we have found that our planet tends toward the shape of a pear, with its stem at the North Pole. This discovery may produce major changes in our ideas on the interior structure of the earth.

Each of these discoveries was made with the aid of a U.S. satellite having a payload with a weight of approximately 10 pounds. It is a remarkable fact, and to the credit of the scientists responsible for the design of these small satellites, that they could be constructed to yield so much information per pound of instruments. It can be reasonably stated that we have obtained more fundamental scientific information from our satellites than the U.S.S.R. from its instruments, and on a per pound basis our yield of information has been amazing.

Of course, this is not to say that we could not have done even more in this first stage of space exploration, if heavier satellites had been available.

In addition to these two results of greatest fundamental importance, both the U.S. and the U.S.S.R. space research programs have also yielded other interesting data on the properties of the ionosphere and on the density and tem-



About the Author

Robert Jastrow, 33-year-old geophysicist and nuclear theorist, is chief of the Theoretical Division and chairman of the Lunar Explorations Working Group of the National Aeronautics and Space Administration.

Jastrow, who was graduated from Columbia College at the age of 18 and won his Ph. D. at 22, has lectured in physics at Columbia, Cooper Union, Leiden (the Netherlands), California, Yale and Maryland universities. He has been a member of the Institute for Advanced Study at Princeton, N.J., and consultant to the U.S. Naval Research Laboory, the Convair Division of General Dynamics, and the Los Alamos Scientific boratory. Jastrow joined NASA in 1958.

what are the particles? . . .

perature of the upper atmosphere.

• **Trapped particles**—The discovery of an intense zone of radiation in the outer atmosphere was first reported by Van Allen and his collaborators at the State University of Iowa on May 1, 1958. at a meeting of the National Academy of Sciences in Washington. Van Allen's results were confirmed by *Sputnik* data released by the U.S.S.R. at the Moscow IGY conference early in August, 1958. The zone discovered by Van Allen is commonly called a radiation belt, but the term is a misnomer because it is really a belt of particles rather than radiation.

We shall begin with a few remarks on the general features of the Van Allen particles. They are known to be electrically charged (probably a mixture of electrons and protons), because their intensity follows precisely the shape of the earth's magnetic field. A magnetic field acts on charged particles, but it does not have an effect on neutral particles and radiation.

Also. we know from a great deal of theoretical research, going back to papers published by the Norwegian physicist Stoermer a half century ago, that charged particles can be trapped in the earth's magnetic field in orbits in which they spiral about the lines of magnetic force, traveling back and forth between the north and south magnetic poles. Fig. 1 shows typical orbits of trapped particles, reproduced from the original paper which Stoermer published in *Videnskapsselkapets Skrifter* in 1913. The particles can stay in these trapped orbits for very long times, perhaps as long as several years if they are at altitudes of one thousand miles or more. The trapped particles are injected into the outer atmosphere at an exceedingly slow rate, but because they stay there so long the *total number* of particles in the atmosphere will still build up to very large values. That is the key to the formation of the Van Allen layer.

The *Pioneer III* space rocket showed that the layer actually consists of two separate zones, as shown in Fig. 2. Each zone contains particles with energies varying from approximately 20,000 to several million volts or more. There may be an appreciable number of particles at still lower energies, but these could not have been detected with the instruments flown thus far.

It is found that the particles only appear in appreciable numbers above 200 miles in the northern latitudes and above 600 miles over the equator, and have a maximum density of about 1 per cubic centimeter. However, the Russians have reported *Sputnik III* results which suggest that in or near the auroral zone, the outer belt may reach a density of 100 particles/cm at an energy of 10,000 volts.

• **Protons or electrons?**—The component at the lower energies probably consists of electrons. The more energetic particles are protons or a mixture of protons and electrons. In the inner zone, the penetrating particles have been definitely identified as protons with energies up to one billion volts, according to the results of an emulsion experiment recently conducted by White and Freden of the Livermore laboratory. The concentration of energetic particles is greatest in the inner zone, but is still only 0.1 per cent of the density of soft electrons in that zone.

The inner zone is peaked at an altitude of 2500 miles. The outer zone has a maximum at an altitude of 10,000 miles, and extends into space to a distance of approximately 35,000 miles from the center of the earth.

Until recently, we did not know the mechanism that produced the two zones. This problem of the origin of the zones was the subject of a very lively debate, marked by high atmospheric temperatures, at a recent conference sponsored by the NASA Theoretical Division. However, it is now believed, on the basis of a preliminary report by Van Allen on the *Pioneer IV* results, that the outer layer is produced by particles coming from the sun. The surface of the sun boils and bubbles in a very active manner, occasionally emitting large gusts of plasma or charged particles into the solar system. The *Pioneer IV* flight came immediately after 5 days of continuous and unusually intense solar activity of this sort, *and showed radiation intensities in the outer zone which were many times greater than those measured in the* Pioneer III *space rocket*. The *Pioneer III* flight had occurred in a time of solar quiet. The difference between the radiation levels measured in the *Pioneer III* and *IV* flights definitely establishes that the outer zone is fed by particles from the sun.

It is not yet precisely clear how the outer zone is built up by the solar streams. It may consist of the actual solar particles which have been trapped near the earth by the geomagnetic field, or it is possible that the sola stream produces the trapped particle indirectly by collisions with air atom The NASA schedule of rocket an satellite launchings includes exper ments which will indicate which c these theories is correct.

• **Cosmic ray reflection?**—The caus of the inner zone has not yet been de termined, but the available theoretic evidence indicates that at least som of the particles in this belt are produce by the beta decay of cosmic ray neu trons, as suggested by Christofilos, b Singer, and by the Soviet physici Vernov. The observations by Frede and White also support the hypothes that the inner belt is produced by co mic rays. The Freden-White data i dicate that the number and energ distribution of the energetic proto are in good agreement with what w expect from the beta decay of fa neutrons.

The presence of a gap between th two zones still presents a serious prol lem. On the hypothesis of beta-deca for the inner zone and a solar orig for the outer zone, we would expe the inner zone to rise smoothly in the outer, and it is difficult to expla the finding of a minimum in radiatic intensity between the two. In this co nection an interesting suggestion w made at the NASA conference by D Dessler of the **Lockheed Missile ar Space Division,** who pointed out th there is an irregularity in the geoma netic field which may be described a hole or depression in the magnet contours. He pointed out, further, th the lines of force passing through th irregularity are located at the positi of the gap between the zones. Wh particles are trapped on these lines force in the magnetic field they desce to lower altitudes than would be t case in a perfect dipole field. At t lower altitudes they pass through denser atmosphere and are rapidly moved from the radiation zone.

• **Geophysical effects**—As Fig. 2 i dicates, the particles in the outer zo are funnelled into the Arctic and A arctic by the concentration of the ma netic field near the north and sou poles. The outer zone dips down ir the atmosphere in these regions a disturbs the normal conditions whi exist at other latitudes. Two examp will indicate the consequences of t interaction between the trapped p ticles and the atmosphere.

First, we are rather certain that t *aurora borealis* and the *aurora aust lis* result from the excitation of t Arctic and Antarctic atmospheres collisions between air atoms and particles trapped in the outer zone.

Second, the trapped particle zo

xplain the recent surprising discovery hat the air at high altitudes is warmer n the arctic than in the temperate ones. This discovery was made by the nalysis of experiments performed in .S. rockets at the White Sands missile nge in Arizona, and at the Fort hurchill range in the Canadian Arc-c. The rocket measurements indicated hat at altitudes above between 90 and 40 miles the air over Fort Churchill as a temperature of approximately 000°F., as compared with a relatively ool 2000°F. over Arizona.

We can understand these tempera-re differences as a result of heating oduced by collisions between the apped particles in the outer zone and e atoms and molecules of the upper mosphere. The Van Allen data, sup-emented by *Sputnik III* results and rocket measurements performed by e Naval Research Laboratory and the ate University of Iowa, provide opportunity to make a quantitative st of this heating mechanism. With e aid of the rocket and satellite data, Harris of the NASA Theoretical Di-sion and the author have carried out lculations that show that collisions th the Van Allen particles must use an increase of several thousand grees in the temperature at the cen-r of the auroral zone, in qualitative reement with the observations.

Thus we see that the trapped par-le layers provide the explanation for a number of geophysical phenomena. is this geophysical significance of the apped particles that makes their dis-very so important to fundamental search.

• **Radiological hazard**—The trapped rticle layer has an additional signifi-nce for space technology in that it ay constitute a serious radiological zard to the personnel of future man-d space flights. In order to determine e biological exposure level produced the layer, we must know the ener-s of the trapped particles, and ether they consist of electrons, pro-ns, or heavier particles. Detailed swers to these questions should be ovided in the future by further ex-riments now in preparation. The ta available at present tell us only t the exposure levels appear to be hin the range from 2 to 50 roent-gs for personnel in a vehicle passing ough the atmosphere to the moon outer space. These levels are far ow the estimated lethal dosage for mans, and they can be further re-ced by body shielding. This problem y not be a major one in comparison h other uncertainties of the first ce flights.

Of course, the exposure can be ch greater for personnel in a man-ned orbiting satellite. It may in fact be necessary for the early manned satellites to remain at low latitudes and relatively low altitudes, below 400 miles, where the intensity of the radiation belt is sharply reduced.

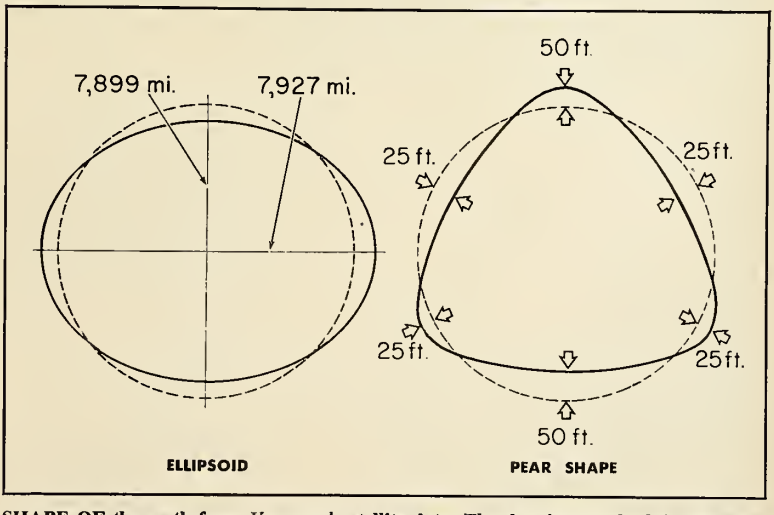
• **Shape of the Earth—1958**—*Beta 2*, the first *Vanguard* satellite, was launched on March 17, 1958. Later in 1958, O'Keefe, Eckels, and Squires, three scientists in the Theoretical Division of the NASA Goddard Space Flight Center, recognized certain changes in the perigee height of the satellite (orbital point closest to the earth) that were contrary to the established theory on the shape of the earth. This theory maintained that the earth had the shape of nearly perfect sphere, flattened somewhat at the poles, and bulging at the equator by about 12 miles as a result of the outward centrifugal force produced by the rotation of the earth. If the "flattened sphere" theory were correct, the force of gravity on the satellite would be the same in the northern and southern hemispheres. Actually, the orbit was found to be different in the northern and southern hemispheres. This indicated that the earth was not symmetrical above and below the equator as previously indicated.

The new findings show that the sea level at the north polar cap is raised by about 50 feet above what has been considered normal. At the solar polar cap there is a depression of 50 feet in the sea level. There are also small changes of the sea level in the temperate zones. The combined effect of these variations is to give the earth a tendency toward the shape of a pear, with the narrow end in the Arctic and the broad base in the Antarctic. A schematic representation of the old and the new shapes is shown below in Fig. 3.

This result is not entirely new. Without indicating his reasons, Columbus stated in the 15th century that the earth must be pear-shaped, as the following quotation proves: ". . . that it is not round in the way they have written, except that it has the shape of a pear that is very round, except where it would have a stem, where it is higher . . . " (Henry Vignaud, *Histoire Critique de la Grande Entreprise de Christophe Colomb*, Paris, H. Welter, 1911.)

A 50-foot variation seems insignificant in comparison with the 4000-mile radius of the earth, or even in comparison with the 12 mile difference between the polar and equatorial radii. However, this change means that there is an excess of matter near the North Pole, or a deficiency at the South Pole, sufficient to draw up the level of the sea by 50 feet *over an area the size of the Atlantic Ocean*. Such variations in the distribution of mass imply very large shearing forces in the interior of the earth.

We may ask what can be the cause of the pear shape. That is not known, but we can make some interesting guesses. For example, we know that the earth is currently growing warmer. It is possible that the Antarctic ice cap has been decreasing in thickness faster



SHAPE OF the earth from *Vanguard* satellite data: The drawing on the left represents the old conception of the spheroidal earth, with a 26 mile difference between the diameters at the pole and the equator. The figure on the left shows, in exaggerated form, the effect of adding a pear-shaped component to the ellipsoid, as required to fit the *Vanguard* data. In both drawings dashed circle represents an equivalent spherical earth with equal volume. (Fig. 3)

shape of geoid established . . .

than the earth beneath can bounce back beneath the reduced load. That would account for the depression at the base of the pear.

The above result indicates that the interior of the earth is not as plastic as originally assumed. NASA scientists have in fact concluded that a mechanical strength at least as great as that of a brick wall is required to support the dome in the north and the variations in the southern hemisphere.

• **Ionosphere properties**—The U.S.S.R. satellites have been the major source of ionospheric information thus far, primarily because these satellites transmit on the relatively low frequencies of 20 and 40 megacycles.

Low frequencies are poor for tracking purposes because the signals are bent by the electrons in the ionosphere during the course of their passage from the satellite to the ground tracking stations, producing an error in the apparent position of the satellite. At 40 megacycles the ionosphere produces an average error of 6 miles in the position of a satellite 600 miles from the observing station.

However, the bending that adversely affects the low-frequency signals for tracking purposes can provide valuable data on the state of the ionosphere, provided the true position of the satellite is known at all times. For example, the difference between the true position and the apparent radio position depends on the number of atmospheric electrons in the path of the signal from the satellite to the observing station. This effect has been used by several scientists to measure the electron density in the ionosphere. The true position can be determined by optical methods if the satellite is sufficiently large. Otherwise it can be done by combining a large number of radio observations for improved accuracy.

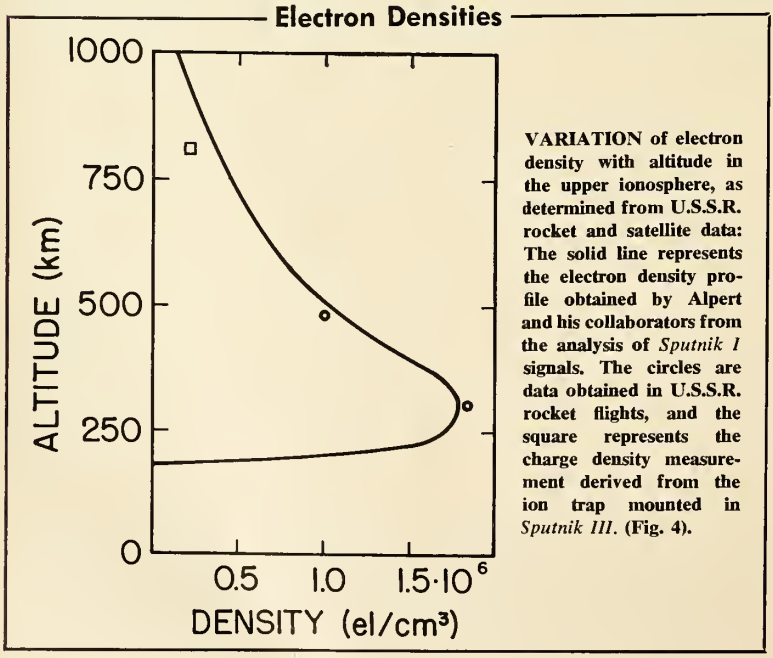
The U.S.S.R. satellite, *Sputnik I*, is a particularly intriguing satellite for ionospheric studies because it transmitted signals on both 20 and 40 megacycles for an extended period. Excellent worldwide recordings were obtained on both frequencies during the radio lifetime of this satellite. The ionosphere physicists must know the true position of *Sputnik I* in order to extract scientific information from these records. Thus far the U.S.S.R. has unfortunately not furnished any detailed information on the orbits of *Sputnik I* or the other Russian satellites, although requests for this information were made in 1958 at the IGY conference in Moscow.

• *Sputnik* **ephemeris**—In the absence of orbit information from the U.S.S.R., the Theoretical Division of NASA has collected all available radio observations and combined them to produce an ephemeris, or table o true positions, for *Sputnik I*. Thi ephemeris has an accuracy of only te kilometers in the position of the satel lite, but it is the best one available t American and European scientists a the present time. The NASA ephemeri for *Sputnik I* is being made available t all scientists in the U.S.A. and in othe countries.

The Moscow IGY conference in cluded a Soviet report on ionospheri investigations, based on undisclose U.S.S.R. orbit data. Prof. Alpert of th University of Moscow gave the result of an analysis of the *Sputnik I* signals which indicated that the upper layer o the ionosphere extends to much highe altitudes than had been anticipated Alpert found the very important resul that the number of electrons above th level of maximum density in the iono sphere is 3.5 times greater than th number below the maximum. The elec tron density profile obtained by Alper is shown in Fig. 4, together wit U.S.S.R. rocket data. The Alpert profil appears to be a reasonable representa tion of ionospheric densities unde average conditions.

The third U.S.S.R. satellite, *Sputni III*, has also yielded interesting iono sphere results obtained from a devic called the "ion trap." The ion trap i a spherical collector approximately 1 inches in diameter, attached to the sur face of the satellite by an extendin rod 30 inches long. A negative voltag is placed on the trap, drawing all near by positive ions to it. The rate at whic the ions are collected is telemetere automatically to the ground, and pro vides a measurement of the number o positive ions in the neighborhood o the satellite.

A few samples of the ion trap dat were presented at the Moscow con ference. They indicated that the io density values are in reasonable agree ment with the electron densities meas ured by Alpert, as shown in Figure 4 As a by-product of the experiment, th ion trap also showed that *Sputnik II* acquired an appreciable negative charg in its passage through the ionosphere corresponding to negative potentials o several volts. An investigation by scien tists in the NASA Theoretical Divisio indicates that a satellite can be charge to still higher potentials, on the orde of thousands of volts, in those parts o its orbit that extend into the region o the great radiation belt. An extensio of the calculations published in 195 by C. A. Pearse and the author show that if the satellite is charged to kilo volt potentials, it will be slowed dow



VARIATION of electron density with altitude in the upper ionosphere, as determined from U.S.S.R. rocket and satellite data: The solid line represents the electron density profile obtained by Alpert and his collaborators from the analysis of *Sputnik I* signals. The circles are data obtained in U.S.S.R. rocket flights, and the square represents the charge density measurement derived from the ion trap mounted in *Sputnik III*. (Fig. 4).

y an electrical drag force which is 10 100 times greater than the ordinary erodynamic drag.

• **Density and temperature**—Direct easurements of the density of the atosphere have been made by installg ionization gauges in rockets. These easurements extend to an altitude of 50 miles. For altitudes above 150 iles the density has been measured inrectly, by analysis of satellite orbits. he indirect measurements depend on e fact that the atmospheric drag rces acting on the satellite are proortional to air density. The drag forces use a decrease in the energy and erefore in the period of revolution of e satellite, which can be easily meased and analyzed to give the average r density in the orbit.

The striking feature of the latest cket measurements of density is their eat variability with time of day, sean and latitude. The data show that an altitude of several hundred kiloeters the upper atmosphere is two hes heavier in the day than at night, d two times heavier in the summer hn in winter. During a summer day arctic latitudes, where the "day" lasts rarly 24 hours, the density is four to ht times greater than the density at e same time in the temperate zones.

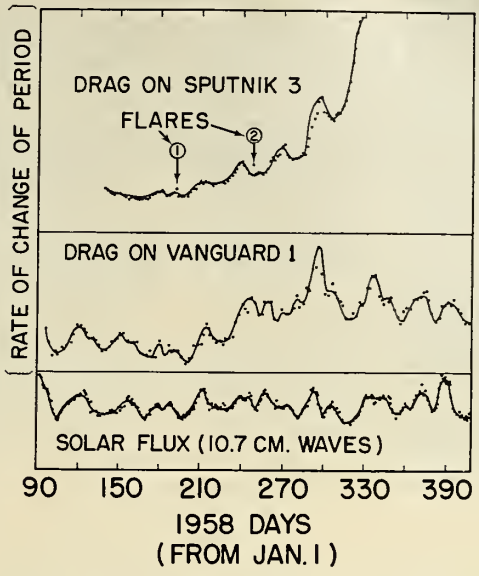
There appears to be a simple exnation for all of these effects, rmely, that prolonged exposure to the sn heats the atmosphere and causes a upward expansion, producing very ge relative increases in the thin air a high altitudes.

• **Satellite drag variations**—The satite density data also show large fluctitions in addition to the systematic riations described above. These fluctitions are probably the result of atospheric heating produced by streams o energetic particles and radiation m the Sun. Dr. Jacchia of the rvard Observatory has in fact discovered that the apparently random fluctuations are actually proportional to the changes in the intensity of the 10-centimeter radiation from the sun, which constitutes an excellent measure of solar surface activity. The correlation between the satellite drag and solar flux is shown in Fig. 5.

Jacchia has been able to eliminate electromagnetic radiation as the source of the drag variations, and has succeeded in identifying the heating effect with the arrival of corpuscular streams in the vicinity of the earth, following major solar flares. The proof of this result is shown in a report recently published by Jacchia in *Nature*. Fig. 6 shows that the drag increases observed after two solar flares did not occur at the time of the flares, but began approximately 1 day later at the same time that the magnetic K index spurted upward. A rise in the K index signifies the onset of a magnetic storm, and therefore the arrival of the relatively slow-moving solar corpuscular stream which accompanies the flare.

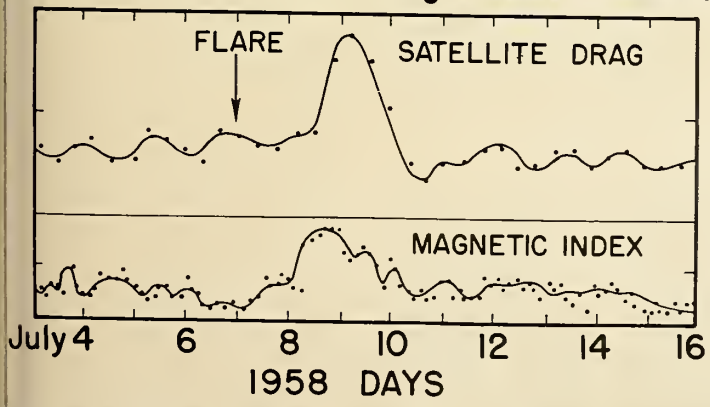
This beautiful demonstration of the relation between upper atmosphere properties and solar corpuscular streams promises to open a new chapter in the study of solar-terrestrial relationships. I believe that in retrospect it will turn out to be one of the most significant results to come from the IGY satellite program.

Solar Effect on Satellite Drag

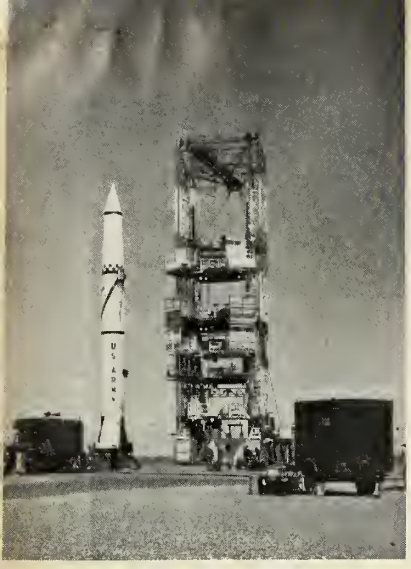


CORRELATION between solar activity and satellite drag. In the graph satellite drag is plotted on the same base with the observed flux of solar radiation in the 10 centimeter region of the spectrum. The 10 centimeter radiation is an accurate measure of solar activity. The figure demonstrates a perfect correlation of maxima and minima in the two curves. (Fig. 5).

Drag Increase with Storms



CORRELATION of drag increases with magnetic storms, following a major solar flare: The time of occurrence of the flare is indicated by an arrow. The onset of the magnetic storm, which signifies the arrival of corpuscular streams from the sun, is marked by the increase in the magnetic index plotted from the lower graph. (Fig. 6).



SERVICE tower for *Redstone* at White Sands.

Missile Support Progress . . .

Bigger Vehicles Will Pose More Baffling Engineering

Solution to missile support problems largely rests with Army's Corp of Engineers which has lion's share of responsibility

WASHINGTON—The art of launching a rocket has reached such refinement that the supporting mechanisms and structures required to get our exotic birds off the ground present the most baffling of engineering problems.

The solution of some of these support problems is a responsibility of the U.S. Army Corps of Engineers, headed by Maj. Gen. E. C. Itschner. As the Chief of Engineers explains it, the Engineers' role in the Government's missile and space program is a multiple one—performing a variety of missions for the Army Missile System; constructing missile bases for the Air Force; and carrying on construction projects for the Advanced Research Projects Agency and the National Aeronautics and Space Administration.

Working closely with the Army Ordnance Missile Command, the Corps of Engineers' support of guided missile and rocket operations includes the provision of Engineer troops; construction of missile sites, test laboratories, training centers and other facilities needed to train men and develop weapons; supply and maintenance of engineer equipment and material; provision of maps and geodetic data; and development by research; often in cooperation with industry, of new engineer equipment for the Army's family of missiles.

• **Keeping abreast**—All of these areas of support are equally important to the Army missile program, Gen. Itschner said, but to those whose interests lie primarily in keeping abreast of new developments in the constantly changing requirements of the program, a review of the research efforts of the Corps is in order. These efforts affect all Army missiles, from the operational *Lacrosse* to the still-to-be tested *Pershing*, successor to the *Redstone* family.

"Nuclear warfare will impose a requirement for great mobility on our ground forces, which must have the capability of hitting the enemy, then dispersing and regrouping again for another strike where it is least expected," Gen. Itschner explained. "We must be able to move our rockets and missiles into the battle area and out again on short notice. Supporting equipment, such as power generators, fuel tanks, fire control vans and radar equipment must also be easily and quickly moved. To attain this mobility, the Corps is developing smaller and lighter equipment which will do the job for which a particular missile has been designed.

"For example, the presently avai able conventional engine generat capable of providing power r quired for guidance of the *Lacros* missile weighs 900 pounds with a cessories. Since it is necessary th this generator be manpacked to t forward observers' position, we a developing a generator of 3 KW ou put, 400 cycle with precise pow regulation capable of being carri by one man, or with a full fu tank, by two men. The **Curtiss-Wrig Corporation, Santa Barbara Divisio** developed and demonstrated enginee ing models in sixteen months. One the unusual engineering characteristi of this generator is the silencing fe ture. Operational noise from this equi ment will not be heard further than few hundred feet.

"Also under development is t power pack for the *Pershing* miss system. This pack is a combination utilities ordinarily furnished by t Corps of Engineers as separate piec of equipment. The various units a packaged on one base plate, with lit greater total weight than is norma found in any one of the componen Electric power of three different outp characteristics, high pressure air (30 psi), and conditioned air all generat from one gas turbine drive, are cluded for a total weight of abo 2600 pounds. This unit will be tra ported on a vehicle weighing 95 pounds which also mounts a fire co trol hut. The standard air compress of the size needed, three generato and an air-conditioning plant heati unit, with four vehicles previously quired to transport them, would wei upwards of 28,000 pounds."

• **Interservice cooperation**—Of vi

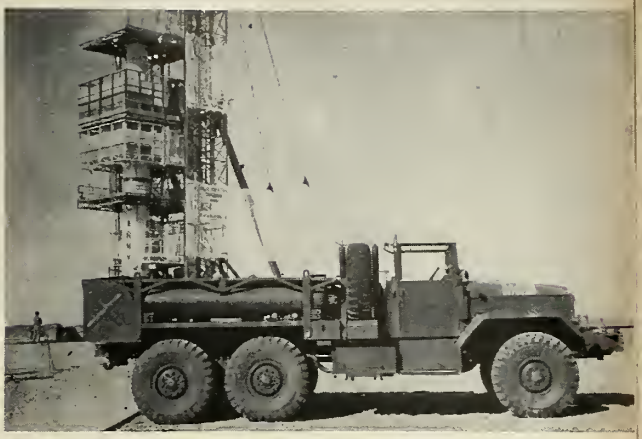


About the Army Engineer Chief

Maj. Gen. Itschner has charge of the booming missile construction program for both the Army and Air Force. In addition, he is responsible for the Corps' nationwide civil functions. A graduate of West Point (1924) and Cornell, the General has served in Army construction projects all over the world—Europe in WWII, the Philippines, and Korea. Known as a "man in a hurry," his major responsibility now is directing construction of the new Air Force ICBM bases along with a whole range of missile research and development, testing, and launching facilities, including the Army's Nike bases.



IYDROGEN peroxide service truck is part of support equip-ıent for *Redstone*.



BIG TASKS are performed by vehicles in missile support. Representative is this 5000-lb compressed air storage tank.

enefit to the Army in speeding the evelopment of the *Pershing* system is ıe precedent established by having one chnical service participating directly ı the program of another, the Chief f Engineers said. Specifically, the ower pack is being developed by the **Martin Company,** contractor for de-elopment of the missile system for the rdnance Corps, Army Ballistic Mis-le Agency, and the Engineer Research nd Development Laboratories (ERDL) ho serve as technical supervisor of the ack development for the ABMA, op-rating within the framework of the rime contract.

"Again, in the high power acqui-tion radar (HIPAR) building for the nproved *Nike-Hercules*, as in the *ershing* power pack, we have an in-grated Engineer-Ordnance working elationship," Gen. Itschner pointed ut. "ERDL is the technical super-isor for the Army Rocket and Guided lissile Agency for the development f a pre-fabricated building to house new radar. It is evident that the rmy will gain from this joint opera-on in both the development and logis-cs stages. Experience gained by the orps of Engineers from participation development will enhance our capa-lity for providing spare parts and aintenance support of the resulting roduction item."

In the HIPAR building, where mo-lity and weight are of prime im-ortance, the unique engineering prob-m is in retaining the necessary air-ght panel seal despite repeated as-mbly and disassembly of the build-g, a problem not heretofore involved prefabricated building. Inflated seals e being used at all joints, and it ppears possible that a technical break-through in this particular problem area may result, the General disclosed.

Another development item with a requirement for high performance and low weight is the air-conditioner—heater plant for an Army field missile. This plant, a unit weighing 350 pounds, provides 38,000 BTU of air-conditioning and approximately 35,000 BTU heating per hour. It will be used in a van or a shelter of a field battery control center. Two difficult engineering problems—vibration and noise level—were encountered due to the high rotating speeds of the motors and compressors. Both are being solved through unique packaging and insulating methods. Because of an immediate requirement for this unit, a six month development time was imposed. Production models are scheduled with an initial delivery time of nine months.

• **Skyscraper on wheels**—Recently, the design was completed for a 305-foot missile service tower to be built at Cape Canaveral for the Advanced Research Projects Agency space vehicle, the *Saturn*. (MISSILES AND ROCKETS, June 8, 1959.) The tower, as tall as a 28-story building, will be on wheels.

Another ARPA project at Redstone Arsenal, is a static test tower being modified for use with the *Saturn*. This is the Army Ballistic Missile Agency's 140-foot tower previously used to test missiles up to the size of the *Jupiter*. Upon completion of the work, the tower will be capable of statically testing missiles having up to 1,500,000 pounds of thrust.

The work consists of driving approximately 6000 lineal feet of steel piling, constructing two reinforced concrete underground anchors 61 feet below bedrock and erecting approximately 470 tons of structural steel to be used for mounting the hold-down devices for the missile test. A cantilevered 100-ton bridge crane and hoist will be erected atop the modified structure for lifting the missiles and equipment into test positions.

Another missile service tower, fabricated by the **Noble Co.,** Oakland, Calif., is under contract with ERDL and scheduled for erection at Cape Canaveral in July. It is a mobile structure 150.25 feet tall, composed of twin towers mounted on a rubber tired trailer 42½ feet long. The tower has a traveling crane on top and is designed to handle *Jupiter* and *Redstone* type missiles. When servicing of the missile is completed, the tower moves away on its own trailer.

As missiles become more sophisticated, the demand for purer fuel becomes more urgent, Gen. Itschner said. The Ordnance Corps has determined the maximum allowable hydrocarbon count as .03 parts per million in the liquid oxygen as it is pumped into a missile such as the *Redstone*, largest field operational weapon of the Army. There must, therefore, be frequent purity checks by the soldier missilemen of the Engineer unit charged with supplying the fuel. To meet this requirement, ERDL is pursuing a project for developing a test instrument that can be easily used by the engineer soldier for checking the purity of LOX with a maximum of accuracy and a minimum of danger. Another field instrument under development by ERDL is for checking the dew point moisture content of compressed air at temperatures as low as –85 Fahrenheit.

• **Storage problems**—Loss of liquid

oxygen through evaporation during storage and transfer to the missile is another problem which plagues the Engineers. This loss, which now varies from 50 to 75 percent, is being reduced by improved equipment, especially fittings. ERDL is also developing a new type of storage container with unusual types of insulation. Inasmuch as LOX must be hauled from our mobile field generating plants to the launching sites in nine-ton tank trucks, the handling problem is a major one. Even though the Engineers have developed LOX plants with capacities of up to twenty tons per day, fantastic amounts are required to fuel a 70-foot missile. Heavy losses, particularly in the event of an actual combat situation, might cripple operations.

The Corps of Engineers' research and development work for the Army missile systems presently constitutes at least 25% of the research and development effort at ERDL. This work is being carried on both by ERDL personnel and by contract. It includes dozens of projects not heretofore mentioned, such as special air-transportable and mobile cranes, safety shower bath units to decontaminate personnel and clothing worn around toxic fuels, night vision equipment and special tools such as a welding machine for use on thin gauge materials. ERDL is even developing an unusually effective vacuum cleaner for cleaning the electronic and other delicate equipment used in the control vans.

Recently, the Corps completed an engineering analysis of the power requirements for the *Nike-Zeus,* including consideration of the remote stations where commercial power is not available. Transportation of fuel is a costly and often hazardous logistical effort. It has been determined that nuclear power plants can be designed to meet the stringent specifications required in operation of *Nike-Zeus* radar and electronic equipment. **Alco Products, Inc.,** which built the first Army power reactor plant at Fort Belvoir, Virginia, has completed a preliminary design and has been selected by the Army to complete the final plans of the proposed plant.

Missiles, regardless of whether they are Army surface-to-surface weapons or the Air Force's intercontinental ballistic missile, must be aimed at the target before they can be fired, Gen. Itschner noted. To attain the degree of accuracy needed to make missile warfare pay off in victory, the man aiming the weapon must know two things. First, he must know precisely where the missile is located at the time of launching, and second, he must know precisely where the target is in relation to the missile.

The task of locating targets and the guiding of the missiles to them is a complicated one requiring close coordination of the efforts of many men. Basically, it is a mapping job. The Engineers are responsible for providing the interconnected grids and earth measuring information necessary to direct longer range strategic missiles.

Said Gen. Itschner, "With the Air Force, we are working on the use of high altitude electronically controlled aerial photography to speed the compilation of maps, and we are using helicopters and geodimeters to accelerate field surveys. By using electronic digital computers, the time required for geodetic control adjustment has been reduced by years.

• **Where we are**—"Engineer teams on Pacific islands, using tracking devices, are obtaining valuable data from the *Vanguard* satellite as to precise island locations, which heretofore have been mistakenly located on maps from hundreds of meters to miles from their actual positions. This activity is helping us to get the answer to the question, 'Where in the world are we?'

"To help perfect methods of rapidly and accurately locating targets within a tactical area, which might be 200 miles deep on an atomic age battlefield, the Corps of Engineers is evaluating various target location systems. These involve the use of day and night aerial photography, radarscope photography to map the ground through clouds and darkness, and electronic systems to locate the photographic aircraft with respect to known ground stations."

A large part of the Engineers' efforts in construction are being directed toward the Army and Air Force missile programs. Construction of missile support facilities involves types and methods of building undreamed of a few years ago. Specifications now require construction tolerances which were possible before only as laboratory experiments.

"The *Zeus,* third generation of the *Nike* family, will create greater problems," Gen. Itschner predicted. This weapon is the Army's anti-missile missile designed to intercept enemy ICBM's in flight. The *Nike-Zeus* is a highly complicated system that brings the scientist, manufacturer and construction man together. Missile, test, and launching facilities are designed, developed, and built simultaneously. Flexibility will be the watchword at all times for those connected with the development of this missile. Constructors, designers and manufacturers will have to adapt themselves to the demands imposed by the rapidly widening knowledge being acquired by missile experts, for whom there seemingly are no limits except the horizons of their imaginations.

"Where these scientists and missile experts will take us in the space age is difficult to foresee at this point. The Army's Corps of Engineers, however, is preparing for whatever problems present themselves, whether they be on the moon or some fantastic reconnaissance space station on the route to Mars. Our Engineer research and development experts are conducting studies on space construction problems in sanitation, water supply, thermodynamics, electric power and advanced methods of prefabricated shelter construction. One of the programs considered important to the future involves a look into new sources of energy such as thermoelectric and thermionic generators and solar energy.

"The by-products of the research which our space program has brought about are leading us to portals of knowledge which are only now beginning to open for the benefit of mankind."



TWO IMPORTANT items for *Jupiter:* 100 KW power generator and vertical check-out shelter.

Fertile Field for New Applications

Microminiaturization, solid-state physics and communications technology are promising areas

by Robert J. Jeffries

DANBURY, CONN.—Whenever a new ientific fact is discovered, or when a w technology gains momentum, there a great tendency for authors and blishers to rush into print with a ultitude of predictions and projec- ns as to what the future will bring. areas already established there are e traditional articles on the "state the art" which appear periodically.

Both categories of exposition— e projections and implications of new chniques, and the periodic review established technologies—fill impor- nt functions. In general, they serve e needs of the "lay" public, as a basic ucational tool, and the practitioner the field, possibly as a stimulant, and rtainly, in the minimum, as a con- nient tabulation of the art, by means which he can mentally check his n progress and understanding.

Progress in Space Instrumentation ses a particularly difficult subject on ich to write an article for the read- of MISSILES AND ROCKETS Magazine. be correct, the author must define at he means by "Instrumentation"; must also define what he means by pace"; the meaning of "Progress" may take as self-evident. Also it obvious that the audience is not a y" audience in the sense of being technically unsophisticated in the subject, and lastly, for reasons of security, it is impossible to present an up-to-date review of the state-of-the-art in any detail.

What objective and means is there left then which justifies an article at all? The answer lies in perspective. If an article can present a situation in perspective in such a manner as to aid the reader in a better comprehension of his own role and problems, if it can stimulate the reader to a more creative synthesis of solutions to his problems, if it can direct attention to critical areas in need of attention and potentialities as yet unexploited, then it serves a useful purpose. In a modest way these shall be the objectives of this article.

• **What is instrumentation?**—Literally hundreds of efforts have been made over several years to define instrumentation. A synthesis of these several efforts, which in the least serves to define the scope of interests of this article is as follows:

"Equipment and techniques associated with and essential to the detection, measurement, transmission, translation and display of information, and including possible associated computation and utilization of the information for control purposes."

• **What is space?**—For purposes of this discussion, space may be defined as the volume around us excluding the earth, the oceans, and the atmosphere. Unfortunately, this definition tells us little, really, in that it assumes a precise definition of "atmosphere." One can define "atmosphere" as one chooses. For immediate purposes, let us assume as a purely arbitrary decision, that the atmosphere extends from the surface of the earth and its oceans to a height of 100 miles. Space then becomes the volume around the planet Earth, but external to a spherical shell 100 miles thick, surrounding the Earth. Obviously this definition is unique to the understanding and use of an earth-oriented creature.

• **What is space instrumentation?**—From the definitions above, it is apparent that Space Instrumentation embraces all the instruments that guide and control space vehicles, measure characteristics and performance of space vehicles and operate on and digest, display, and automatically react to the resultant information. It also includes the hardware and techniques of measurement of space and its contents. This is to say that Space Instrumentation embraces virtually every technique and piece of hardware designed to gather data in space or related to the gathering of that data. Space instrumentation is not generally understood to include considerations of propellants, propulsion or structures. But what of a nose cone? In some instances, a nose cone becomes, in itself, an instrument—detecting, and measuring directly and indirectly, meteoric dust, temperature, etc. All the above considerations demonstrate the necessity for an arbitrary agreement as to what shall be embraced by the term space instrumentation. For purposes of this discussion, space instrumentation is defined to include the following:



About the Author

Robert J. Jeffries is president of Data-Control Systems Inc., Danbury, Conn. A former assistant to the president of Daystrom Inc., Dr. Jeffries was president of the Instrument Society of America in 1957-58.

He has taught engineering at various universities and has been a consultant to all three military services, the National Bureau of Standards and numerous commercial firms. Jeffries is a founder and trustee of the Foundation for Instrumentation Education and Research.

small business to benefit . . .

• Instrumentation for measuring characteristics of space vehicles,

• Instrumentation for measuring characteristics of space and its contents,

• Instrumentation for communicating and displaying space data.

Measurements of temperature, acceleration, position, flow, stress, vibration, noise, etc. are commonly made today by means of a host of different transducers. These measurements will continue to be made in the years to come. This past year has seen a continuation of the long-term trend, in which transducers are becoming smaller, lighter, of higher frequency response and greater output. There is evidence of a renewed interest in variable-reluctance phenomena in transducers. Most transducers in use today yield analog output signals. There are coming to the fore an ever-increasing number of techniques, combined with conventional transducer principles, which yield digital output signals. The number of measurements which can be made with sufficient accuracy to justify the resolution of digital representation is still small. The advantages of reduced susceptibility to degradation of data in subsequent handling is currently the most important influence in the stimulation of digital techniques.

• **Terse messages**—Space engineers are employing techniques of predigestion of data in flight, with subsequent transmission of derived and statistical characterizations of phenomena. Probably the greatest incentive and utility of such techniques lie not in the inherent data analysis that occurs but in a reduction of the total information to be relayed to a remote point or points.

Solutions to several of today's problems will undoubtedly become operational in the next few years. For example, with the advent of transistor circuitry we can anticipate that transducer outputs will ultimately be adapted to current-input circuits, rather than voltage-inputs. In the near future, however, and before the above can come to pass, the present 0-5 volt input levels will begin to lose popularity. Signal-conditioners, that is amplifiers, and signal translators for modifying available transducer signals to adapt them to conventional standardized telemetry equipments will increase in number and complexity. Finally, the technology is forced to an entirely new approach based on the characteristics of solid-state circuitry. Low-level, solid-state computers will replace electromechanical devices and multi-channel amplifiers. Some prototypes of this type already exist.

A prime objective will continue to be the reduction in size of all equipment. Many components, such as voltage-controlled oscillators, are already approaching a situation wherein the connectors and junction boxes are as large as the components themselves. Further reduction in actual size of individual components does not appear to offer as much margin for improvement as do several other avenues. In the near future, one can expect high-speed, low-level commutation to reduce the space requirements of multi-channel systems. New multiplexing concepts will permit more efficient utilization of available power, thus reducing space requirements for RF components and space and weight in the energy source. For sustained flights, power "captured" in flight is already being used to reduce overall weight requirements. The present enthusiasm for digitized data, while justified in many instances, must be tempered with the sobering fact that in most applications digitization of data increases the space and weight requirements of the instrumentation equipment required for a given information capability.

The most important and exciting promise of the future for all types of flight instrumentation lies in the evolving techniques of microminiaturization. There can be no doubt that these techniques have the potential to reduce the size and weight of all flight instrumentation circuitry. Some equipment of this type is now in use. However, several fundamental facts stand out at this time: (1) Microminiaturization techniques, being relatively new, have not yet progressed to a stage, at which it is possible to achieve accuracies and stabilities comparable to conventional circuit techniques in reproducible units. (2) Microminiaturized circuits are essentially custom-made, with a high rate of failures, with complicated fabrication problems and large capital equipment requirements.

The manufacturers of space instrumentation hardware are, in the main, small businesses. This is so because of the rate of technological advance, the relatively small production runs involved, and the high premium on individual initiative and adaptability. As small businesses they are not able to undertake the basic research inherent to microminiaturized circuit development. For these reasons it is not to b anticipated that conventional *miniatur ized* standard flight instrumentation wil be replaced in the near future, for th bulk of space vehicle instrumentation with *microminiaturized circuitry*.

• **Measuring characteristics of spac** —The obvious questions asked first b any explorer of a new world are "What is present?", and "How much i there?" As we initiate our manned ex plorations of space we begin with thes elementary questions. It is almost cor rect to say we are in the Stone Age o space knowledge; we must first find ou whether the environment of this nev "space world" is hostile to our being We must first detect and measure, an later evaluate, the effects of such thing as radiation, meteorites, weightlessness etc. The fundamental problem is to de cide what we should be looking for Once the variables to be detected an measured are defined, then the appro priate hardware can be developed.

While we progress toward manne exploration of space, we learn muc from unmanned observation station Missiles in trajectory, satellites in or bit and balloon-borne stations affor us effective vantage points for view ing space from a new angle an without the distractions and interfer ences associated with an earth-boun observatory. Obviously, most of th measurements made on far-space fron any vehicle located in near-space mus be based on electromagnetic phenom ena—received, reflected, refracted, o absorbed. The sciences and techno ogies of astronomy, optics, chemic analysis and photometry, working wit the instrument technologists are no evolving the transducer hardware adapted to the near-space environmen Balloon-borne telescopes, spectometer star trackers, etc. are now familia items for work in near-space.

• **Instrumentation for communicat ing**—Telemetry is the all-inclusive wor used to embrace the concepts and hard wares involved in remote measure ments. In practice, one usually differ entiates among transducer, telemetry and display equipment. Telemetr equipment provides the communicatio links between the measuring tran ducers and the display equipment.

The prime objectives of currer telemetry development are improve accuracy, reliability, space and weig reduction. Improved resolution is po sible through pulse code technique (However, improved resolution do not necessarily mean improved accu acy.) Pulse-coded data can be relaye from point-to-point either by radio o wire with no theoretical degradatio of quality. This represents a distin advantage over transmission of data i

nalog form. If however, in a pulse-
ode system, the transmission bit rate
high, there is the possibility of lost
ts, ambiguities, and loss of synchroni-
ation. These must be accounted for in
ny evaluation of ultimate accuracy.

Size and weight reduction in the
verall telemetry system can probably
e best effected by employing new
stem concepts. Pulse-coded systems
ill almost certainly increase size and
eight requirements. The power and
pace requirements of pulse-code equip-
ent capable of transmitting several
hannels of high-frequency intelligence
ata today are much greater than the
rresponding analog system. Employ-
ent of RF links in the microwave
nds poses additional problems. The
ficiencies of transmitters in these
nds is relatively low. Compromises
ill be necessary to balance increased
formation-handling capability against
duced electrical efficiency. A recently
nounced heterodyne technique, which
rmits the superposition of several
andard analog multiplexes and the
multaneous transmission of very high-
equency intelligence over a single RF
nk, appears to hold considerable
omise for reduction of overall system
ze and weight.

The display of telemetry data poses
veral problems that are not solely
chnical. During flight, ground per-
nnel are aided by real-time informa-
on displays. During subsequent data
alysis much time and effort can fre-
ently be saved, if, instead of reduc-
g all available data, a quick search
n be made for "interesting" phe-
mena, and that portion of the data
spected minutely. Inasmuch as every
ght represents a large investment, it
desirable to process all available data
every conceivable way, usually prior
the next flight. In general, then the
splay problem is really three prob-
ms; (1) real-time quick-look, (2)
ta-reduction search and quick-look,
d, (3) detailed comprehensive data
duction. All three appear to be essen-
l to full and effective utilization of
e flight data. As intelligence frequen-
es go higher, as the number of chan-
ls of information increases and as
mmutation rates increase, new and
sically different techniques of real-
ne and quick-look display will be
quired.

In summary, Space Instrumentation
n be said to be a fertile field for the
plication of new ideas. These ideas
w encompass the most sophisticated
ncepts of solid-state physics, com-
unication theory, and astronautics.
t the most successful hardwares are,
d will continue to be, those that are
e simplest, most reliable, most ac-
rate, and available on short procure-
ent-lead times.

Liquid Engine Progress . . .

Power, Simplification, Reliability Still Criteria

Cheaper oxygen-jet fuels will be dominant for some time because of tremendous propellant consumption of rockets still under design

by Roy Healy

LOS ANGELES—Major current trends in the design and development of liquid propellant rocket engines for space vehicles and ballistic missile booster applications are (1) simplification for increased reliability, (2) higher thrust chamber pressures for improved performance, (3) optimized packaging for ease of installation and better accessibility and (4) clustering of individual engines to attain very high thrust levels.

The **Rocketdyne** Model H-1 engine, eight of which are to be assembled as the 1,500,000 pound thrust powerplant of the ARPA/Army *Saturn* space vehicle booster, exemplifies the current trends in large liquid propellant engines. Other new Rocketdyne engines under development, such as the 1,500,000 pound thrust single-chamber Model F-1, four of which will form the NASA *Nova* vehicle booster, will emphasize the same trends.

In mid-1958, Dr. Wernher von Braun, Director of Development Operations for Army Ballistic Missiles Agency asked Rocketdyne management to submit a proposal on clustering eight Advanced *Jupiter* engines for a huge space vehicle, then designated as the *Juno V*. He established design goals of simplification, improved performance, optimized packaging and clustering.

Available rocket engines were considered. Rocketdyne decided to propose a repackaged, uprated, much simplified version of the 150,000 pound IRBM engine being used in both the *Jupiter* and *Thor* ballistic missile program. We took advantage of the accumulated three years of developmental experience, including flight testing, on those programs as well as technical data from the *Navaho, Atlas* and *Redstone* engines. These enabled us to select and arrange components and the operational sequence.

• **Experimental testing**—Entirely separate from its production programs, Rocketdyne maintains an Experimental Engine group that constantly studies and tests new concepts and advanced designs for possible future use. A number of devices and techniques selected for incorporation into the H-1 engine had been proved promising by that group.

The Advanced Research Projects Agency accepted the Army Ballistic Missile Agency *Juno V* (now *Saturn)* proposal in September 1958. In that same month, Rocketdyne received the go-ahead to initiate engine design and development.

Rocketdyne adopted the philosophy of developing and delivering the H-1 as a single, basic, "any-position, plug-in" engine. This approach permitted the use of existing test facilities and



About the Author

Roy Healy is manager of the Saturn rocket engine program for Rocketdyne, a division of North American Aviation, Inc. Healy has more than a quarter of a century of experience in aircraft and rocketry. He first became interested in rockets in the mid-20's, and by 1935 had joined the ARS. He was president of ARS in 1942, and again in 1947.

His earlier work at Rocketdyne was on the Redstone system, and by 1954 he was supervisor of the unit. He participated in adapting the Redstone for use of Hydyne. In 1958 he was appointed as program manager for Jupiter engines.

testing H-1 engine . . .



INDIVIDUAL firing of Rocketdyne's H-1 engines for Project *Saturn* is accomplished in Santa Susana mountains.

reduced the propellant requirements for testing to a modest proportion. Utilization of basic components from the latest models of *Jupiter* and *Thor* engines allowed the use of existing tooling and manufacturing techniques and minimized the long-lead time for procurement of components. The approach is expected to make possible the goal of flight testing in late 1960.

The initial prototype engine was assembled to R&D type drawings. Firings were initiated at the Propulsion Field Laboratory in the Santa Susana mountains in December, 1958. The initial engine was delivered to ABMA after acceptance testing in April 1959, eight months after the design effort commenced.

• **Eliminated components**—To arrive at the H-1 engine, we modified existing *Jupiter* and *Thor* engines by eliminating many minor components, simplifying operation, and further improving and repackaging of major components. As an example of the former, the initial IRBM engines delivered in 1956 were built with five pneumatic pressure regulators and seventeen solenoid valves for proper start and shutdown operation. Gradual improvement of the engines reduced these requirements to a single pressure regulator and three solenoid valves. The more advanced H-1 design eliminates pressure regulators and solenoid valves entirely. A greatly simplified start sequence, using a pyrophoric fluid to ignite the main thrust chamber, has sharply reduced the electrical circuitry required. By mounting the turbopump assembly, valves, and other accessories directly on the sides of the thrust chamber, we achieved a lighter, more compact engine of smaller envelope dimensions.

Each of the eight engines powering the *Saturn* booster will be mounted into the missile by attaching the upper portion of the gimbal block assembly to structural members. The missile can then be controlled directionally by gimballing or swiveling the four outer engines. The missile guidance equipment exercises control through the medium of movable struts that adjust the positions of the outer engines.

The first cluster assembly and the firing of the eight-engine power-plant will be accomplished at ABMA on a mammoth test stand now being modified from its original *Jupiter* configuration. Initial launchings are planned from Cape Canaveral. Studies are in progress on parachute recovery of the *Saturn* first-stage booster.

The ARPA/ABMA *Saturn* booster is a natural outgrowth of Rocketdyne's experience in multi-engined projects. The original *Navaho* powerplant consisted of a pair of 120,000-pound thrust oxygen-alcohol engines. The advanced *Navaho* (G-38) consisted of three 135,000-pound thrust oxygen-jet fuel engines. Although the *Navaho* program was terminated prior to flight of the latter assembly, the engine development was progressing in a most satisfactory manner. In test firings, thrust levels of the clustered engines had reached more than 400,000 pounds, the highest level attained this side of the Iron Curtain at the time.

The original *Atlas* engine concept under development at Rocketdyne required a takeoff thrust of 660,000 pounds, a cluster arrangement consisting of four 135,000 pound booster engines, a sustainer of 120,000 pound output, and two 1000-pound thrust vernier engines for roll control and terminal velocity trim. During 1953, a breakthrough in thermonuclear warhead design permitted the sharp reduction in power requirements. This permitted the current *Atlas* concept of two boosters of 150,000 pounds each, plus a sustainer of 60,000 pounds thrust—with the vernier engine requirements remaining unchanged.

Extensive developmental and flight experience had been obtained on these cluster arrangements by the fall of 1958, when the Saturn program was initiated.

• **Parallel development**—The ARPA *Saturn* program, based on a cluster of existing engines, and the NASA program for development by Rocketdyne of a single engine of 1.5-million pounds thrust complement each other. When the more powerful NASA engine is available it too, in all probability, will be clustered to give the U.S. greater-tonnage-in-space capabilities. As more powerful engines are developed they will be used in groups of four, six, eight or more to make possible larger and larger spacecraft with increasing payload carrying capabilities.

One of the most effective factors utilized in the improvement of current production engines, and in the design of advanced models, has been Rocketdyne's extensive system of reporting troubles, inspection squawks and operational malfunctions. This embraces not only difficulties encountered in firing tests and missile launch operation, but also pre- and post-firing checkouts of the engine systems. The accumulated data are fed into automatic calculating and data storage machines, permitting rapid analysis and review of those items requiring design improvement. Constant scrutiny of reliability of the various components, operating sequences, etc., is invaluable in product improvement and the formulation of new engine concepts.

This continuous survey will sometimes reveal that the engine system has a component with an unacceptable record of malfunctions. In such a case

we review possible design and quality control improvements in that component. We also decide whether the component might not be eliminated and its function served by dual-function use of other components in the system.

Rocketdyne conducted over 4000 large rocket engine tests during 1958 at the Santa Susana facility, using over 24 million gallons of liquid oxygen. In addition to the engine tests, close to 18,000 component tests were performed with propellants at the same facility.

The energy released in a 150,000-pound IRBM engine is equivalent to exploding some 1500 half-pound sticks of dynamite per second in the engine's thin-walled thrust chamber. To harness and control this tremendous energy, components and operational sequences must not only be reliable functionally but extremely precise in reproducibility of operation. It is not sufficient that a valve open or close upon receipt of a signal to do so—it must act in a predetermined number of milliseconds and in proper time relationship (again in milliseconds) to the operation of other system components. It is because of this rigid requirement that components developed for industrial use, and even the more rigorous requirements of aircraft use, are not suitable for rocket engine application.

• **Severe specifications**—In addition to the criticalness of operation as outlined above, the extreme temperature and vibration environments of rocket operation make more severe the specifications for rocket engine parts. The fact that America's missile program is progressing in a satisfactory manner is a tribute to the ingenuity and capabilities of this country's rocket designers.

Some clearly defined trends are becoming apparent in the liquid propellant field. For future ballistic missiles the desirability for instant readiness has promoted interest in the storable propellant combinations. Because of good performance and non-corrosive nature, nitrogen tetroxide is tending to replace the red and white fuming nitric acids as an oxidizer. To maintain performance at the oxygen-jet fuel levels, unsymmetrical dimethylhydrazine and hydrazine are the most commonly used fuels, both being hypergolic with the nitrogen tetroxide.

All of Rocketdyne's current production engines, designed for operation with oxygen-jet fuel, have been fired with storable propellants after relatively minor modifications. A number of our experimental engines have also been operated with the storable combinations.

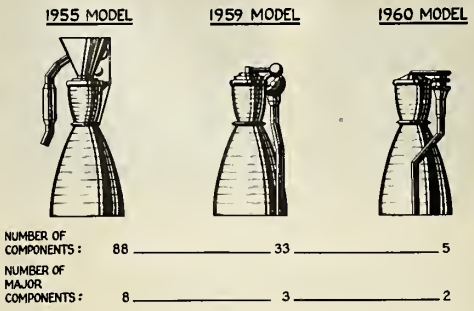
Increasingly more powerful space vehicle booster rockets are inevitable. Power levels in the tens of millions of pounds of thrust are now being considered. The tremendous propellant consumptions of these powerplants, and the fact that instant readiness is not a requirement, make it probable that the plentiful, inexpensive (2¢ a pound) and easily handled oxygen-jet fuel combination will be dominant for some time to come. Sea-level specific impulse values in the 245-275 second range can be expected from these booster engines.

For first-stage engines the trend toward higher chamber pressures continues with newer designs featuring thrust chambers operating in the 1000 psia range. Conversely, for upper-stage and in-space engines the trend is toward thrust chambers operating in the 200 to 300 psia range, and there are advocates of much lower pressures. These lower pressures, coupled with recent advances in the fabrication of lightweight, high-strength pressure vessels, makes attractive simple, pressure-fed rocket systems using helium as the pressurant. In such simple systems the tanks, lines and thrust chamber can be integrated into a compact power package.

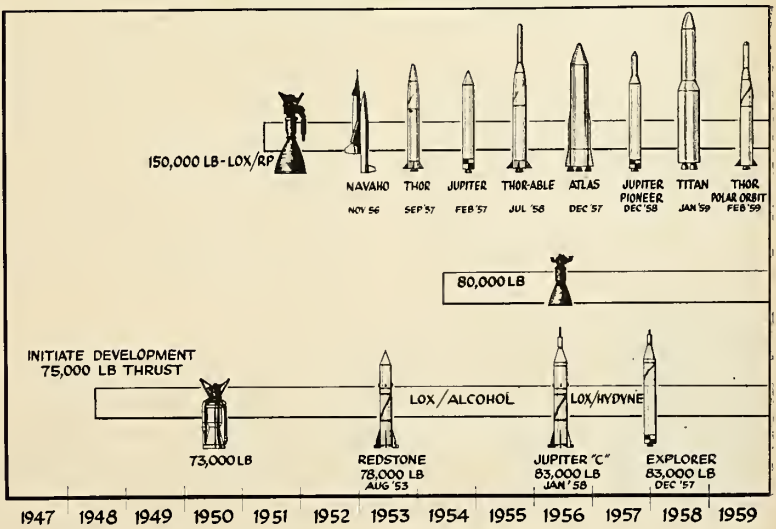
The increased importance of specific impulse, and the relatively small size of upper stages as compared to the huge booster stage, makes the high energy propellant combinations, such as fluorine-hydrazine and oxygen-hydrogen, attractive for upper stage use. Vacuum specific impulses in the 350- to 475-second ranges may be attained.

The advances achieved in the past decade by the high-thrust liquid propellant rocket engine have been outstanding. Continuation of current trends in seeking ever more powerful, more simplified, higher performance engines will make the accomplishments of the next decade even more fantastic. That time-span may see the fulfillment of a goal that I knew 25 years ago only as an amateur rocketeer's dream—the landing of a man on the moon.

SIMPLIFICATION and reliability have been major efforts in liquid propellants.



Large Rocket Engine Development





SERIES OF PHOTOGRAPHS of dog-carrying *Sputnik II* made it possible to deduct that the total length of rocket body and

Astrometry Progress . . .

Little Support for Vital Program

Additional equipment and new methods for using it are needed if U.S. is to have continuous location capability for spacecraft

by Dr. Douglas Duke

MELBOURNE, FLA.—For defense reasons, it is mandatory that the U.S. be continuously aware of the space location of all earth satellites and space vehicles. This is so, due to the possible future necessity of distinguishing approaching ballistic missiles from other vehicles which present no threat. There exist, in addition, other reasons that make this capability very desirable. Principal among these are performance analysis of our own space vehicles, geophysical and geodetic applications, testing of instrumentation capabilities and obtaining further information on the structural and operating features of foreign satellites.

A beginning toward developing space-location ability was made, shortly after the first *Sputnik* made its appearance, with the establishment of Project *Spacetrack* within A. R. D. C. The purpose of this project was to gather the maximum possible amount of tracking and configuration data on foreign satellites. The writer had the good fortune to be intimately involved with these efforts at the Atlantic Missile Range for the first 15 months of the project's existence, during which time the A. M. R. furnished the majority of the information received by the *Spacetrack* Filter Center at A. F. Cambridge Research Center, where prediction computations were carried out. During this period, there were many successes and failures. These have indicated the direction in which the development of new instrumentation systems and data-reduction techniques should move and also the most efficient organization of existing facilities.

One obvious method of knowing the position of a space vehicle at any arbitrary moment is simply by maintaining continuous track of it. However, this would require world-wide instrumentation, which would be extremely costly, especially in the case of satellites that revolve only a few hundred miles above the earth's surface. Since it is reasonably expected that there will be a considerable number of orbiting satellites in the space about the earth in the near future, there would be an increasing requirement for simultaneous tracking of more than one body at individual stations. This would further increase the scope and cost of a continuous real-time tracking operation on all space vehicles.

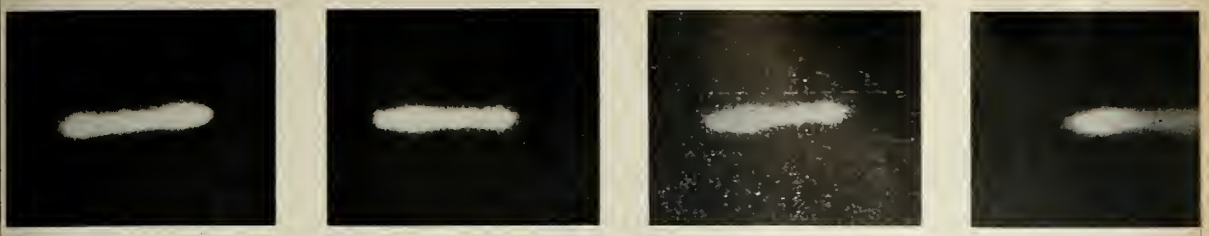
Such an operation is, however, quite unnecessary. The laws of celestial mechanics show that the relative orbit of one mass point about another will be an ellipse. In the absence of any external perturbing influences the geometrical features of the ellipse will remain forever the same, as will the period of revolution about the orbit. Once we determine these quantities accurately, we can use them in a machine computer to predict where the object would be considerably later in the future. We could also improve the accuracy of the quantities continuously, merely by obtaining occasional later observations and combining these with those obtained earlier. Thus the need for real-time tracking could be reduced drastically and the capacity of a space surveillance system would be very large.

Unfortunately there do exist disturbing influences which impair the above prediction method considerably. The fact that the earth is not a perfect sphere, but flattened and otherwise deformed at the poles, and the presence of a tenuous but definitely existing trace of the atmosphere out to several hundred miles—both cause large departures from the invariant elliptical orbit, especially for close satellites. The earth's



About the Author

Dr. Douglas Duke is technical adviser for space technology at Radiation Inc., Melbourne, Fla. From November, 1957, to January, 1959, he was project engineer for the Spacetrack Project at the Atlantic Missile Range. Duke obtained his Ph. D. in astronomy and astrophysics from the Yerkes Observatory at the University of Chicago in 1950. He taught astronomy at several universities and has worked in the fields of missile and satellite tracking instrumentation since 1955.



unseparated instrument compartment was slightly less than 80 feet.

oblateness affects the space orientation of the orbit but not its size, shape, or period of revolution. The drag caused by the thin layers of the atmosphere has just the converse effect, not affecting the former ones, but causing changes in the latter quantities. For vehicles quite far from the earth, the above effects become small, but in this case, we must then consider the perturbing gravitational effects of the moon and the sun.

• **Complex calculations**—Practically all of the early work done at A. M. R. involved close satellites, so that earth's oblateness and atmosphere drag were of great importantce. The oblateness provided only minor difficulties since there existed theoretical formulas and enough observational material to take these effects into account reasonably accurately. The difficulties encountered with atmospheric drag have, however, been quite severe. Although the loss of energy due to drag is small during a single revolution, the effect is a cumulative one. During each revolution, the size of the orbit is reduced slightly by drag. Therefore, on the next revolution, the satellite spends more of its time in the lower atmospheric region where drag occurs, and the drag itself is greater than on the previous orbit. The net result is a decay type of behavior of the period of revolution and the size of the orbit. Both values decrease at an ever-increasing rate, until the satellite passes so low into the atmosphere that the remaining orbital energy is completely dissipated by a final meteor-like plunge to earth.

Supposedly a knowledge of the atmospheric density as a function of altitude and of the drag coefficient of the satellite should allow fairly accurate calculation of the future course of the decay of the orbit. But our knowledge of atmospheric densities at high altitudes is quite meager. We also have little idea how the densities may vary as the hour of the day, the season of the year, or the latitude are changed. Moreover, in the case of foreign satellites, our knowledge of configuration details is scant so that the drag coefficient is not well known. Since these bodies also have had considerable tumbling motion, the effective cross-sectional area of the drag-producing surface has been subject to unpredictable changes.

• *Sputnik* **deviations**—The result of all this is that position predictions of low altitude foreign satellites have been far from satisfactory. The drag rate has varied in essentially an unpredictable manner. An example is shown in Fig. 1, where the rate of change of the period of revolution is graphed with revolution number since launch for the last-stage rocket of *Sputnik III (1958 Delta 1)*. The oscillations present seem small, but over several hundred revolutions, they produced errors of the order of twenty minutes in the time of appearance of the rocket. For this reason, the distant past history of orbit behavior was of little value in making predictions. At the *Spacetrack* Filter Center, it was necessary to restrict the computer analysis to perhaps the last one or two weeks of observational data, predict future positions for perhaps ten days, and then hope for the best. Usually departures of several minutes appeared in three or four days, and often it was necessary to repeat the prediction calculations several times a week. Otherwise the calculated passage times would soon have been in error by a considerable fraction of an hour.

Even the position in the sky is affected seriously by errors in the time of appearance. At the latitude of the U.S., the earth rotates about 15 miles every minute. An error in appearance time of ten minutes means that the satellite will pass over a point 150 miles distant from the calculated point. At low passes (height 150 or 200 miles), this means either a large departure in the place in the sky where it will be seen, or that it will pass too low on the horizon to be seen at all.

It is evident that the neat theoretical scheme, which called only for "occasional" observations to verify the calculations, was completely imposible. In the case of the *Sputniks,* there were two periods every six weeks, each approximately one week in duration, during which they could he tracked optically from the Atlantic Missile Range. At other times, the objects passed overhead either during broad daylight or in the middle part of the night, when the earth's shadow allowed no optical target from reflection of sunlight.

• **Triangulating** *Sputniks*—The tests involved principally the use of Askania cine-theodolites and Mark 51 optical trackers. Every attempt was made to obtain angular positions from at least two stations on the range, so that the actual space position could be triangulated. Since there is a fair amount of cloudy weather along the range, this meant usually four observing stations per pass to have a high probability of at least two successful sets of angles. The Askanias provided an accuracy that was an order of magnitude better than the optical trackers (.01 degree vs. 0.1 degree), but since all the Askanias at A. M. R. are in a small area around Cape Canaveral, it was necessary to use the optical trackers whenever downrange data was desired. It is expected that theodolite coverage soon will be available downrange.

The highest accuracies obtainable optically are those of the ballistic camera. But such high accuracy is only needed for geodetic studies with satellites. For merely keeping track of the period of revolution, the ability of the Askania to track fainter objects and the greater speed and ease of theodolite data readout made its use most practical. Of course, there is a delay for processing and reading the film. This delay could be eliminated by digital readout equipment. It is expected that such equipment will shortly be procured for A. M. R. theodolites. When this is so, real-time satellite angle position can he fed directly to the *Spacetrack* calculation center at Cambridge for instantaneous checking and correction of calculated satellite position.

Even after these improvements have heen made, there still will remain some difficulties. One is that of observing faint satellites. In the case of the *Sputnik* rockets, their relative brilliance eliminated such a problem. But with the smaller American *Explorer* and *Vanguard* satellites, and for the *Sputnik III* nose cone, considerable observation difficulty has been encountered. These objects are usually just barely visible or entirely invisihle to the unaided eye. Therefore, the theodolite observer cannot take advantage of the wide field of view of the unaided eye but must point his tracking telescope in the predicted position and wait for the satellite to

enter the field of view. This field is only about four degrees in diameter. Usually, the object either does not enter the field, or passes near the edge so quickly that observation is impossible. This difficulty is greatly enhanced in the case of non-spherical objects that are tumbling. The intensity of their light varies widely. Thus the object may be much fainter than maximum light during the short time it is in the field of view.

• **Telescopes needed**—The addition of very wide field, low-power, high-brightness acquisition telescopes is a prime necessity, if full success with theodolites is to be realized. The field of view should be about 20 degrees in diameter. Thus the area of the sky in the field of view will be 25 times the present case, and the probability of acquisition correspondingly larger.

There are other places where significant improvement is possible, subject to development of suitable equipment. Image-tube or television techniques should make it possible to detect the brighter objects in broad daylight. This would mean possibility of optical track at least once each clear day and give much greater continuity to the data. There would be no 4-week "holes" when daytime track was impossible. Also, a method of determining the tracking errors of the theodolite operators in real-time would improve the accuracy. Corrections for these errors could be applied automatically to the digital readout of theodolite axis angles. Without such a tracking correction, one is dependent on the pointing ability of the operator. Although performance appears to have been excellent in the past, such correction capability seems quite desirable.

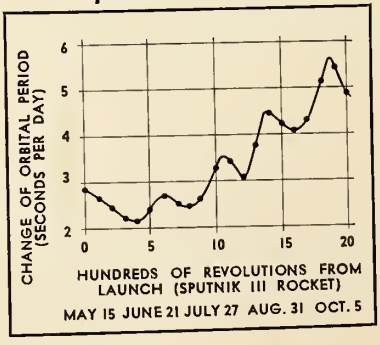
Radar tracking of satellites at A. M. R. has been extremely limited. This is completely due to lack of electronic acquisition equipment to furnish pointing angles for the precision radars. Without pointing information, it has proven to be useless to attempt to pick up satellites with very narrow-beam high-gain systems. Successful track has only been obtained when the target was optically visible so that optical trackers could be used to direct the radar antennas. Results of these cases indicate clearly that addition of electronic acquisition equipment would increase coverage tremendously.

Continuous radio interferometric data has been obtained on the nose cone of *Sputnik III (1958 Delta II)* since its launch on May 15, 1958. A 20 megacycle North-South oriented baseline has made it possible to determine latitude crossing times each day. This unbroken series of observations has yielded interesting information on perturbations of the period of revolution. Considerable efforts have been made to increase the sensitivity of the system, and several other improvements are planned.

• **80-foot rocket**—One of the most interesting results obtained at A. M. R. is the configuration photographs of the *Sputnik* rockets. We were fortunate in possessing a good amount of high-performance long-focal-length tracking optics, due to long-range missile tracking requirements. With such equipment, it was possible to obtain recognizable images to distances of three or four hundred miles. A series of photographs made of the dog-carrying *Sputnik II* on Dec. 21, 1957, at a slant range of about 190 statute miles is shown on the preceding pages. From such photographs, it was possible to deduce that the total length of the rocket body and unseparated instrument compartment was slightly less than 80 feet. At the time this length measurement met with considerable disbelief. However, the reduction method was exceedingly simple and left no possibility for gross errors. That the injection of such a configuration into satellite orbit was possible was demonstrated last December when the U.S. orbited an entire *Atlas* missile.

Gradations in brightness along the length are apparent, and occasional frames show "hot spots" due to specular reflection of the sun's light from certain surface areas. Tumbling of the object is quite evident. However, details other than the gross length of the object are too blurred for identification. It is reasonably certain that this is not due to tracking error, since, on the best film records, the positions of successive images with respect to the frame edges are nearly constant. It is likely that the limitation is related to atmospheric turbulence.

Sputnik III Record



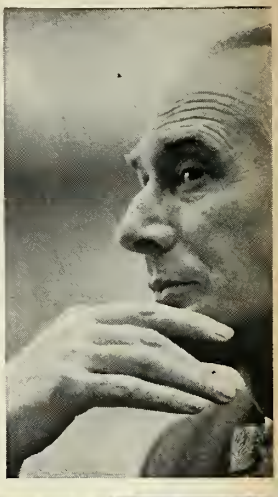
The difficulties that had to be overcome to obtain these images can only be appreciated by the people at A. M. R. who were involved in the effort. Acquisition by tracking personnel was hampered greatly by the presence of a dome with only an opening for the telescope. The absence of wide-field finder telescopes, such as those discussed above on theodolites, and the lack of any external optical tracker located in the open, which could provide coarse pointing information, greatly reduced the amount of coverage. All the telescopes have conventional two-axis azimuth and elevation mountings. This meant that on high elevation angle passes the satellite could not be tracked as it passed nearly overhead at the very times when the slant range and optical path through the atmosphere were at a minimum.

• **Missile tracking easier**—Of course the instrumentation described above was never intended to be used for satellite tracking, but rather for the launching of missiles from Cape Canaveral. The problems described above are a consequence of this. Compared with satellite observation, the acquisition of a gradually accelerating missile perhaps 20 miles away is a relatively simple matter. Indeed none of the equipment used at A. M. R. for tracking satellites was designed for that purpose. Changes in the equipment, methods of using equipment and the organizational effort will all have to be effected if optimal gathering of information is to take place. Personnel involved in the *Spacetrack* program and other tracking programs have acquired much practical experience and capability. Yet the efforts made up to now have, speaking generally, been too small. They have been made for the most part by individuals or small groups of individuals working almost alone. Relatively little interest and support has been evident up to the near present. We must accelerate the effort if the mission of continuous location capability for all satellites is to be attained within a reasonable time. A high level of cooperation between responsible agencies and between experienced technical and administrative personnel is mandatory. It is hoped that recent plans for an overall study of this problem will lead to its successful solution.

The author wishes to express his gratitude to Walter H. Manning, Jr., Spacetrack task scientist at the Atlantic Missile Range, who assisted in the preparation of the article and the accompanying photographs.









WASP







THESE MEN DO ALMOST NOTHING BUT THINK

Unique new group helps Westinghouse anticipate and plan for future military needs

It's harder than ever to stay out front in defense. Weapons systems are now fantastically complex. New innovations—like thermoelectricity and molecular electronics—threaten to make key subsystems obsolete overnight. New developments may suddenly reduce the tactical usefulness of a U. S. weapons system.

Westinghouse, like many other firms, has been concerned about how to meet this problem—and how to organize its many R&D and manufacturing operations to more effectively support America's increasingly complex defense needs. It seemed that the organization which had worked fine in the past simply wasn't adequate for anticipated future demands.

So things were completely reorganized in February, 1958. A new Defense Products Group was established, centralizing control of all defense-oriented activities within the company.

But a most interesting—and promising—part of this new organization, the new Westinghouse Advanced Systems Planning Group (now commonly called WASP), wasn't announced publicly until August.

This was a significant development. Since technology is moving faster than ever before, there's a real need to effectively anticipate what will be needed in 5 or 10 years. If this can be done, longer-lived defense systems can be developed more quickly and substantial sums can be saved. WASP should be able to provide the advance thinking needed by Westinghouse to meet this need.

Staffed with hand-picked engineers and scientists—specialists in electronics, outer space, atomic power, ASW, operations research, etc.—and headed by Allan Chilton (top center photo above), WASP operates on a unique charter: to concern itself primarily with

CONTINUED



MATCHING NAVAL REQUIREMENTS with Westinghouse capabilities, Leanard Daw, a prafessianal career specialist in naval strategy, tactics, and weapans systems, is associating advanced technology to future naval systems.



"The idea is saund, but how can we kee
fram burning up? Present insulatians w
wark. How abaut ablative heat sinks? N
they won't work either in this case."

complete advanced weapons systems, to dea
the "whole" instead of "parts".

This is not just a "blue-sky thinking" assigr
Westinghouse believes future defense needs v
so complex that only a full-time team of specia
like WASP—will be capable of the kind of conc
planning and guidance needed.

There's another reason why defense planne
be interested in WASP. This new group gives t
single point of contact within one of Am
largest and most versatile industrial firms to
they can take immediate and long-range d
problems. No longer will it be necessary for so



". . . san, it circles the earth at 18,000 miles an hour." Space consultant, K. Satyendra, a Ph.D. fram India, keeps WASP and other campany scientists abreast af space needs. He is an authority in mission, trajectory, and communication concepts.



TOP ENGINEER AT WA
Rein Kraan jained Westingho
in 1931. Amang other acc
plishments, he headed the
gineering graup respansible
the design af the first Ameri
turbajet engine far aircraft.



"What's the best way to destray an enemy recannaissance satellite? Attack it fram earth? Or fram anather satellite? Haw would we go abaut either methad?"

to guess which Westinghouse division is best
ped to tackle a given job.
s is a bigger advantage than might be apparent.
ly-published capabilities chart*, for example,
different Westinghouse facilities and, for each,
tes specific study, design, or manufacturing
ilities in 33 different areas (infra-red, rocket
plants, torpedoes, missile base equipment, etc.).
ame chart lists 16 Westinghouse facilities which
ndle system analysis and 7 capable of complete
n management.
*ilable to qualified individuals and firms upon
f.*



Could we deflect enemy ICBM's by sending them false signals at the me af launching? If so, cauld this be dane fram distant transmitters? ould this be done automotically from remote un-manned statians?"



MAN ON THE MOVE, Bill Rabinson has his sights on tomorrow's systems and pravides guidance for WASP in planning far future Department af Defense needs.

Westinghouse

DEFENSE PRODUCTS

1000 CONNECTICUT AVE., NW, WASHINGTON 6, D.C.

YOU CAN BE SURE... IF IT'S Westinghouse

CAN A SYNCHRO MAINTAIN ACCURACY



OVER A WIDE RANGE OF TEMPERATURE?

Synchros have to take punishment. They are often exposed to blistering heat and stratospheric cold . . . and they still must operate accurately.

Naturally, Ketay synchros meet *and surpass* the new MIL-S-20708A ambient temperature requirement of −55° to 85° C. (or to 75° C. for size 23). Even more important, they give you a remarkable 6 minute accuracy *over this whole temperature range.*

Ketay is the *only source* currently manufacturing and shipping a complete line of the new Mil-type synchros. They are available in production quantities in sizes from 8 to 23, with 60 cps units as small as size 15. Because of their superior accuracy, with some units offering 3′ accuracy at room temperature, Ketay synchros one or more sizes smaller than previously required may often be used.

Ketay engineers are working on many advanced environmental and accuracy problems in developing prototype systems, and have an unusual degree of experience in high temperature work. Why not call or write for help in solving your special problems?

Ketay precision components:
SYNCHROS
RESOLVERS
POTENTIOMETERS
SERVO MOTORS
TACHOMETERS
SERVO AMPLIFIERS
GYROSCOPES
Catalogues available

NORDEN Division of United Aircraft Corporation

KETAY DEPARTMENT, Commack, Long Island, N.Y.

Circle No. 34 on Subscriber Service Card.

Control, Guidance and Navigation Progress . . .

Propulsion Available Will Set Designs

Biggest problem areas are in components hardware and in this area inventiveness and imagination will make greatest inroads

by S. S. Edwards, W. C. Griffith, & J. I. Osborne

Speed is, of course, the key to space flight. The fact that the possibilities of space flight are presently being discussed arises from the recent development of large rocket motors capable of accelerating sizeable masses to speeds approaching escape velocities. Speed is required to overcome the inexorable pull of gravitational fields and to negotiate the tremendous distances involved in a feasible time. Command of thrusting power, therefore, makes possible the contemplation of space travel. However, the present state of propulsion technology does not allow unlimited power. It seems quite reasonable to assume that consideration of power available will impose difficult design requirements on space vehicle weight as also on design of guidance and navigation systems.

In principle, Newton's laws of motion and universal gravitation provide a basis for complete solution of space flight problems in the sense that initial conditions at launch may be adjusted to arrive at any desired place at the correct time without the necessity of providing navigation and terminal guidance systems. However, it is at present inconceivable that a space vehicle could be accelerated in a few minutes to the magnitude and orientation of its velocity vector with sufficient precision for a trip to be measured in weeks or months. Such a direct extrapolation of present technology is obviated by uncertainties in the original velocity and acceleration vectors and in the physical constants.

The gravitational constant is known from laboratory measurements with sufficient accuracy to yield satisfactory figures for the masses of all bodies having observable satellites. In the case of the Moon, Venus, and Mercury, however, the masses have been determined only indirectly and with considerably less accuracy. This does not create any real difficulty, for better data will certainly become available from exploratory probes before actual landings are attempted. The 0.02 percent uncertainty in the astronomical unit, on the other hand, presents a significant problem. Thus, the range of Venus at closest approach is unknown to about 5000 miles, a sizable figure in terms of navigational requirements. Further work with radar returns from the planets, however, will certainly help science to resolve this question.

• **Trajectory uncertainties**—By far the largest present uncertainties originate during missile launch and early powered flight. These result from misalignment in guidance reference; time of launch, thrust direction and magnitude variations; and atmospheric winds. Improved technology may be expected to reduce all of these contributions somewhat but cannot be expected to eliminate them entirely. Thus wide course and terminal navigation and guidance systems will be necessary.

We must assume that by the time a spacecraft reaches a point where its motion is dominated by the gravitational attraction of the target body, the vehicle is on a hyperbola that does not intersect the surface of the target. In general, the energy required to shift trajectories is smaller the farther away the vehicle is from the target. The desirability of making changes as early as possible must be weighed against the penalty of carrying sufficiently precise navigation and guidance equipment to determine what the required changes actually are.

For an initial heading error, simple geometrical analysis indicates that the fuel required to correct the heading

ABOUT THE AUTHORS



Edwards



Griffith



Osborne

S. S. Edwards, W. C. Griffith and J. I. Osborne are with the Missiles and Space Division of Lockheed Aircraft Corp. at Palo Alto, Calif. Edwards, assistant manager for aerodynamics and flight sciences in spacecraft and missiles research, has been with Lockheed since 1956. He was with the Ames Aeronautical Laboratory of NACA at Moffet Field, Calif., from 1947 to 1956. Griffith, associate director for spacecraft and missiles research, was a professor of physics at Princeton University from 1950 to 1957, when he joined Lockheed. Osborne, assistant manager for missile dynamics and performance, was engaged in research at the University of Southern California, Douglas Aircraft Corp. and Boeing Airplane Co. before joining Lockheed in 1956.

favors mid-course equipment . . .

halfway to the destination would be three times that required at one-quarter of the way to the destination. If the correction were made at the three-quarter range point, the fuel used would be as much as at nine times one-quarter of the way. Therefore, the trade-off between fuel weight to correct heading and additional weight for precise navigational equipment to determine heading would appear to favor the mid-course navigational equipment. The above computation assumes that the velocity along the course and the fuel weight required to correct a given angle is constant. Fuel weight of approximately 1.4% of vehicle weight is required to correct an error of 1 milliradian for specific impulse of 240 seconds. Improvements in specific impulse will, of course, improve this number.

If the launch guidance requirements are relaxed because of the availability of excess power, a mid-course navigation system is required. Path correction by power application requires that vehicle orientation with respect to its velocity vector is known. The inertial reference system used during the launch maneuvers probably could not be depended upon to maintain orientation to the order of accuracy required for mid-course maneuvers, at least without resetting. However, electronic gyros, presently under development, might perform this function.

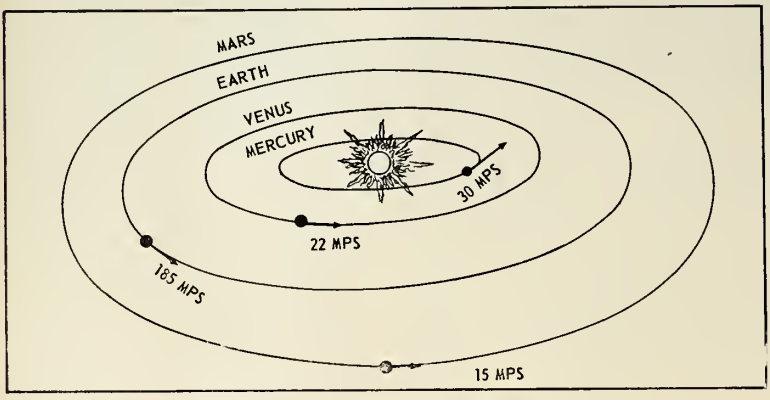


FIG. 1—Solar System Configuration.

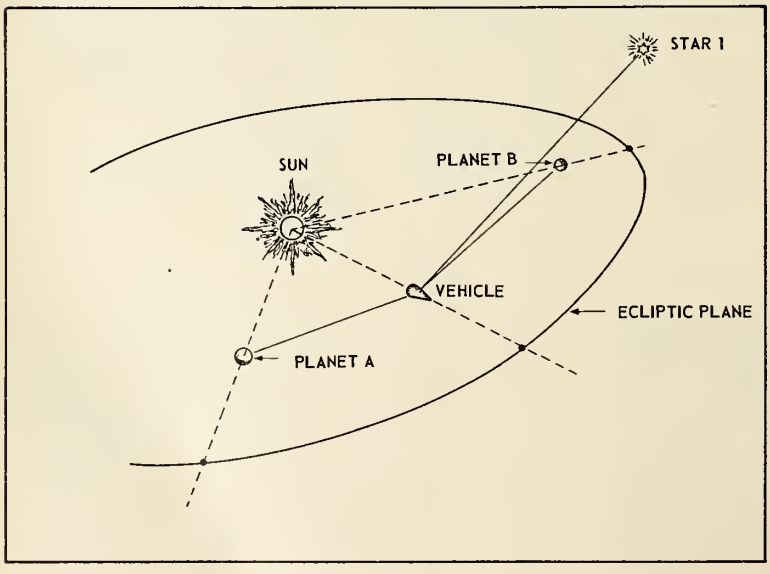


FIG. 2—Position Determination.

• **Celestial astrogation**—Star position readings taken with a sextant may be used to correct a gyro, which can then be used for continuous reference. The accuracy of celestial observation is greatly enhanced if the missile axis system is stabilized in space. This would rule out the use of spin stabilization. Also, changes in vehicle orientation are awkward in a spin-stabilized system. Accordingly, it makes better design sense to spin small gyro elements in an inertially stabilized reference system and measure and control vehicle attitude with respect to these axes. Maintaining constant attitude control by referencing spinning gyros has the disadvantage of cumulative expenditure of power.

Another method might be to omit the gyros and use the stars as a reference system. The vehicle would then be stabilized with reference to the stars probably only during the interval required to fix position.

We assume that the flight is in the ecliptic plane and that the configuration of the solar system is known at all times (Fig. 1). Position in the solar system may be determined in a number of ways, each of which offers certain advantages of accuracy or convenience. The direction of the sun offers the most obvious line for vehicle reference (Fig. 2) and two planets (one of them the target) or a star and planet along with a clock completes the required information. The alternative use of radar ranging on the target has the advantage of giving better range and velocity data but suffers from the extra payload for power and antenna, and gives less angular resolution.

Velocity is obtained by successive position readings and the time interval between them. In the process of evaluating these data, it should be remembered that the inertial guidance used during the launch phase has a digital computer as a major component. The position and velocity measurements discussed are then inputs to the digital computer for orbit computation and error determination. Knowing the orbit errors and the vehicle orientation, it is possible to make mid-course corrections to the trajectory.

Problem areas exist in the realization of the component hardware designed to perform as a system. Here is where inventiveness and imagination will make the greatest inroads in the future.

• **Landing problems**—Having successfully traversed the vast distances separating the earth and planet destination, the successful space flight yet must negotiate the tricky maneuver that



...NEWS IS HAPPENING AT NORTHROP

Now being produced and delivered to the U.S. Army Signal Corps, the Radioplane SD-1 gives greater battlefield surveillance flexibility to combat units than ever before. (This photo of terrain was actually taken from an SD-1 at 1,000 feet.)

RADIOPLANE PRODUCES FIRST COMBAT-READY SURVEILLANCE DRONE

Meeting tough Army Signal Corps requirements and being produced in operational quantities, the SD-1 is proved and ready to fly unmanned photo reconnaissance missions for tactical troops.

Highly mobile, the camera-carrying SD-1 may be zero-length launched in rough terrain from a camouflaged position. It is flown by remote control over enemy installations on surveillance missions without risking a pilot's life or man-carrying aircraft. Within minutes after the SD-1 returns from its mission, photographs are delivered to the requesting unit.

Other specialized sensory equipment may be carried by the SD-1 depending on particular mission requirements.

This Army-Radioplane achievement exemplifies Radioplane teamwork with all of the U.S. Armed Forces. Radioplane provides a complete drone family spanning medium speeds through supersonic performances.

RADIOPLANE
Van Nuys, California, and El Paso, Texas
A Division of
NORTHROP CORPORATION

Circle No. 35 on Subscriber Service Card.

will allow descent to the surface. Presuming that the incremental velocity given the vehicle in powered maneuvers has not exceeded appreciably the escape velocity from the earth, the speed at which the trajectory has been traversed is approximately the orbital velocity of the earth or about 18.5 miles per second. If the terminal phase of the flight were to result in a tail chase maneuver, the only planets which could be overtaken would be those located at a greater distance from the sun than the earth, in which case, the vehicle would have excess velocity over that of the planet (Fig. 2). Another possibility is that the vehicle could be guided into a relationship such that it could be overtaken by the planet (which then has the greater speed advantage). There are certain advantages in considering such maneuvers in that presumably very little reference to the vehicle-objective relationship would be required. This could result in advantages particularly if rapid computational methods are not available. The interception in which approach is made at large angles between the vehicle and target orbits involves an increasingly more precise monitoring and correction of the closing condition.

To negotiate a landing upon the surface of the planet, the relative differences in the kinetic energy per unit mass between vehicle and target must be considered. Eventually, of course, soft landings will be made in which this difference is adjusted essentially to zero either through atmospheric braking or controlled impulse. Several maneuvers that could be considered are:

1. Ballistic descent with powered braking.
2. Capture in the gravitational field of the target planet and ballistic descent from satellite orbit.
3. Lifting entry from orbit about the planet.

The band of approach paths (figure 3) for which impact can occur is, of course, larger than the band of paths for which appreciable curvature of the hyperbolic paths in the vicinity of the target occurs. Accordingly, guidance accuracy for the collision course is less severe. The large entry angles, however, would essentially preclude the possibility of using atmospheric deceleration to expand excess energy. Reliance upon powered landing would be required.

To orbit about the target planet in preparation for a deorbiting maneuver requires that the approaching vehicle be guided into a fairly narrow circumferential band at which point the vehicle velocity relative to the planet must be adjusted downward to appropriate orbital speeds. Unless atmospheric braking is obtained this deceleration must be accomplished in a powered maneuver. To graze the atmosphere—a very thin band relative to the planet diameter—requires the greatest precision in the guidance and control.

The problem of landing on an airless planet places greater requirements on the flight control system (and of course a rocket fuel supply) than those of going into orbit or landing in an atmosphere. Terminal guidance requirements, however, are somewhat less severe. Here the initial objective is to move into a trajectory which has zero angular momentum with respect to the intended landing point. This presents a relatively simple computational problem since Mercury and all the airless moons of the solar system for which observations are possible have a rotational period equal to their orbital period, i.e., they present the same face to the parent body. Thus, the landing point is under continuous observation for a long time.

• **Fuel-saving trick**—Corrections to the hyperbola of approach should be made as early as possible to conserve fuel, just as in the other cases being considered for the same reason. Deceleration to land using retro-rockets should be postponed as long as possible compatible with the maximum tolerable "g" limit. Probably the most satisfactory terminal navigational aid is a radar that makes use of pulses for ranging and Doppler shift for velocity of approach. With this information the retro-rocket thrust can be programmed for proper descent.

Special problems arise in the last few hundred feet. Accurate measurements of height become difficult because the time interval between pulse and return is very short (on the order of one microsecond). The large ion cloud from the rocket exhaust would certainly render any microwave velocity measurement useless by masking the small doppler shift existing. No automatic control system appears to have been devised that improves on the possibility of human observation and control of the actual landing. This is probably very desirable, anyway, since selection of the exact landing spot to avoid rock or crevasses can be done by a human pilot. The control system should be designed to handle like that of a VTOL aircraft, for which adequate training and experience is readily available.

Significantly, the problem of landing upon the surface from an orbit about a planet is nearly in the dress rehearsal stage at this time in Project *Mercury*. Certainly the important major framework associated with this problem is fairly well understood essentially as a legacy of the ballistic missile program. Challenging problems exist in all areas; however, the encouraging and exciting fact remains that no insurmountable factors exist to prevent man's exploration of space.

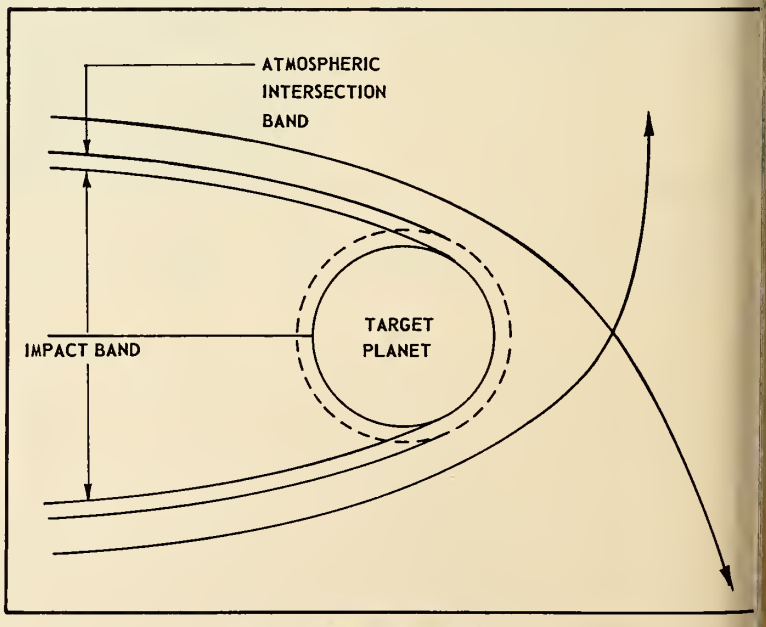


FIG. 3—Hyperbolic Approach Orbits.

ENGINEERS ☆ SCIENTISTS

Are you getting these advantages in your present position?

☐ **Space-age assignments.**

Boeing's space-age orientation, its advanced research and test facilities, and its wide weapon systems management experience have already laid the foundation for continuing growth and leadership in the future. Underway are company projects probing the very frontiers of knowledge—including orbital, lunar and interplanetary systems.

☐ **Advanced research facilities.**

Boeing's research, development and engineering facilities are among the most varied, extensive and complete in the industry. If your field is design, you'll get the answers you want, in a hurry. If you're in research or development, you'll be working with equipment as modern as this minute. Backed by extensive research laboratories covering a tremendous range of engineering fields and the sciences, you'll make more progress—faster. And you'll work with men who have literally "written the book" on the state-of-the-art.

☐ **Opportunity for advancement.**

Boeing takes steps to see that you don't get lost in the shuffle. You work with small, integrated teams where initiative and ability get plenty of visibility. A personal merit review every six months assures you a continuing opportunity for individual recognition and advancement. In addition, you are eligible for advancement to higher level positions at any time. Since its very beginning, Boeing has recognized the desirability of developing personnel for added responsibilities.

BOEING

Seattle • Wichita • Cape Canaveral

☐ **Better family living.**

There's a real bonus of better living in the heart of the evergreen Puget Sound area. Dramatic sea-and-mountain scenery and year-round outdoor recreation are unsurpassed. Your surroundings are air-conditioned by nature—four full seasons, yet moderate, comfortable. Average minimum temperature is 46.3°. Sea-level and ski-level are only an hour apart. Per capita ownership of sail and power boats is America's highest. You play your best, and work your best—because both career and living conditions are ideal.

There is more to getting ahead in engineering and science than one's own ability. Of almost equal importance is the environment in which you work. If, in your mind, there is any lingering doubt that your present surroundings do not meet all *the requirements for achieving your fullest professional growth, it will pay you to check the advantages Boeing can offer.*

FOR A CAREER THAT OFFERS ALL THE ADVANTAGES, MAIL THIS COUPON TODAY!



Mr. Stanley M. Little
Boeing Airplane Company
P. O. Box 3822 - MIE
Seattle 24, Washington

Please send me a free copy of "Environment for Dynamic Career Growth."

Name .....

Address .....City .....State ....

Degree(s) .....

Field of Interest .....

Falling Behind Engineering Advances

by Dr. T. C. Helvey*

ORLANDO—The limitations of the human organisms are probably the most restrictive in astronautics. Engineering has solved the problems of boosting a projectile into orbit about the earth and of escape from the earth's gravity. If it were desired, the engineers probably would be able to shoot a small object out of the solar system—perhaps even from the galaxy. But a whole host of separate questions must be answered—indeed several new sciences must be developed—before men can travel safely any great distance in space.

Nevertheless, we can predict that our species will solve these problems if they can be solved. Man is a proud creature. His ambition knows no limit.

One of the limitations the human organism probably will impose for the next few centuries is in travel radius. Since medical science is unlikely to prolong the average human life beyond 120 years and it is hardly likely that the speed of light will be exceeded, the presumed maximum length of a manned trip is 100 light years. This would set an action radius of 50 light years if we plan a return to earth.

But our own galaxy, the Milky Way, has a diameter of 200,000 to 300,000 light years. The 50-light year radius would restrict travel to a tiny segment of the galaxy.

To extend this action radius, there are two approaches that do not require artificial tampering with the human organism. One is to slow the normal body functions to retard aging. Scientists in the fields of biophysics and biochemistry are studying suspended animation. Although this would involve loss of consciousness for very long times, amazingly little psychological aversion has been aroused by discussion of this method. The other approach is based on the dilatation of time implied by Einstein's theory of relativity. The theory states that time slows down for all objects traveling at speeds approaching that of light. In this case, consciousness would not be lost, but the extremely low perception rate would sharply reduce the effectiveness of human observations en route.

* *Research Division, Radiation, Inc., Orlando, Fla.*



HUMAN capability of performing a certain psychomotor function while under acceleration. (Fig. 1)

• **Genetic attack**—A more radical attack on the problem is that of genetics. Perhaps we can adapt man to greater endurance of the stresses inherent in space. Of course, the utilization of presently known principles of eugenics to breed astronauts would be time consuming. Such projects would last many centuries. But it is conceivable that controlled artificial mutation, brought about by some mutagenic agent or radiation, might speed the process. However, we must face the fact that there are deep philosophical implications to the thought of creating a *homo sapiens var. spatialis*. They must be realized as such.

In the closer future, we shall have to adapt the space machine as much as possible to the human limitations. By using symptomatica and possibly post-hypnotic suggestion we may make the astronaut more resistant to space stress.

What is the problem of space medicine in the immediate present? The primary task is to maintain the normal operational integrity of the human organism under space-equivalent conditions. We must consider human reactions in terms of performance, stress endurance, bodily changes and behavior.

Several overlapping sciences can serve us in controlling these factors. The fields are so strongly interwoven that subdivision is very arbitrary. One such division could be the following:

1. The approximation of terrestrial environment,
2. Biophysical and pharmacological aid to overcome or partially compensate for the alien environment,
3. Psychological considerations,
4. Prevention and alleviation of pathological problems.

We shall discuss the above parameters quite elastically and show the main fields of interest and their interaction, without attempting to deal with the problems involved nor to go into great technical details.

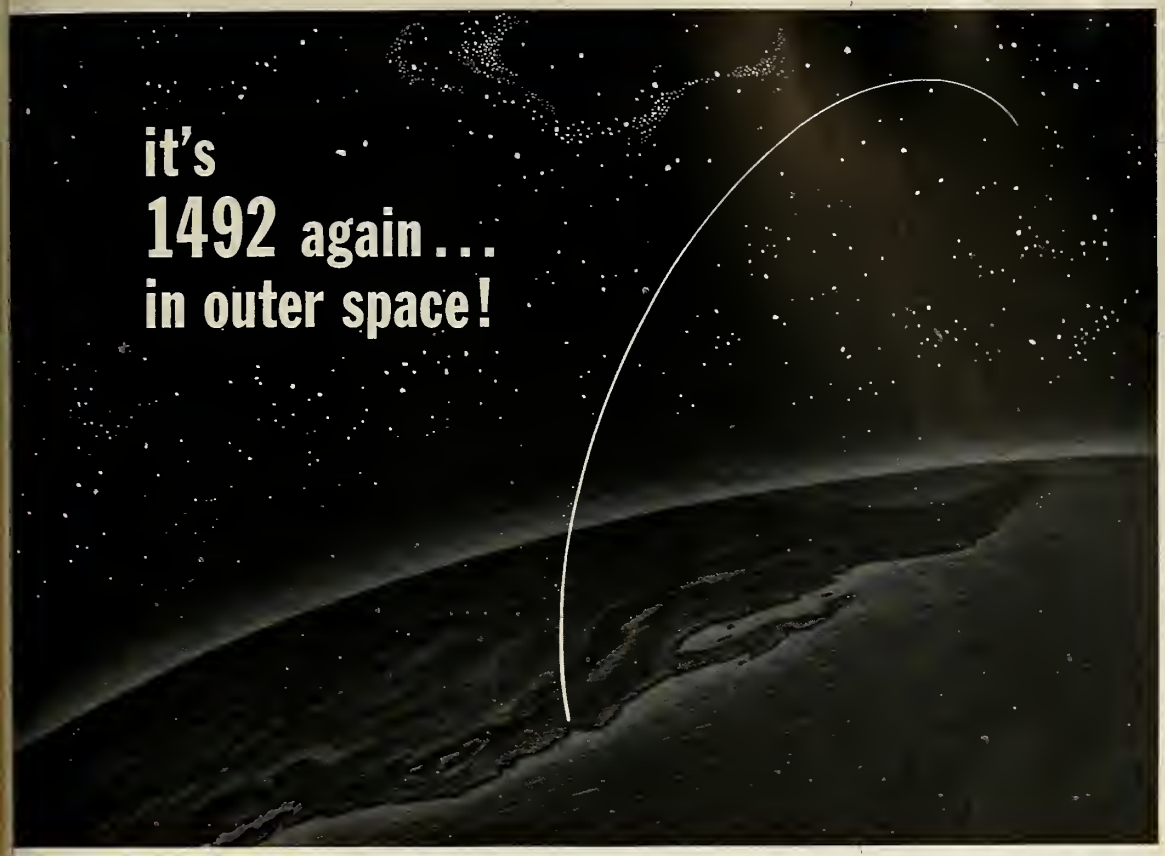
• **Artificial environment**—Although the assignment of proper values of importance is not possible, obviously the first item should be the artificial environment of the crew compartment.

An ideal environment, however, would suit "ideally" only the "average man." But we know that there is no "average man" thus the "ideal environment" is only an approximation and must have a significant spread to fit even a selected group of Western men. With these restrictions we can write the following set of factors:

Temperature: 68-72°F
Humidity: 40-50% R.H.
Acceleration: 0.8-1.2 G
Altitude: 900-1000 Millibars
Oxygen partial pressure: 18-21%
Carbon dioxide content: 0.3-0.5%
Ozone and atmospheric pollution: 0
Nuclear radiation (ambient flux): Less than 300 Milliroentgen/week
Ambient illumination: 5 Millilambert
Ambient random noise: 2 db
Air movement: 2 ft/sec and 100 ft^3/min
Clothing: Short sleeves
Minimum living space: 650 cft per capita

Any, even slight, deviation from the "ideal environment" places a stress on the individual. One of the prime functions of space medicine is to study the stress tolerance of the human organism and to find methods to adapt the ecosystem of the crew compartment to the human limits. Another task is to find pharmacological, biophysical and psychological means to extend the human tolerance limits to environmental stress.

• **Approximation of terrestrial environment**—For the near future and from the point of view of the operational integrity of the space crew, it would be ideal if the ecosystem of the crew compartment were identical to or just slightly divergent from the best terrestrial conditions. It is quite obvious that the provision of such conditions would be very expensive and in



Philco Ground-Space Communications System commands and tracks **DISCOVERER** satellite

DISCOVERER . . . the United States' newest earth satellite . . . is opening new vistas on the frontier of outer space. And Philco is proud to play an important role in this renowned achievement as a part of the Discoverer Team . . . in conjunction with the Lockheed Aircraft Corporation and the Air Force at the direction of the Advanced Research Projects Agency of the Department of Defense.

As the subcontractor for Discoverer's entire communications system, Philco designed and developed the vast complexity of ground-space communications, tracking, commanding and data gathering and processing systems.

The Philco-designed and equipped system observes and commands Discoverer through a series of five tracking and data collection stations in Alaska, California, Hawaii and a specially equipped ship at sea. Philco continues its participation in the Discoverer Program by assisting in the actual operation and maintenance of the communications and data handling network.

Philco's part in the Discoverer Program is typical of the many and diverse advanced research and development activities being conducted in our laboratories on the East and West Coasts where outstanding career opportunities abound for Engineers, Mathematicians, and Physicists.

In the wonder-world of advanced electronics, look to the leader. Look ahead . . . and you'll choose Philco !

PHILCO®

GOVERNMENT AND INDUSTRIAL DIVISION
WESTERN DEVELOPMENT LABORATORIES
PHILADELPHIA, PENNSYLVANIA PALO ALTO, CALIFORNIA

Circle No. 36 on Subscriber Service Card.



dead center

Kelsey-Hayes thrust vectoring systems give missiles proper directional control.

Kelsey-Hayes is contributing substantially to the design, development and production of new thrust vector control systems for solid fuel propulsion.

For example Kelsey-Hayes, in a recent crash program, designed and fabricated a movable nozzle control that passed static firing tests for one of the newest sophisticated missile systems.

The swivel nozzle control is just one of the latest developments by Kelsey-Hayes as a subcontractor of propulsion subsystems, flight componentry and high performance materials. Spearheading Kelsey-Hayes activities is the Advanced Design Group, a flexible team of experienced design specialists. Kelsey-Hayes Company, Detroit 32, Michigan.

KELSEY HAYES COMPANY

Automotive, Aviation and Agricultural Parts
Hand Tools for Industry and Home

18 PLANTS: Detroit and Jackson, Michigan; Los Angeles; Philadelphia and McKeesport, Pennsylvania; Springfield, Ohio; New Hartford and Utica, New York; Davenport, Iowa; Windsor, Ontario, Canada

Circle No. 37 on Subscriber Service Card.

environment same as earth's . . .

many cases technologically impossible. Therefore the crew members will have to be satisfied with conditions that will differ strongly in many parameters from, what we may term, best laboratory conditions. It is in the realm of space medicine to provide the quantitative analysis for the maximum deviation from the ideal environment without causing significant performance decrement in the crew. For example, if the ambient temperature of the crew compartment is 75 to 77°F the crew will still be able to perform its duties without too much fatigue or discomfort. But should the temperature go to 85 or 90° the mission profile of the individual crew members must be radically changed due to the early deterioration of their work output.

Special emphasis must be given to multiple stresses. We must study thoroughly what effect deviation from the ideal conditions in more than one environmental parameter will have on the performance of certain psychomotor tasks. The main reason for this is that in physiology and psychology multiple stresses are not additive but may influence the result by factors of 2 or more. Not only are these multiple stress factors non-linear but the performance of the crew is further complicated by other dependent variables such as the non-linear human gain control. The complexity of the question of human performance under multiple environment stresses is such that it cannot be computed or even closely approximated. Therefore research must provide the necessary information.

There is a wealth of information available in the literature on the endurance and work efficiency of a human exposed to individual environmental stresses. For illustration, let us consider the effect of peak acceleration on human transfer functions. In the relatively new science of ergology, that is the study of the human work output, the human transfer function is defined by the speed and accuracy by which the human organism translates a sensory stimulus into muscle action. As an example, the subject is indoctrinated that upon the flash of a red light he should punch a certain button with his right index finger.

Space flight has given great emphasis to the study of the effect of acceleration on the human performance. Since the pioneering work of Col. John Stapp valuable information has been gathered with the high performance human centrifuges operated by the Navy in Johnsville and by the Air Force at Wright Air Development Center in Dayton. The question of the human performance under acceleration stress has a number of parameters:

1. Direction of the acceleration force,
2. Peak acceleration,
3. Duration of the acceleration.
4. Rise time to peak acceleration.

• **Man under stress**—The human capability of performing a certain psychomotor function while exposed to acceleration stress can be shown by a three-dimensional graph (Fig. 1). On the transparent plate in the center of the illustration, a mannequin is fastened in such a position that the so-called transverse g-load shows horizontally and the vertical measures the positive and negative acceleration in g's. The third dimension, on a logarithmic scale, represents the rise time to peak g-loads. The shadows cast on the vertical and horizontal planes break the three-dimensional graph down into two two-dimensional illustrations.

We learn from this graph that with fast rise time the human operator will be operational only if exposed to very little acceleration. If the peak g-load is reached between a half and one second, the performance will be satisfactory even if the operator is exposed to a transfer g-load of more than 20 g's. But if the rise time is prolonged to 10 or 100 seconds, the performance radically decreases.

This strange behavior of the human organism can be explained as follows: With fast rise time to peak g-load, the impact or shock effect will set a limit to the proper human performance because time is needed before the muscles will compensate and the nervous system can coordinate muscle action. On the other hand, if the rise time is relatively long, then factors involving the rate of blood flow in the arteries and veins come into play. Much research is required for the understanding of this new field of hemodynamics. The flow of blood can by no means be compared to that of water in a system of iron pipes. Blood is a non-Newtonian liquid that does not behave as water. The arteries are pipes or tubes that are pulsing or changing their diameter. Their walls can be influenced by emotions. Obviously, we cannot make predictions based on computations for a system so complex. However, we can gather the necessary information by research.

We have here discussed only a small fraction of one of the parameters of the space equivalent environment. The other parameters cover the whole range listed in the earlier portion of this paper. In addition, there are the metabolic needs of solids, liquids and gases, waste disposal and hygiene. We can only throw a spotlight on fragments of space medicine in this paper to outline its scope.

• **Biophysical and pharmocological assistance of the space crew**—It was obvious from the beginning that for technological and economic reasons the ecosystem of the space capsule cannot be perfect. Therefore, the crew must be assisted to overcome or partially compensate for the alien environment. A number of difficulties will arise due to the weightless state during the coasting of the vehicle, which may last for weeks or months. Many symptoms caused by zero-gravity in the human organism can be predicted and certain countermeasures can be taken. The effect of zero-gravity of long duration can, however, only be studied when a man is placed into a satellite.

The establishment and the problems of the various cycles of the human ecosystem in the space capsule, such as the food cycle, the water cycle and the respiratory gas cycle can also be considered as a part of space medicine. For shorter flights, such as a moon mission, such commodities as water, food and oxygen can be carried from earth. For longer lasting missions, however, a re-cycling of food, water and oxygen is inevitable. The problem with the re-cycling of water is more or less solved. The utilization of unicellular plants, such as algae, for oxygen production and carbon dioxide elimination is under study. However, the utilization of photosynthesis for this purpose is very cumbersome.

Food for the crew poses a knotty problem. Due to weight considerations, it should be completely digestible. But we still do not know whether the human digestive system can adapt itself to a bulkless food without severe symptoms. If all the food is absorbed in the stomach and in the first turns of the duodenum, the emptiness of the major part of the digestive system may cause permanent hunger sensations. These in turn could build up nervousness and irritability to a degree where the whole mission might be seriously jeopardized. Possibly, medication could counteract such symptoms.

The excellent adaptability of the human organism makes for further concern. During a flight lasting months or perhaps years, anatomic and physiological changes would occur in the bodily functions. After return to earth, crew members would have to undergo very long lasting re-adaptation to terrestrial conditions. The problems aris-

ing in this connection are considerable. Since space navigation will require much skill and patience, the returning experienced crew will have to be used for new missions. But the adaption to space-equivalent conditions and the re-adaptation to terrestrial environment may be so uncomfortable that the crew will be reluctant to undergo the same experience again. In the present cultural and social structure of our society, it is unthinkable that the crew that signs up for a space mission should never be permitted to return to earth. This is another difficulty we must overcome.

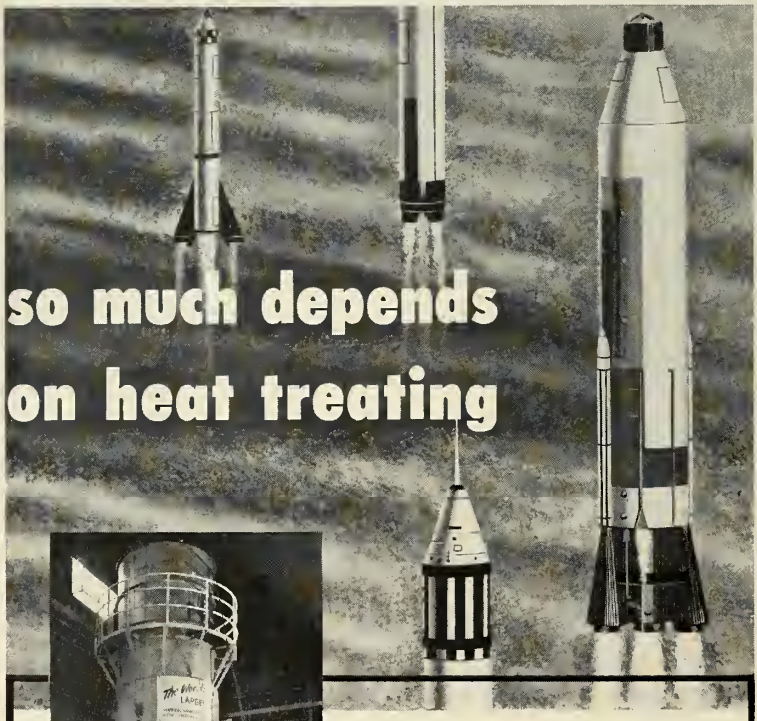
• **Psychological considerations**—It is evident that space medicine must maintain the mental health as well as the physical well-being of the crew. The psychological problems associated with space flight are at least as severe as the physiological problems. Most problems revolve around the two main fields of fatigue and anxiety. Both of these factors and related ones can and would handicap the crew performance. There is where a new science, psychopharmacology, has a most promising field of application. This leads directly into another aspect of space group-psychology, namely the proper control of group interaction in the society of the crew compartment. It is obvious that means have to be found to optimize the cooperation of the crew members and to eliminate every element which may cause friction or hostility. This can be achieved by the proper combination of crew selection, indoctrination, training and again the application of psychopharmacology.

• **Prevention and alleviation of pathological problems**—It is of great concern to space medicine how to prevent malfunction of the bodies of the crew, or if it cannot be avoided how to cure them. Everybody will agree that a toothache of a crew member in a space craft could cause a severe situation. On the other hand, it is unlikely that complete dentistry equipment, can be carried in the vehicle or that a prerequisite for signing up for a space crew would be to pull all teeth. Although the crew and the crew compartment would be in a sort of semi-sterile state this, however, would not prevent the occurrence of a cavity and a subsequent inflammation with its severe consequences if left without care.

The probability that any of the crew members would suffer appendicitis is low under the prevailing conditions. Nevertheless, provision has to be made that in case of its occurrence the crewman should not be left to die. This raises the question of how far crew compartments should be equipped with surgical facilities.

The avoidance of contagious diseases can be achieved by proper pre-flight treatment of personnel and equipment. Yet it is conceivable that some of the harmless micro-organisms, such as the coliform bacteria in the intestines, may mutate under the influence of cosmic radiation and develop a strain that could cause severe symptoms and incapacitate the crew. These mutant bacteria might resist most of the antibiotics. Such an organism could be isolated and a life-saving serum could be developed if the necessary facilities were available. But it is quite unlikely that serum production could be incorporated into the payload. Thus space medicine also must decide on and coordinate with the mission profile the materials and equipment needed for safeguarding the bodily and mental health of the crew.

It is apparent from the foregoing that space medicine touches on all the fields of astronautics. When man is put into the space vehicle, all of its parameters must be adjusted to make the vehicle livable. Propulsion, the air frame, guidance, communications and engineering must be modified and new specialties must be developed to meet the peculiar needs of the human organism. Thus space medicine is a science that stands astride the disciplines.



Every step in the fabrication of a missile is critical. All the more reason to turn to the expert in precision heat-treating, when your mission in research, development or production requires heat-treating support.

At Metallurgical, Inc., experience combines with facilities to achieve results which meet your close dimensional tolerances and rigid specifications.

RESEARCH • FIXTURE ENGINEERING • PRECISION HEAT-TREATING

METALLURGICAL, INC.

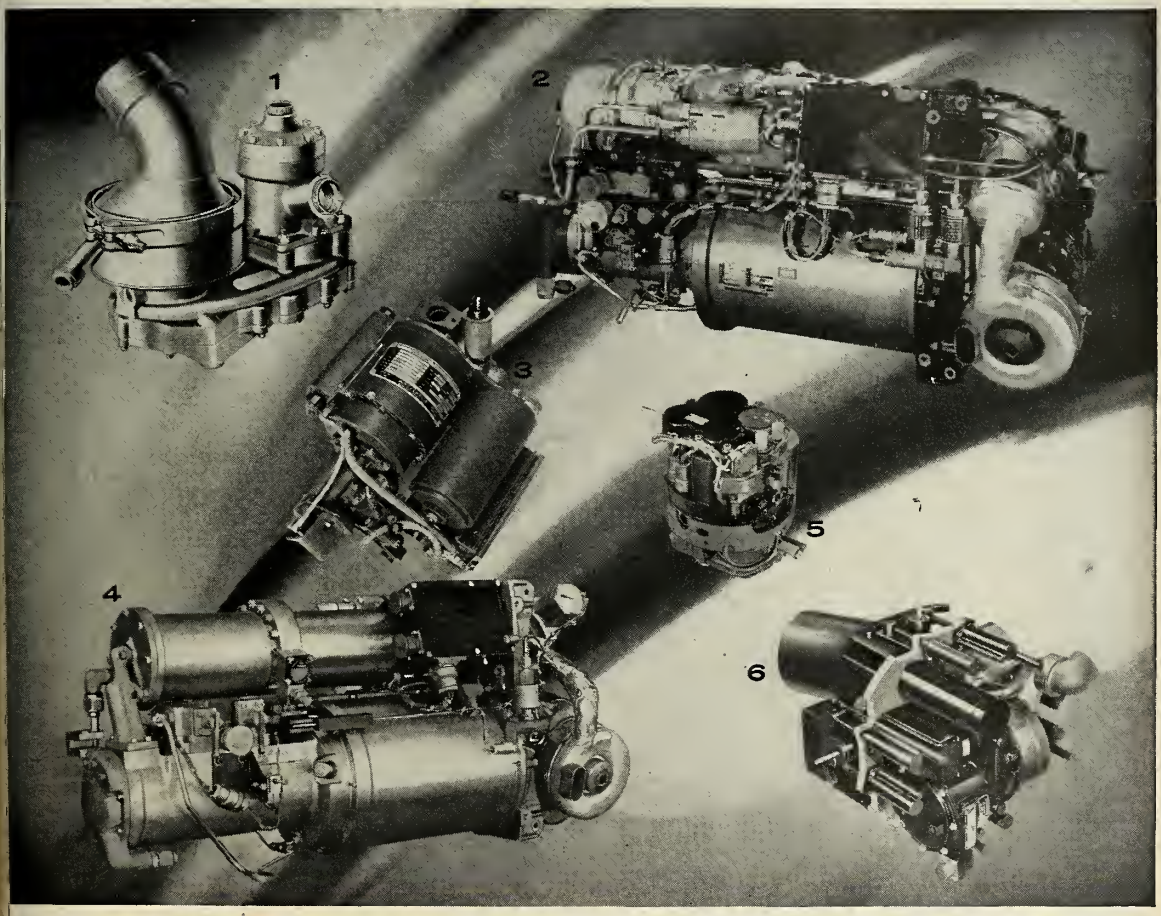
GENERAL OFFICE AND PLANT:
900 East Hennepin Ave., Minneapolis 14, Minnesota

BRANCH PLANT:
1727 Manchester Ave., Kansos City, Missouri

GOVERNMENT AND INDUSTRY CAN DEPEND ON METALLURGICAL, INC.

Circle No. 1 on Subscriber Service Card.

DELIVERED—thousands of missile APUs



. *Solid propellant—hydraulic output* **2.** *Liquid propellant—hydraulic and electric output* **3.** *Solid propellant—electric and mechanical drive output*
4. *Liquid propellant—hydraulic and electric output* **5.** *Solid propellant—hydraulic and electric output*
6. *Solid propellant—hydraulic, electric and steering outputs*

AiResearch has designed, developed, manufactured and delivered thousands of missile accessory power units. Extremely reliable and lightweight, these various solid and liquid monopropellant APUs are completely self-sustaining within the missile system. Designed to minimum space and weight requirements, they are built to withstand high G loading and severe temperature extremes.

The several units pictured above provide hydraulic, electrical and/or steering surface control depending on the customer's requirement. Delivered horsepower ranges from 1.2 to 35 h.p. over hot gas operating durations from 30 seconds to 20 minutes. Electrical regulation is maintained as closely as ±½%. A significant advance in missile APUs is unit #6 pictured above. This package represents the first integrated hydraulic and electrical power unit providing a steering surface actuation system.

These tailored systems utilize the extensive hardware experience and complete laboratory, test and production facilities of AiResearch needed for quick and efficient quantity production of complex APU systems. AiResearch is the world's largest and most experienced manufacturer of lightweight turbomachinery — the key component of its APU systems. Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

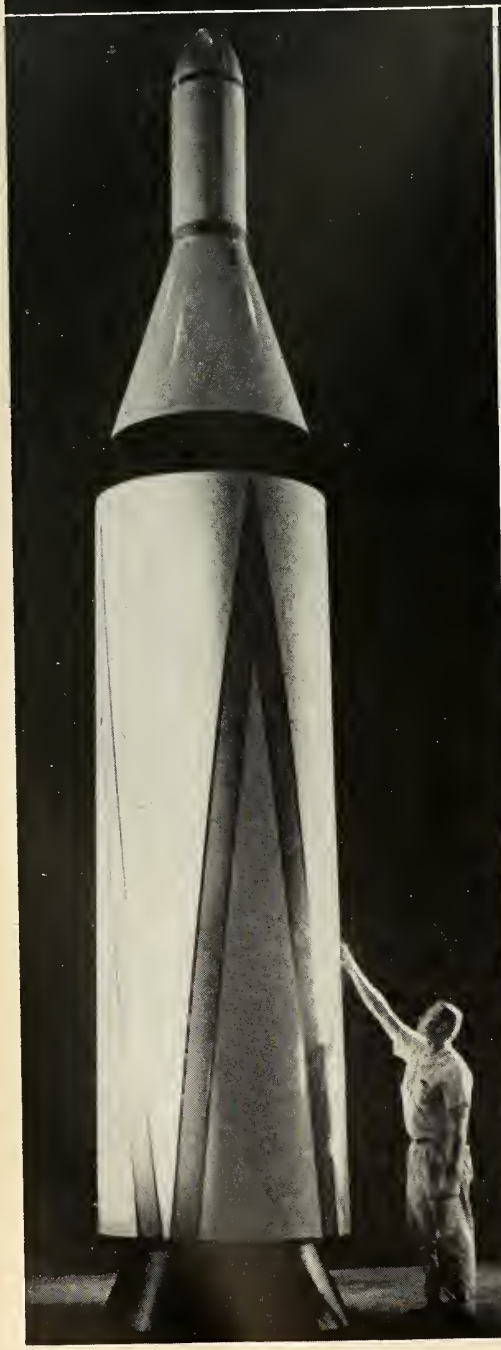
Los Angeles 45, California • Phoenix, Arizona

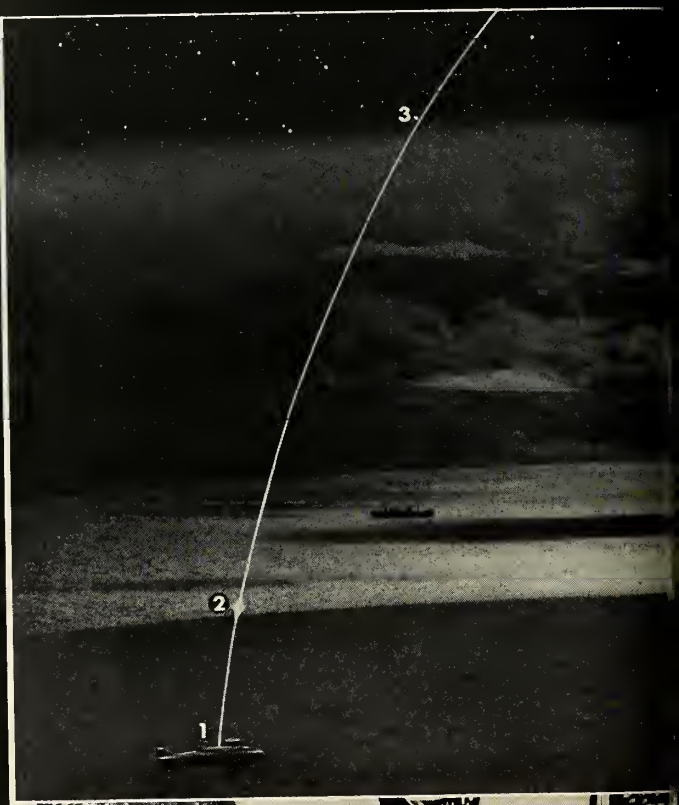
ystems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

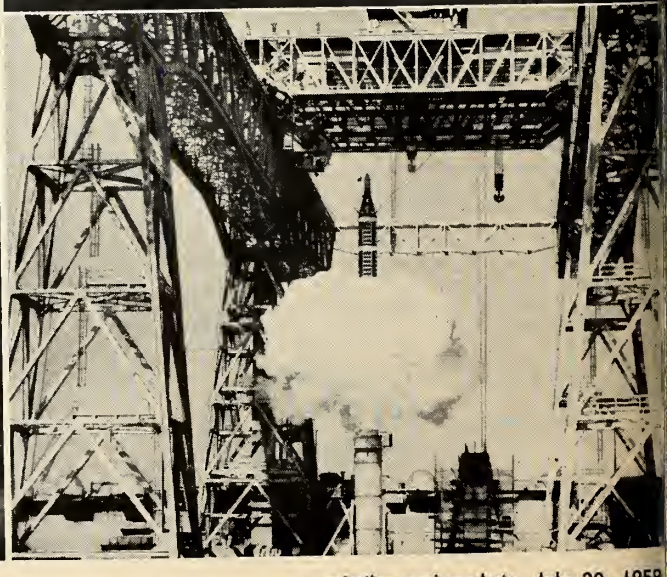
Circle No. 40 on Subscriber Service Card.

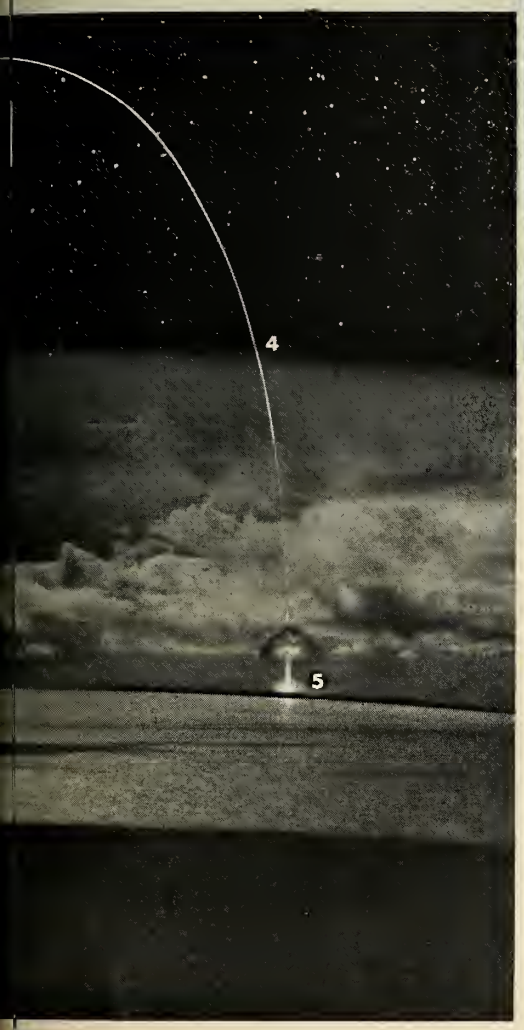
The Lockheed-developed U.S. Navy POLARIS:

Missiles launched from ocean depths









ft *"Operation Sky-Catch" tests,* conducted jointly by S Navy, Westinghouse and Lockheed, reveal effects of r n stresses. To prevent damage to POLARIS test missile m onents, huge overhead assembly catches it in mid-air.

r **eft:** *Carrying awesome destructive power,* Navy's OL RIS is markedly smaller than other U. S. ballistic iss es of same range. To enable one submarine to carry an missiles, Lockheed scientists achieved miniaturi- tic breakthroughs on all major systems of POLARIS.



Above: *Propulsion system firings* light up night sky at Lockheed Missiles and Space Division's 4000-acre test base in the Santa Cruz mountains, Calif. A nearby vertical test stand permits simulated flights of complete POLARIS missiles, to test their propulsion and guidance systems.

Left: *Nuclear powered U. S. Navy sub* (1) launches solid-propellant POLARIS missile which erupts from ocean depths (2)—then rockets its way on a ballistic missile trajectory high above the earth's atmosphere (3) into outer space. Re-entering the atmosphere (4) the re-entry body of the POLARIS plunges earthward to destroy its target (5).

Launching an IRBM from submerged submarines involves technological developments that are unique in ballistic missile history.

As POLARIS Missile System manager and prime contractor, Lockheed's Missiles and Space Division is responsible for coordinating all phases of its design, development, and production.

The POLARIS, a solid-propellant missile, will be operational in 1960—ahead of schedule. The operational missiles will be delivered to U. S. Navy submarines in Lockheed ready-service transporters under controlled humidity and temperature conditions. And Lockheed's ACRE—Automatic Checkout and Readiness Equipment —will maintain the constant ready-to-fire capability of POLARIS missiles, right up to the moment of launch.

With an ultimate range of 1500 nautical miles, the POLARIS will become one of the most formidable deterrent weapons ever devised. For any significant military target on earth will be within range of its nuclear warheads.

LOCKHEED

JET TRANSPORTS • JET FIGHTERS • JET TRAINERS • COMMERCIAL & MILITARY PROP-JET TRANSPORTS • ROCKETRY
ELLISTIC MISSILE RESEARCH & DEVELOPMENT • WEAPON SYSTEM MANAGEMENT • ANTI-SUBMARINE PATROL AIRCRAFT
NCLEAR-POWERED FLIGHT • ADVANCED ELECTRONICS • AIRBORNE EARLY-WARNING AIRCRAFT • AIRPORT MANAGEMENT
NCLEAR REACTOR DESIGN & DEVELOPMENT • GROUND SUPPORT EQUIPMENT • WORLD-WIDE AIRCRAFT MAINTENANCE

Industry Faces Tough Assignments

by David R. Hull

WALTHAM, MASS.—Accelerated study, research, and development brought on by the advent of *Sputnik* have caused daily advances in the vast and unsettled field of space and missile technology. Electronics is contributing immeasurably to these developments.

A quick examination of the space vehicle itself will determine the role that electronics is playing in the space activities during the current "first generation" of space technology. The rocket-powered flight vehicle contains four basic elements: the airframe, the rocket engine, the propellant, and the payload. And electronics varies from slight to dominant in degree of importance to these elements.

The industry has less impact on the airframe portion than on the engine and propellant because electronics provides only control of these elements. Not so regarding the payload—the main area of interest.

The possible use of ionized propulsion for thrust directly concerns the electronic industries to the extent of the need for electrical power generation and control devices. The payload, on the other hand, contains the electronic sensing, recording, storing and transmitting segment that is able to reach regions previously inaccessible and gather scientific data heretofore unobtainable. This element consists of TV cameras, infrared detection devices, radar gear and data recording and storage equipment. Putting the payload into orbit is the sole purpose of all the other elements of the space vehicle.

• **Guidance**—Without guidance, however, the space vehicle cannot fulfill its mission, and without electronics there can be no guidance. Guidance operations consist of the measurement of vehicle position and velocity, computation of control actions necessary to properly adjust position and velocity, and the delivery of adjustment commands to the vehicle's control system. Guidance operations may occur during the vehicle's take-off, during flight in space, or during the vehicle's return to earth.

Space-flight missions in the immediate future will use ballistic rockets, and the electronic guidance of such vehicles will be extensions of current ballistic missile guidance techniques. "Ascent guidance" for such missiles is used only during powered flight. The electronic guidance system determines the free-flight path.

When the desired combination of position and velocity is reached, guidance systems signal cut-off of the propulsion systems. Electronic control of this function is vital.

• **Margin for error**—The classic example is that an ICBM at a range of 5500 nautical miles will have an "impact miss-distance" in the direction of flight of about one nautical mile for an error of one foot per second in the magnitude of its cutoff velocity. At the same one foot per second error in magnitude of velocity at thrust cutoff, the miss-distance to the moon is 20-100 nautical miles, and to Venus it would be about 25,000 nautical miles.

Using modern electronic components and techniques, inertial guidance is accurate enough in most instances to establish earth satellites. Placing payloads on the moon's sursface and establishing satellites around the moon, however, requires refinement in such control techniques. Travel to the other planets of the solar system, on the other hand, will demand mid-course and terminal guidance systems to avoid the miss-distance.

Near-to-earth mid-course guidance can be executed with our present electronic navigational ground networks. But flights substantially far out in space will require a guidance capability in the vehicle itself. Such mid-course guidance will require measurements on board the spacecraft using such electronic instruments as radio telescopes, TV cameras and infrared sensing equipment.

These devices will base their measurements on star or planet sightings. Additional electronic instruments are necessary to compute suitable control actions and to signal operations to the rocket engines. Speed and reliability of equipments during these operations are mandatory.

Terminal guidance systems will require infrared radiation detection equipment and radar systems. Such radars employ repeater transmitters in the rocket, a ground computer, and a radio command link to the vehicle.

• **Communications**—The industry faces a stiff assignment in providing communications in space. Electronic equipment is needed to cope with strange space environments, severe size and weight limitations in space vehicles, large communications ranges and extreme requirements for lengthy unattended operations.

The industry is actively investigating countless possibilities for communications associated with space flight in such areas as electrical energy and power sources, radio frequency power innovation, data storage and data encoding, and receiver sensitivity. A 10-to-1 reduction in receiver noise is expected through the development and use of ultrasensitive devices such as cooled detectors and masers.

Highly directional space vehicle antennas will improve communications and achieve power savings. Successful operation of this system depends upon attitude stabilization of the spacecraft. This is another area of present electronic research and development. Radio astronomy, the air-defense surveillance net and current space flight tracking activities are building up a backlog of experience in the use of very large steerable ground antennas which will



About the Author

David R. Hull is vice president of the Raytheon Co. and president of the Electronic Industries Association. A retired electronics engineering officer and captain in the U.S. Navy, he has been an electronics industry executive for 10 years.

Hull, as a pre-war assistant to the director of the Naval Research Laboratory, coordinated the Navy's radar research and development program. During World War II, he had charge of design and development of radar, sonar, special electronic applications and countermeasures essential to naval operations. He directed the Federal Telecommunication Laboratories of the International Telephone and Telegraph Corp. for two years after he retired in 1948. Hull has been with Raytheon since 1950.

be needed to support space missions.

• **Reliability**—In communications as well as in other electronic space activities, further miniaturization, improved packaging of components and increased reliability is mandatory. Electronic gear must have a high degree of reliability to guarantee output not only for the duration of flight but also for a useful period after arrival in space or impact on a planet.

Keeping equipment working unattended for many months is possible. But the industry finds it requires careful design, extensive testing, and knowledge of the environment in which it will operate. This unquestionably will lead to the use of improved basic materials.

• **Observation and tracking**—Observation and tracking are other tasks that electronics must perform in this Space Age. Various forms of ground-tracking radio, infrared, and optical systems will be required by all space missions in order that vehicle trajectories may be observed and monitored from the earth. The rotation of the earth and the nature of the vehicle's trajectory and orbit generate a requirement for locating tracking stations around the globe. In addition, ground facilities containing electronics will be required for control, landing, and recovery of vehicles.

• **Infrared measurement**—Infrared detection systems mounted in space vehicles are playing a vital role in space exploration. Electronic sensors that measure infrared radiation have permitted man to understand the composition of the atmospheres of the planets and other celestial bodies. The obvious advantage of such probes is that scientists for the first time are able to examine the outer reaches of space without the hampering effects of earth's intervening atmosphere.

Electronic observation of the earth's atmosphere from an orbiting vehicle will permit measurements of cloud cover, water vapor and carbon dioxide concentrations, thus aiding meteorological observations. Infrared sensors in spacecraft will have utility for military reconnaissance and surveillance of the earth. In particular, especially large sources of infrared energy such as afterburning engines of supersonic vehicles and exhaust flames of ballistic missiles may be detectable from orbital platforms. When combined with spectral analysis, infrared sensors would permit clear identification of a planet which will assist the navigation and terminal guidance of space vehicles.

• **Accomplishments**—The electronics industry can boast of many accomplishments in space and missile technology. For example, miniature TV systems for satellites are being developed now to broadcast pictures to

THE GRAND CENTRAL REPORT

Since merging with Food Machinery and Chemical Corp. and Tennessee Gas Transmission Co. a year ago, Grand Central Rocket Co. has developed an organization of highly competent management and efficient modern facilities. FMC and TGT have set as their goal building GCR into one of the strongest, most capable solid propulsion organizations in the country.

With over 500 employees, this seven year old organization (a veteran in this business) has some 200 engineers and scientists with an average of over eight years of experience in solids.

This able group has been augmented with the addition of Mr. John J. Crowley, former director of the Office of Guided Missiles, Dept. of Defense, as Vice Pres. for Project Management and Marketing; Mr. G. R. Makepeace, technical director of propulsion for Polaris, as Vice Pres. for Research and Engineering; Mr. Albert T. Camp, formerly Head of the Propellants Division, NOTS, as Asst. Vice Pres. and Dir. of Research; Mr. G. Daniel Brewer, of the Minuteman missile program, Space Technology Labs, as assistant to Mr. Crowley; Mr. George Cushman, former staff specialist in the Office of the Dir. of Guided Missiles, as Dir. of Marketing, and others.

At this moment the Company has a capacity of 700,000 lbs. of propellant a month to place at the disposal of the Nation's rocket program.

GCR now has the *know-how, men, facilities, financial background,* and the *management capability* to undertake successfully any solid propulsion development and production foreseeable in the Nation's military and space program.

It has a planned standby available *now*—a strong complement of engineers, scientists and support personnel to undertake these programs at once. They are now engaged in company sponsored work on propellants, thrust control, and reliability assurance to advance our knowledge and be ready with new and valuable ideas when called upon. They will not have to be taken off other important projects.

If you have an application requiring a seasoned team of men and facilities to counsel you, to participate in your advanced concept studies, or to start immediately on a new development, contact GCR for a prompt response.

Cledo Brunetti

Cledo Brunetti
Vice President and General Manager

(If you have the qualifications that a fast-moving space propulsion team needs, contact our Director, Personnel. Openings now for chemists and engineers.)

Grand Central Rocket Co.

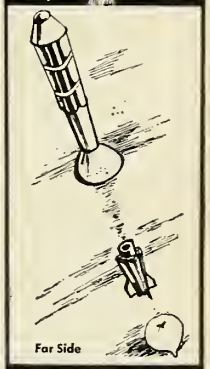
An Affiliate of Tennessee Gas Transmission Company
And Food Machinery and Chemical Corporation

P. O. Box 111
REDLANDS, CALIFORNIA
Circle No. 48 on Subscriber Service Card.


Mercury


Terminal Stage, NASA


Explorer III and IV


Far Side


Vanguard


Nike-Zeus


Test Sled

NEW VOUGHT PROJECTS OFFER CAREER APPEAL TO CREATIVE MEN

Space, ASW, and weapon system work at Vought requires continuous R & D in methods and materials, structures and design. These projects have prompted exploratory work in the following areas:

Structures (Supersonic and Hypersonic)
Heat transfer, thermal stress and deflection analysis, and stress analysis using high-speed computers.

Manufacturing R & D
Welding and brazing of super alloys and exotics; advanced forming and cutting studies; prediction of metal fabricability.

Industrial Engineering
Project estimating, work sampling, line load and balance, and packaging and installation of new procedures.

Antisubmarine Warfare
Studies of detection and classification techniques involving Acoustics, Geomagnetism, Geophysics, Electromagnetics, Electrochemistry, Math.

Engineering Planning
Man-hour and budget forecasting, and project planning and scheduling.

Product Design
Automatic escape devices, atmospherically sound cockpits and advanced instrument displays for space pilot, crew.

Flight Test Instrumentation
R & D in new techniques for electronic gathering and reducing of flight test data.

Aerodynamics
Wind tunnel and model work employing Vought's 3,800-mph high-speed wind tunnel and new "high-temperature" laboratory.

Qualified applicants are invited to write:

J. W. Larson
Ass't Chief Engineer, Administrative Dept. P-14

CHANCE VOUGHT
DALLAS, TEXAS

earth receivers as far away as one thousand miles. These systems are designed to operate for several years. Also, electronic data recording and reduction devices are improving in speed and reliability. Recent developments in the *Vanguard* data reduction facilities may speed up the processing of data two and a half times over the rate at which the data is gathered and received. This system is expected to study up to 10 million items of recorded and processed data telemetered by radio signals from the satellite—resulting in improved flight control of guided missiles and space vehicles.

The planet Venus has recently been contacted with use of a solid-state maser in a practical radar system, verifying that interplanetary communication is possible. Another accomplishment has been the discovery that about six satellites can provide coverage for navigation of the seven seas. About six communication types can provide reliable communications anywhere on earth. Infrared detection equipment is now sufficiently advanced to track satellites hundreds of miles away.

Transistors are employed increasingly in spacecraft. The development of micro-miniaturization solves the size and weight limitations posed by space vehicles. Solar cells, too, are playing an important role in furnishing power over a long period of time in satellites. By their means the energy for generating electrical and electronic devices is obtained from the sun.

• **Second generation**—As the Space Age matures, the electronics industry will find itself more closely involved in space activity. Improved electronic and scientific techniques will have initiated a "second generation" of the Space Age by making it possible for man to be sent aloft in earth-circling satellites. Greater sophistication will create the need for more refined electronic instrumentation and control equipment. For example, the vehicle will carry with it a life-sustaining environment and if the time of flight is to be extended over a long period of time then total regenerative air, water and food cycles are the only answer. Electronics, too, may control the processes of the cycle of photosynthesis reliably and automatically. Electronics will be employed in maintaining the delicate balance of secondary living organisms that will be required in the reconversion of wastes into nutrients, and electronics will guard against leakage of vital materials through detection equipments.

Also, controlling the rotation of the space vehicle which induces artificial gravity may be another important function of electronics.

The industry will be called upon



VOUGHT WILL BUILD NASA SPACE ROCKET

Scout is the name of a new four-stage rocket to be used in NASA research. It will boost 150-pound satellites into earth orbit and fling 1,000-pound instrument probes as far out as 5,000 miles. The beauty of *Scout* is that it will do these things at relatively low cost—about $500,000 per vehicle, according to NASA.

Chosen to build this new approach to space research is Chance Vought's new space development team. This group already has come along fast in areas such as fitting man to a space machine, providing him escape devices and instrument displays.

For example, in Vought's unique orbital flight simulator, NASA and company pilots have already "flown" by the new rules of space, using the same family of instruments the first space navigators will use.

Designing for spacemen is new to Vought, but exploring unknown regions isn't. For more than 40 years, Vought has worked on the frontier in the "human factors" of aircraft design. Matching man to aircraft, the company has pierced imposing barriers to higher and faster flight. Matching man to spacecraft, Vought will continue to extend frontiers.

Astronautics is just one in the broad spectrum of Chance Vought fields of activity. Other areas include: design and production of high-performance missiles and aircraft, antisubmarine warfare, electronics, advanced weapons, range systems management, advanced control computer systems.

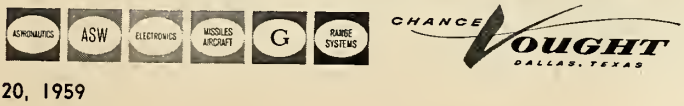
CHANCE VOUGHT
DALLAS, TEXAS

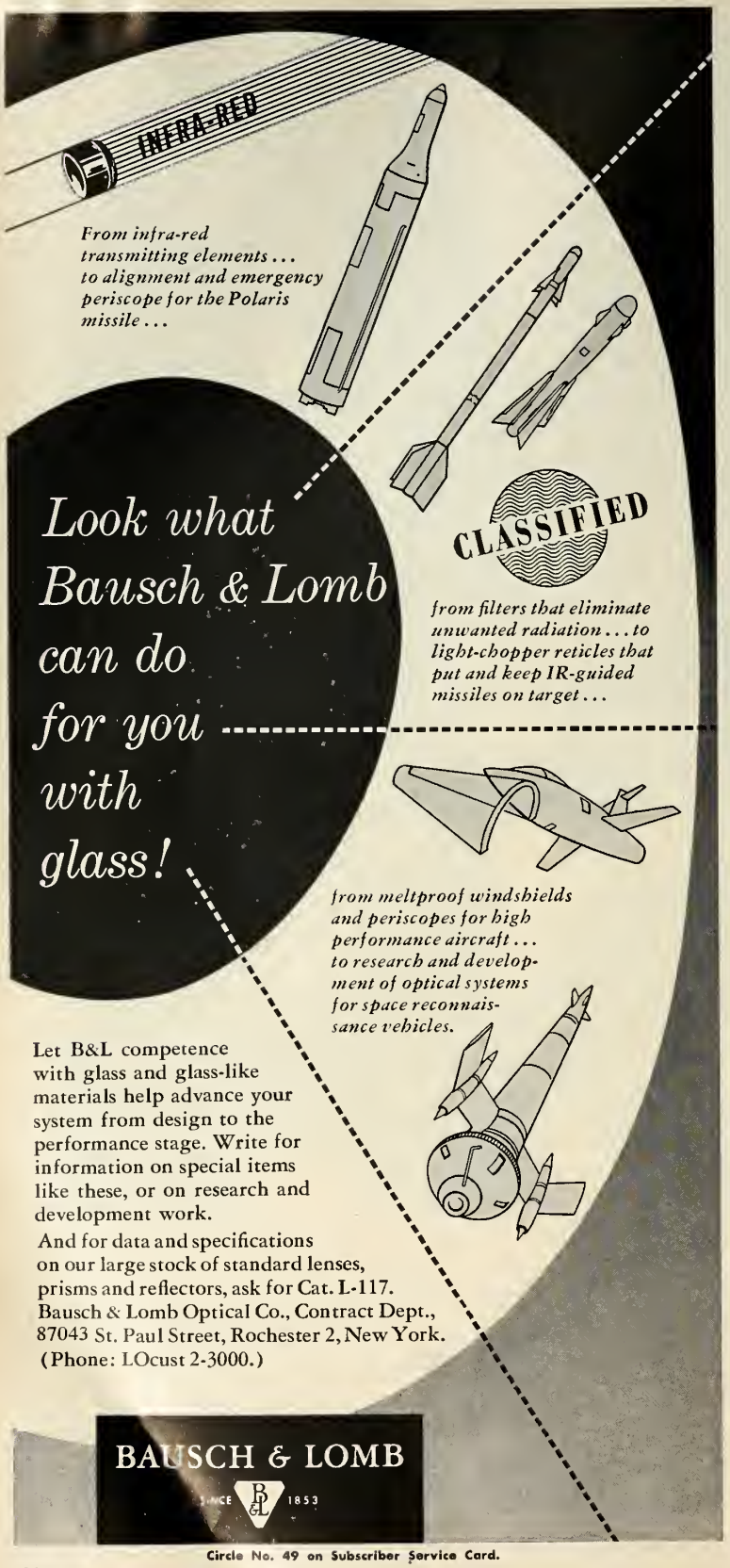


America's civilian space agency proves

IT'S GOOD BUSINESS TO EXPLORE SPACE

Weather forecasts hatched in space will save billions of dollars a year. Satellite transmitters will beam our television programs around the world. In these and other ways, space will pay back the money spent on exploration. Making facts out of these forecasts is part of the job of the National Aeronautics and Space Administration, the engineer-scientist agency that manages U. S. non-military aerospace programs. NASA adds a condition to predictions of a world space-trade boom: space, itself, must remain free. This freedom, NASA men know, depends on whether America leads or lags as a space explorer.





Circle No. 49 on Subscriber Service Card.

to an increasing degree to perform vital functions in the space and missile programs. It has already provided devices necessary for missiles and satellites even with limited payloads. The industry can and will keep abreast or ahead of the Space Age requirements including those sensing and control mechanisms which will be needed for manned space explorations.

But in all its efforts to help solve space and missile problems, the industry has not forgotten that many of its past military developments have been successfully converted to peacetime use. The industry envisions that new and expanding markets will evolve from the application of Space Age technology to production for commerce, industry, and the consumer.

• **Commercial application**—This impact will be felt more distinctly in commercial and public service activities. One television transmitter can serve a continent. Electronic devices placed in orbit will forecast the weather, aid ships in navigating any seas around the earth, improve world-wide communications by serving as relay stations for signals and permit long-range point-to-point communications at low levels—thus helping to conserve the already crowded radio frequency spectrum. In addition, satellites containing electronics will patrol for icebergs, warn of forest fires, map the earth's surface, and conduct geological surveys.

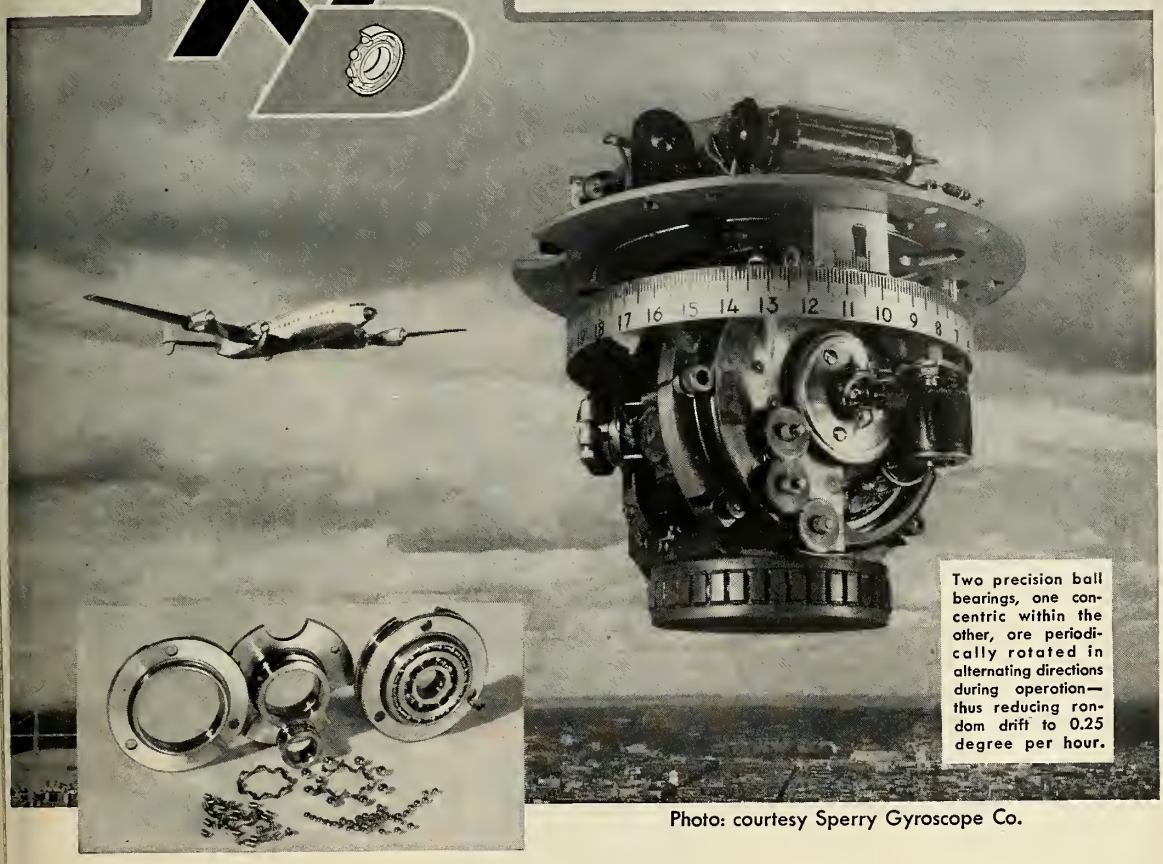
In the industrial area, automatic control devices are using advanced equipment and component designs that have been brought about by Space Age demands. Reduced costs and greatly improved product quality are seen resulting from these changes.

The impact of the Space Age on consumer electronic devices is apparent. One only has to observe miniaturization techniques in radios and other devices to see the relationship between consumer product compactness and the requirements of space technology.

Increased reliability is another by-product of Space Age design that will continue to enhance electronic products in all market areas.

Because Space Age concepts are stimulating academic study, the gap between advanced ideas for the use of electronics and the level of present laboratory and production techniques may widen. It is also conceivable that this problem may be complicated further by the accumulation of new knowledge about our world and the universe made possible through orbital observations. Therefore, it is necessary that the electronics industry encourage the development and improvement of laboratory techniques and facilities that will convert new knowledge into useful functions for everyday living.

CASE HISTORIES



Two precision ball bearings, one concentric within the other, are periodically rotated in alternating directions during operation—thus reducing random drift to 0.25 degree per hour.

Photo: courtesy Sperry Gyroscope Co.

1,200% Gain In Gyro Accuracy With N/D Ball Bearings

CUSTOMER PROBLEM:

Get new, advanced gyro bearing design "off the board" and into production. Sperry Gyroscope Company, in developing its new Rotorace (TM) gyro, designed a special bearing capable of "averaging out" error-producing effects of friction on sensitive gyro gimbals. New manufacturing techniques would be required to achieve high degree of precision required by Sperry design.

SOLUTION:

N/D Engineering, when approached by Sperry, created special manufacturing techniques for the high precision production of these unique piggy-back gimbal ball bearings. Used in the Rotorace design, the bearings helped achieve reduction of the gyro's random drift rate. The 2 or 3 deg. per hour drift, recently considered very good, is now cut to as little as 0.25 deg. per hour, with still lower rates in sight. Another example of New Departure's ability to meet exacting instrument bearing requirements through broad engineering experience and precision manufacturing techniques.

For immediate engineering analysis of your current high precision instrument and miniature ball bearing problems, write New Departure, Department K-7.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

Circle No. 41 on Subscriber Service Card.

compact heat exchangers of conventional or platular design for heating or cooling





precision pneumatic controls for bleed-air combine functions saving weight and space—special control specs invited

air duct couplings and supports in sizes up to 36" feature metal-to-metal seal, quick disconnects, maximum safety





For a proposal you can rely on contact your Janitrol engineering representative when your plans call for components, pneumatic sub-systems, and complete systems for heat transfer and air control. Virtually every modern aircraft and operational missile incorporates the skills that Janitrol translates into practical hardware. Janitrol Aircraft Division, Surface Combustion Corporation, 4200 Surface Road, Columbus 4, Ohio

liquid heaters for ground support equipment in compact sizes to 1 million Btu/hr—multi-fuel use

combustion systems include hot fuel prime units, inert gas generators and aircraft heaters

JANITROL



reliable components for missiles / aircraft / support

Circle No. 42 on Subscriber Service Card.

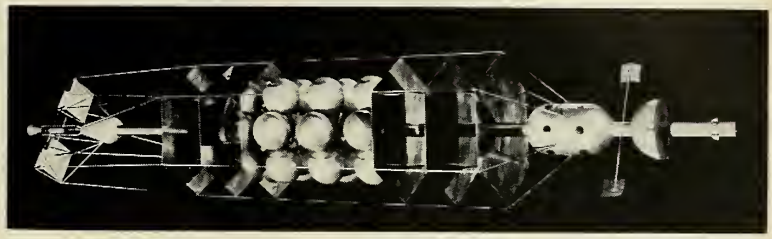
Considerable Theoretical Work Underway

Results are encouraging but experiments still are in the beginning. Here is the state of research, expected performance and the technical problems.

by Ernst Stuhlinger

HUNTSVILLE, ALA.—The use of electric propulsion devices will be restricted to low-acceleration systems operated in empty space. Wherever these restrictions can be accepted, electric systems may prove advantageous because of their very favorable payload-to-takeoff mass ratios. The successful launching of satellites and lunar probes, and numerous study projects on lunar and planetary exploration, stimulate more and more interest in such propulsion systems. Experimental work on electric propulsion is presently under way at many places, sponsored both by government agencies and by private companies. The National Aeronautics and Space Administration recently established a powerful experimental working group for electric propulsion at the Lewis Flight Laboratory.

The possibility of using electrically accelerated particles for space vehicle propulsion was mentioned probably first by Goddard and by Oberth. Basic features of ion motors were discussed in several papers by others during the period from 1948 to 1954. A design study of a complete ionic propulsion system, published by the author in 1954, pointed out that the design and construction of a system using cesium ions should be feasible with presently available technical knowledge. In the meantime, a considerable amount of theoretical and experimental work has been accomplished with the result that electrical propulsion systems appear very promising for a number of applications. The present paper attempts to give a brief account of the state of research, of expected performance figures, and of existing technical problems. The discussion will be limited to ionic propulsion systems; arc-heated and plasma systems will not be considered.



NASA'S MODEL of a hypothetical spacecraft equipped with the components of a nuclear rocket propulsion system.

• **Basic components**—In contrast to chemical rocket engines, electric propulsion systems require a separate source of energy. The only two sources that appear promising today are the sun and a nuclear fission reactor. In both cases, the magnitude of the energy-producing system aboard the space vehicle is dictated by the power level rather than by the total energy. The crucial figure is the power-to-weight ratio of the powerplant, α, measured in kw per kg. Several schemes to transform solar or nuclear heat into electrical power will be discussed later. With presently available technologies, the power-to-weight ratio α is still the figure that influences the thrust-to-weight ratio of electrically propelled space vehicles more than any other factor. Only a fraction of the heat produced by the powerplant can be transformed into electrical power.

The greater part must be absorbed by a heat-exchanging fluid, carried to a radiation cooler, and radiated into space. A large, low-temperature radiation area would be desirable from the standpoint of thermodynamic efficiency; however, a small, high-temperature radiator would lead to a smaller powerplant weight. The best size and temperature of the radiator will in any case be the result of an optimization study, which must also consider such factors as meteorite damage, corrosion effects and repair possibilities.

It may be advantageous to rotate the radiation cooler, and possibly the entire powerplant system, in order to cause the coolant to flow in the desired direction under the action of centrifugal forces. The propellant for electric propulsion systems must lend itself to easy ionization; it should have a large m/e ratio, and good storage properties. Depending on its mission, an electrically propelled space vehicle will carry an initial amount of propellant of the order of 10 to 50% of its total take-off mass.

• **Avoid feedback**—The ion motor, comprising ion source, accelerating chamber, electron emitters and beam neutralization system, will require



About the Author

Dr. Ernst Stuhlinger is director of the Research Project Laboratory, Development Operations Division, Army Ballistic Missile Agency, Huntsville, Ala. Born and educated in Germany, Dr. Stuhlinger was assistant professor of physics at Berlin Institute of Technology for five years before the outbreak of World War II. During the war, he was engaged for three years in nuclear physics research and then went into missile development at Peenemunde in 1943. He came to the U.S. in 1946 and worked on missiles at Ft. Bliss, Tex., and White Sands, N.M., until he went to Huntsville in 1950.

Air Force "Sunday Punch" ATLAS



Boosted into space by the fiery thrust of three huge rocket engines, the seven-story Atlas intercontinental ballistic missile roars upward from its Cape Canaveral launching pad. Quickly it sheds the frost encrusting the liquid oxygen tank and races to its predetermined destination in the far reaches of the globe. In its size and range and capability, the Air Force Atlas is a commentary, for all the world to heed, of the necessity to maintain the peace. RCA's Missile and Surface Radar Department has been privileged to design and develop ground check-out, launch control and cabling equipment as a major subcontractor to Convair (Astronautics) Division of General Dynamics Corporation, the Atlas prime weapons systems contractor.

RCA Tmk(s) ®

RADIO CORPORATION of AMERICA

DEFENSE ELECTRONIC PRODUCTS
CAMDEN, N. J.

Circle No. 94 on Subscriber Service Card.

limited number of ion sources . . .

more development work than any other component. The ion source should have a high efficiency close to 100%; sputtering and erosion of electrodes must be avoided; the current density, limited by space charge effects, should be at least several mA per cm^2; electrons must be injected into the ion beam to form a neutral plasma, but any backflow of electrons into the ion source must be prevented.

A large number of ion sources were developed during the past decades, but only a few of them are suitable for electric propulsion systems. The contact ionization of alkaline atoms on hot tungsten surfaces is unsurpassed by any other source with regard to simplicity, high efficiency, and long operating life. The tungsten may be replaced by other metals of large work function and high vaporization temperature. The surface may be presented by a wire or ribbon grid, a woven structure, or a porous plug. Cesium, as the heaviest non-radioactive alkaline element and the one with the lowest ionization potential, would be the best choice. Metallic cesium is still relatively expensive at present, but indications are that its price will come down as soon as the demand for larger quantities rises.

Higher ion current densities may possibly be obtained from pinched-arc sources of the "duoplasma" type proposed by M. V. Andrenne. Ions of many kinds of atoms and molecules are readily produced by this source. Before its suitability for ionic propulsion systems can be appraised, more details about ionization efficiency, cooling requirements, erosion resistance, and operating life time must be investigated.

• **Beam neutralization**—The limiting influence of space charge effects is encountered twice in an electric propulsion system. First, these effects govern the density of the current between ion source and the accelerating electrodes; and second, they restrict the flow of the jet from the accelerating electrodes out into space. The current density inside the ion source and the accelerating chamber is a function of the accelerating voltage, and of the spacing between ion source and accelerating electrode. It appears that ion current densities as high as 5 to 10 mA cm^{-2} may be obtainable.

Space charges within the outgoing ion beam would render the formation of an ionic exhaust jet impossible unless at least the greater part of the positive charges were neutralized by negative charges. The situation is somewhat relieved by the lateral dispersion of the beam, which decreases the current density. However, injection of electrons into the ion beam will be necessary.

A considerable amount of theoretical work dealing with this problem has been done recently. The results are encouraging, but experiments are still in the beginning. The electrons most probably will be injected at low speeds into the beam, and will then begin to oscillate laterally through the beam, with a longitudinal velocity component of the order of the ion velocity. One proposal suggests that expendable surfaces be exposed to part of the ion beam; when striking the surfaces under grazing incidence, each ion knocks out numerous low-energy electrons, which then mix with the beam and contribute to its neutralization. The surfaces would be renewed as they are consumed by erosion.

• **Accelerating voltage**—The optimum accelerating voltage is a function of the mission under consideration, the specific power of the powerplant, the m/e ratio of the propellant particles, and the total available power. For cesium ions, it will be of the order of 3000 to 10,000 volts. From the standpoint of a large current density in the ion source, a higher voltage would be desirable. Research workers have suggested several designs of accelerate-decelerate systems that combine a high voltage across the ion source with a relatively low ion velocty at the exit of the thrust chamber. A design of this kind would probably lend itself favorably to an integrated system of high-yield ion source, efficient ion-optical collimation of the beam, and optimized exhaust velocity of the ions.

• **Power supply**—The unlimited supply of solar power continues to intrigue space vehicle designers. It has been proven that photo cells operate satisfactorily under space conditions. However, present efficiencies are of the order of 10 to 12% and manufacturing costs are high. While a multi-megawatt solar power supply is still too bulky and too expensive to be attractive as a power source for a large electric propulsion system, a solar supply for a system of a few kw appears promising.

As a source of heat power, the fission reactor seems to be superior to the bulkier solar mirror system. Even though nuclear reactors have not yet been operated in space, no excessive difficulties are expected. The reactor would be of the "fast" type with Na, NaK, Rb, He, or A as a working fluid, and with a simple shadow shield and probably a relatively large distance between the reactor and the rest of the vehicle. Heat exchange system, turbine, generator, cooler, and pumps or compressors should form a hermetically sealed unit to minimize the danger of leakages. The most severe problem is probably that of the high-speed bearings, which must operate unattended for a total period of 1 or 2 years under space conditions.

• **Electric generator**—The thermal energy from the prime power source may be transformed into electric power by a variety of methods. Turbogenerators, thermocouples, photocells and thermionic devices are the most promising conversion systems. A gaseous thermionic generator, using cesium

ANALYTICAL ENGINEERS

career opportunities with an expanding facility in New England . . .

Requirements: BS in Mechanical Engineering or AE degree, 2-5 years experience in one or more of the following: 1) small turbo-machinery (compressor, turbines, fans) 2) lightweight heat exchangers 3) thermodynamic cycle analysis 4) air conditioning, air and vapor cycle refrigeration.

Duties: Work includes both applied theoretical and experimental analysis starting with initial design and continuing through prototype. Involves performance computation defining configurations of components and complete systems to meet specifications. Opportunity to utilize IBM 704 and 705 for complex methods of analysis.

Join a technical group whose facilities and background knowledge are unrivalled in the industry. Your talents will be employed in the development of advanced concepts, and also in internal consulting work on problems encountered by the Design and Development Engineering Groups.

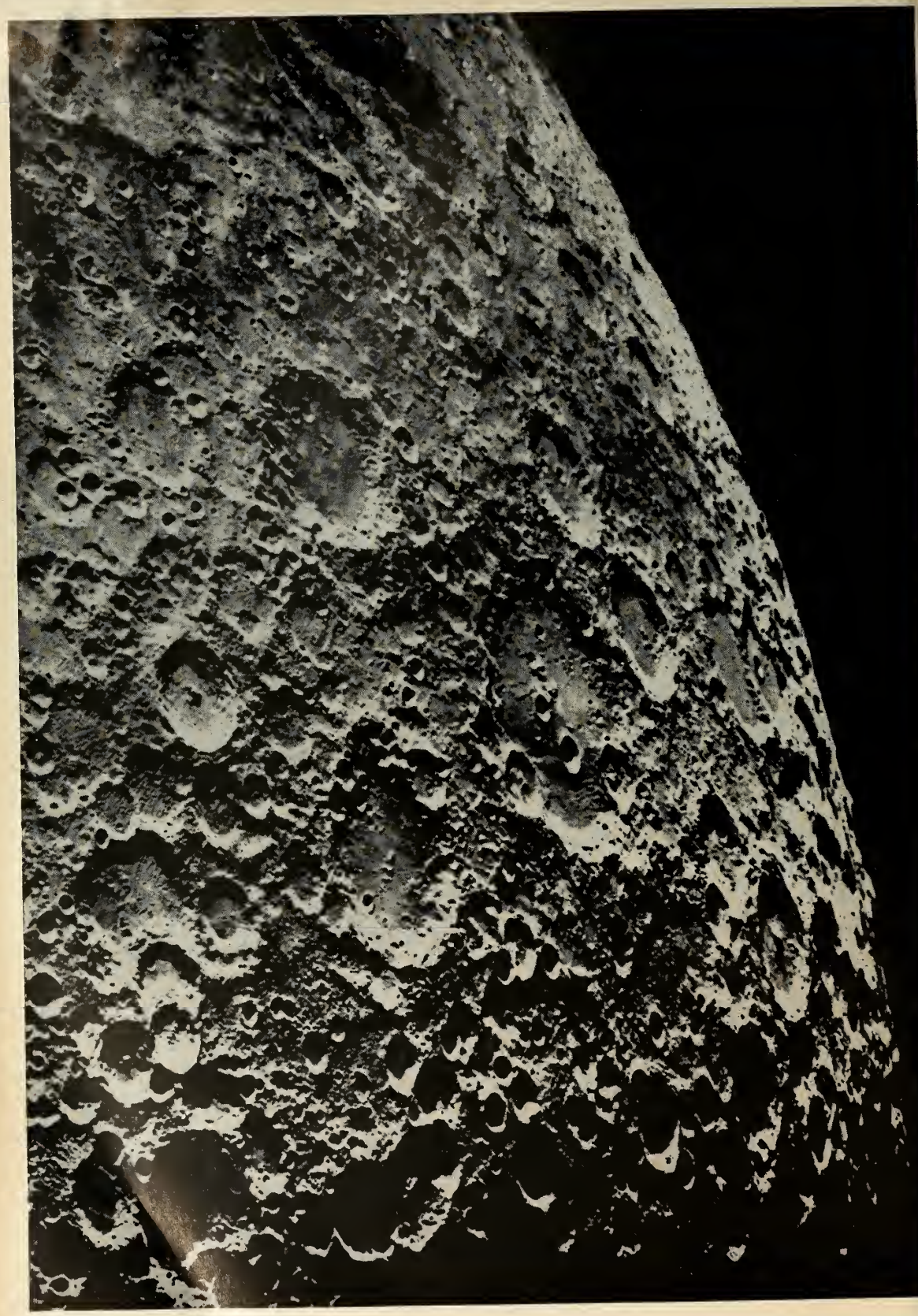
Very pleasant urban or suburban living conditions . . . opportunity for tuition-paid post graduate study . . . generous relocation allowance.

This Division of United Aircraft is now actively engaged in product diversification and development of jet aircraft equipment, ground support equipment and missile components.

Reply to Mr. A. J. Fehlber
Technical Employment Supervisor

HAMILTON STANDARD
Div. of
UNITED AIRCRAFT CORPORATION
431 Bradley Field Rd.
Windsor Locks, Conn.

Circle No. 50 on Subscriber Service Card.



THE MILITARY REQUIREMENTS FOR MOON BASE

This is the title of one of four major space proposals developed by Martin for the military and astroscientific branches of our Government. The importance of this proposal is two-fold: the inevitability of an actual moon base program by this country within the next 5 years, and; the fact that we could and can undertake such a project now—not in theory but in "hard" engineering design. For Martin's eight divisions add up to one of the top capabilities in the free world for man's first ventures in space-planetary exploration.

MARTIN
BALTIMORE·DENVER·ORLANDO

vapor between hot and cold electrodes, should theoretically yield an efficiency of 30 to 40%, but no technically useful design is available as yet. Turbogenerators may be expected to provide an overall efficiency of 12 to 15% under space conditions.

From an engineering standpoint, turbogenerators are the best-understood power-conversion systems. The generator may be an electrostatic rather than an induction type machine; since electrostatic generators must provide surfaces as compared to induction type generators which must provide volumes, the electrostatic generator will be considerably lighter. It appears that a specific power of about 0.2 kw per kg may be feasible, referring to the entire powerplant including fission reactor, heat exchanger, turbine, generator, radiation cooler, and pumps.

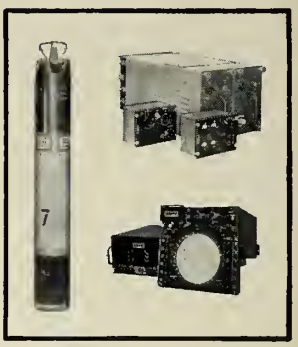
• **Lunar ferry**—Besides interplanetary space ships of a few hundred tons weight, smaller space vehicles may use electric propulsion systems to good advantage. An unmanned lunar ferry could carry 50 tons of droppable payload at a total initial weight of about 85 tons; it would cover the distance from a 300-mile earth satellite orbit to the moon in about 3 months, and the return trip in one month. The ferry could make a number of round trips before exhaustion of the nuclear power supply. The only mass to be reloaded, besides the payload, would be the relatively small amount of propellant needed for one round trip.

A small electric propulsion system of a few kw of solar power and a thrust of half an ounce might be very useful as a corrective system for satellites which must achieve orbital parameters of high precision, such as 24-hour satellites. The total velocity change to be accomplished over a period of weeks and even months would not be more than a few hundred meters per second. The thrust units could be applied to produce changes of the longitudinal, lateral, or radial velocity vectors, of the orbital plane, of the ellipticity, or of the attitude of the satellite. When the desired velocity or direction change is accomplished, the electric power will be used for communications, TV observations, or measurements.

If the transfer time is not at a premium, an unmanned heavy satellite can be transferred from a low orbit to a high orbit with an electric system. With transfer times of a few months, satellites of hundreds of tons can be spiralled into high-altitude orbits with propulsion systems that weigh, including propellant, only a small fraction of the total weight. After arrival in the new orbit, the electric power will be available for other purposes.

AN ASW SYSTEM... DISPLAY/AIRBORNE RECEIVER/SONOBUOYS

Anti-submarine warfare equipment designed, developed and produced by *The Magnavox Company*, in conjunction with the Navy Department, provides patrol aircraft with eyes that see underwater by day and by night. The AN/ASA-16 Display System, together with SONOBUOYS, AN/ARR-26 Receiver systems and other associated equipment provide aircraft with a clear picture of the ocean-depths below them. They are part of the continuing contributions of *The Magnavox Company* in aiding the U.S. Navy to combat the growing submarine menace.

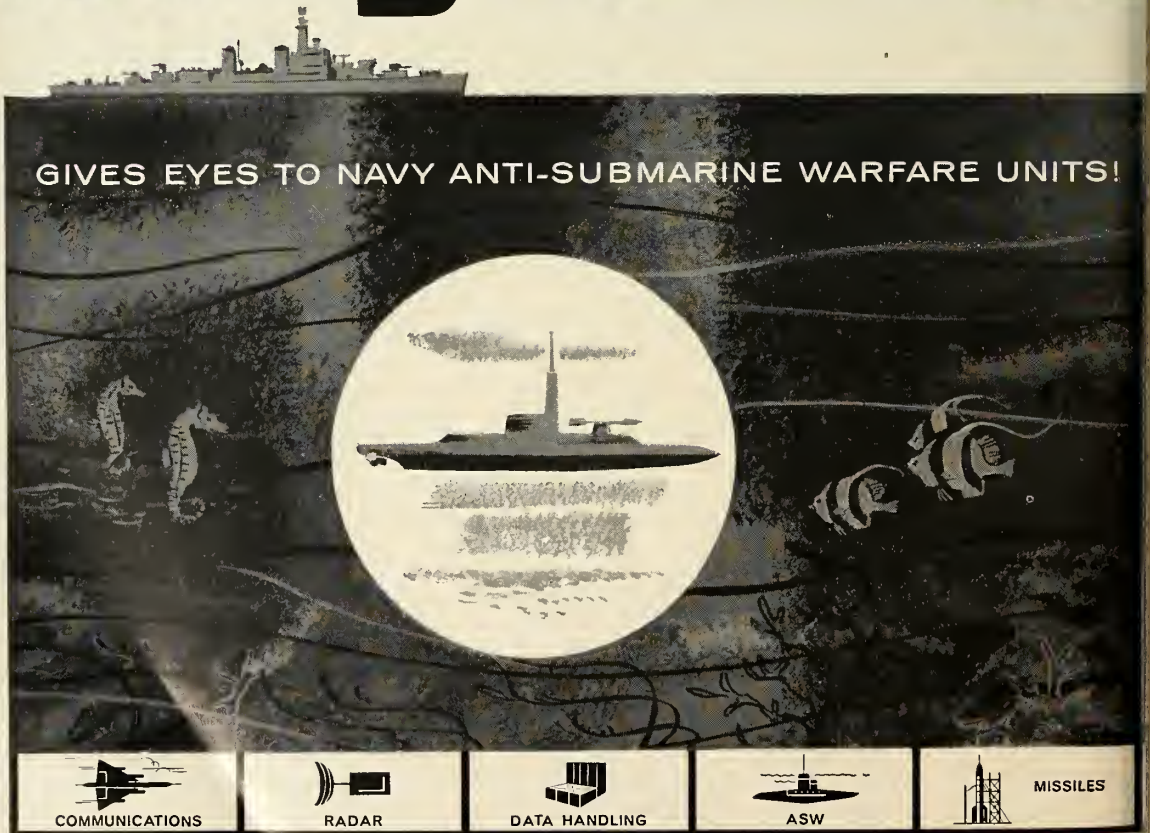


MAGNAVOX capabilities are in The Fields Of Airborne Radar, ASW, Communications, Navigation Equipments, Fusing and Data Handling . . . your inquiries are invited.

PRODUCTS THAT SEE BY THEMSELVES



Magnavox



THE MAGNAVOX CO. • DEPT. 89 • *Government and Industrial Division* • FORT WAYNE, IND.

Circle No. 43 on Subscriber Service Card.

Convair Has 'Advanced' *Terrier* in Production

POMONA, CALIF.—An advanced version of the *Terrier* surface-to-air guided missile is in production at **Convair (Pomona) Division** of **General Dynamics Corporation.**

The weapon—according to Convair—has vastly improved performance compared with the original *Terrier*, which has been operational with the Navy since January, 1956.

Under present shipbuilding programs, the advanced *Terrier* missile will become a major element in the Navy missile arsenal. The USS Dewey, a guided missile frigate to be commissioned late this year, will be the first ship to be armed with the advanced *Terrier*.

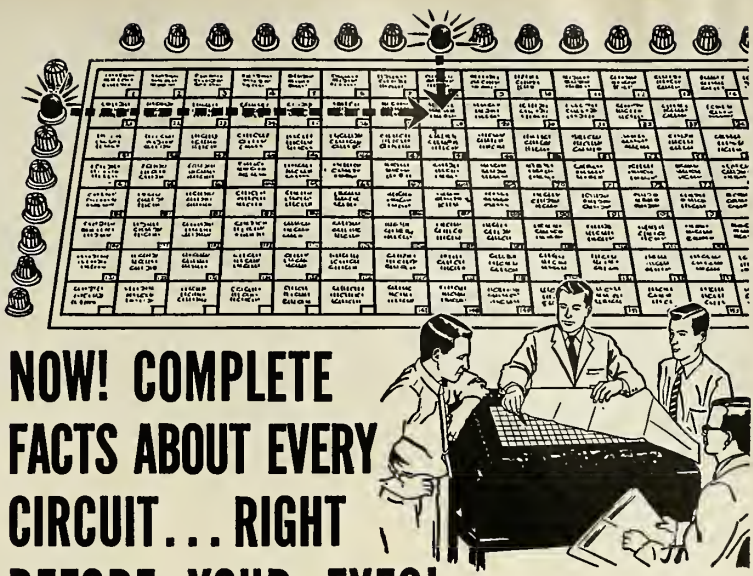
The nuclear-powered aircraft carrier USS Enterprise, as well as two conventional carriers, three guided missile cruisers and 18 more guided missile frigates also will be equipped with the new missile. Eventually the advanced *Terrier* also will be installed in the nuclear-powered guided missile cruiser Long Beach and the nuclear-powered guided missile frigate Bainbridge.

Like its predecessor, the advanced *Terrier* will be used from mobile ground launchers for the antiaircraft protection of U.S. Marine Corps detachments on land.

The advanced *Terrier* will be able to intercept any present-day supersonic bomber many miles from its intended target, Convair said. Like the original *Terrier*, the weapon is a supersonic missile powered by two stages of solid-fuel rockets. The first stage, a separate booster rocket, supplies high thrust for a short period to launch and accelerates the missile to supersonic velocity.

After the booster fuel is expended, the empty booster case falls away and the second-stage rocket ignites. The second stage is part of the missile proper and maintains the velocity required to match any evasive maneuver the target aircraft might take.

Guidance and control systems for the advanced *Terrier* were designed and are manufactured by Convair under the technical direction of the Applied Physics Laboratory of Johns Hopkins University, Silver Spring, Md. Propulsion work for the missile is done by **Allegany Ballistics Laboratory,** Cumberland, Md. The fuze was designed by the Naval Ordnance Laboratory, Corona, Calif., and the warhead by the Naval Ordnance Laboratory, White Oak, Md.



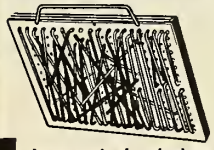
NOW! COMPLETE FACTS ABOUT EVERY CIRCUIT... RIGHT BEFORE YOUR EYES!

DIT-MCO FAULT LOCATION CIRCUIT ANALYZER AUTOMATICALLY PLOTS TEST SEQUENCE... PINPOINTS, IDENTIFIES AND PATTERNS CIRCUIT ERRORS.

DIT-MCO's exclusive cross-reference Motrix Chart outamaticolly pinpoints each circuit flow ond puts cleor, concise test infarmatian directly in frant of the operatar! Horizantol ond verticol indicotor lights cross-reference an the motrix square carresponding to the circuit under test. This square details type of flaw, circuit number ond exact error locotion. Once on error is detected, the operator immediately marks it on the motrix squore, resets the Universal Automotic Circuit Analyzer and cantinues the test.

All corrections ore made direct fram the Matrix Chort ofter the test sequence has been completed. This soves up to 90% correctian time by eliminating time consuming searches through diagroms, manuols or interpretive reodout devices. Because the DIT-MCO Motrix Chort is o simple, concise representatian af all test circuits, specifications, instructions and modifications, *nathing* is left to chance or guesswork! The comprehensive nature of the Motrix Chort system provides important data for statistical anolysis ond permits *effective* checks and balances ... from the drafting boord to obsolescence!

DIT-MCO, Inc. employs on experienced staff of soles engineers in the field. Contact your field engineer or write for important facts about DIT-MCO Electricol Test Equipment.



PLUGBOARD PROGRAMMING MEANS EFFICIENT TESTING!

Jumper-wired plugboard programming utilizes simple, straight-forward adapter cables. Circuit modification problems vanish because all changes are easily made by re-jumpering the readily accessible plugboards.

DIT-MCO, INC.

ELECTRONICS DIVISION • BOX 07-28
911 BROADWAY • KANSAS CITY, MO.

Partial List of DIT-MCO Users

Aircraft Radio Corp. ● AiResearch Manufacturing Co. ● American Bosch Arma Corp. ● American Machine & Foundry Co. ● American Motors ● Amphenol Electronics Corp. ● Autonetics, A Division of North American Aviation, Inc. ● Bell Aircraft Corp. ● Bendix Aviation Corp. ● Boeing Airplane Co. ● Cessna Aircraft Co. ● Chance Vought Aircraft, Inc. ● Chrysler Corp. ● Convair ● Douglas Aircraft Co., Inc. ● Dukane Corp. ● Electronic Products Corp. ● Fairchild Aircraft Division ● Farnsworth Electronics Co. ● Frankford Arsenal ● General Electric Co. ● General Mills, Inc., Mechanical Division ● General Precision Laboratory, Inc. ● Goodyear Aircraft Corp. ● Grumman Aircraft Engineering Corp. ● Hazeltine Electronics Division, Hazeltine Corp. ● Hughes Aircraft ● International Business Machines Corp. ● Jeffersan Electronic Products Corp. ● Lockheed Aircraft Corp., Missile Systems Division ● Martin, Baltimore ● Minneapolis-Haneywell, Aeronautical Division ● Motorola, Inc. ● Northrup Aircraft, Inc. ● Pacific Mercury Television Mfg. Corp. ● Radio Corp. af America ● Radioplane Co. ● Raytheon Manufacturing Co. ● Servomechanisms, Inc. ● Sikorsky Aircraft ● Sperry Gyroscope Co. ● Summers Gyroscope Co. ● Sun Electric Co. ● The Swartwout Co., Autronic Division ● Temco Aircraft Corp. ● Thompson Products ● Topp Industries Inc. ● Trans World Airlines ● U. S. Naval Air Station Overhaul and Repair Depots ● U. S. Naval Ordnance Laboratory, White Oak ● Vertol Aircraft Corp. ● Western Electric Co. ● Westinghouse Electric Corp.

Circle No. 51 on Subscriber Service Card.

Heat Continues as Major Problem

Broad environmental criteria points up need for comprehensive materials R&D program. Here are the current research areas

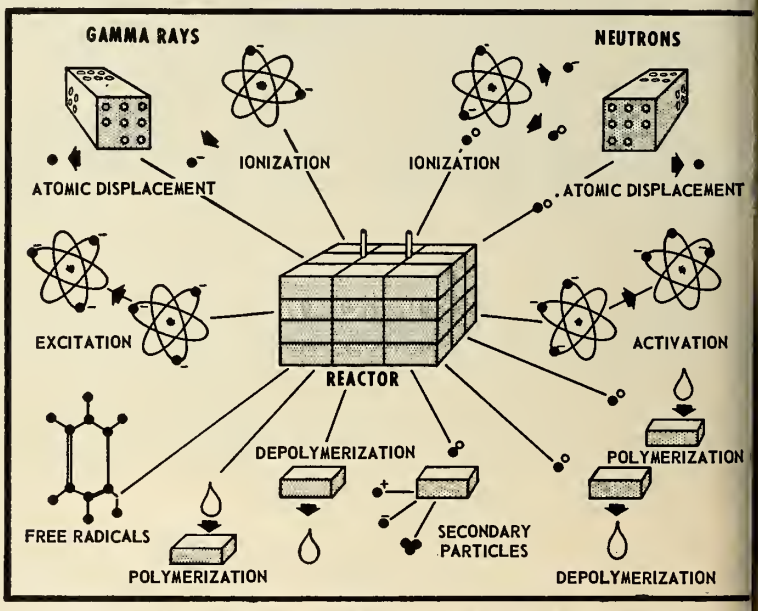
by
Lt. Col. Frederick C. Krug, USAF

WASHINGTON—The materials of which components of an aerospace vehicle are made and joined together are a common denominator basic to a successful weapon system.

Through the years, military departments have leaned heavily on civilian development of better materials from which new and improved equipment could be built. The need for such materials has increased rapidly during the past decade. We in the USAF have made known our requirements to the industrial and scientific communities. They have responded magnificently. One need only pick up and glance quickly through any recent trade or scientific journal to find hundreds of new materials announcements. To mention but a few at random—graphite cloth, energy conversion materials, extremely low thermal conductivity insulation, super-strength titanium alloys, ultra-high strength steels, very wide steel sheet, high-energy fuels, available rare metals with a wide range of properties, beryllium shapes, precipitation hardening stainless steels, sintered aluminum products, magnesium rare-earth alloys, flame-sprayed coating, ablation plastics; glass fibers with high modulus of elasticity and multi-directional magnetic steels. Yet in spite of such splendid advancements, materials problems continue to plague aeronautical vehicle designers.

• **Severe demands**—Contemplated weapon systems are placing these severe demands upon the basic materials of construction. These systems may be conveniently grouped into three broad classes:

a. Hypersonic Strategic Weapons
b. Ballistic Weapons
c. Satellite Weapons



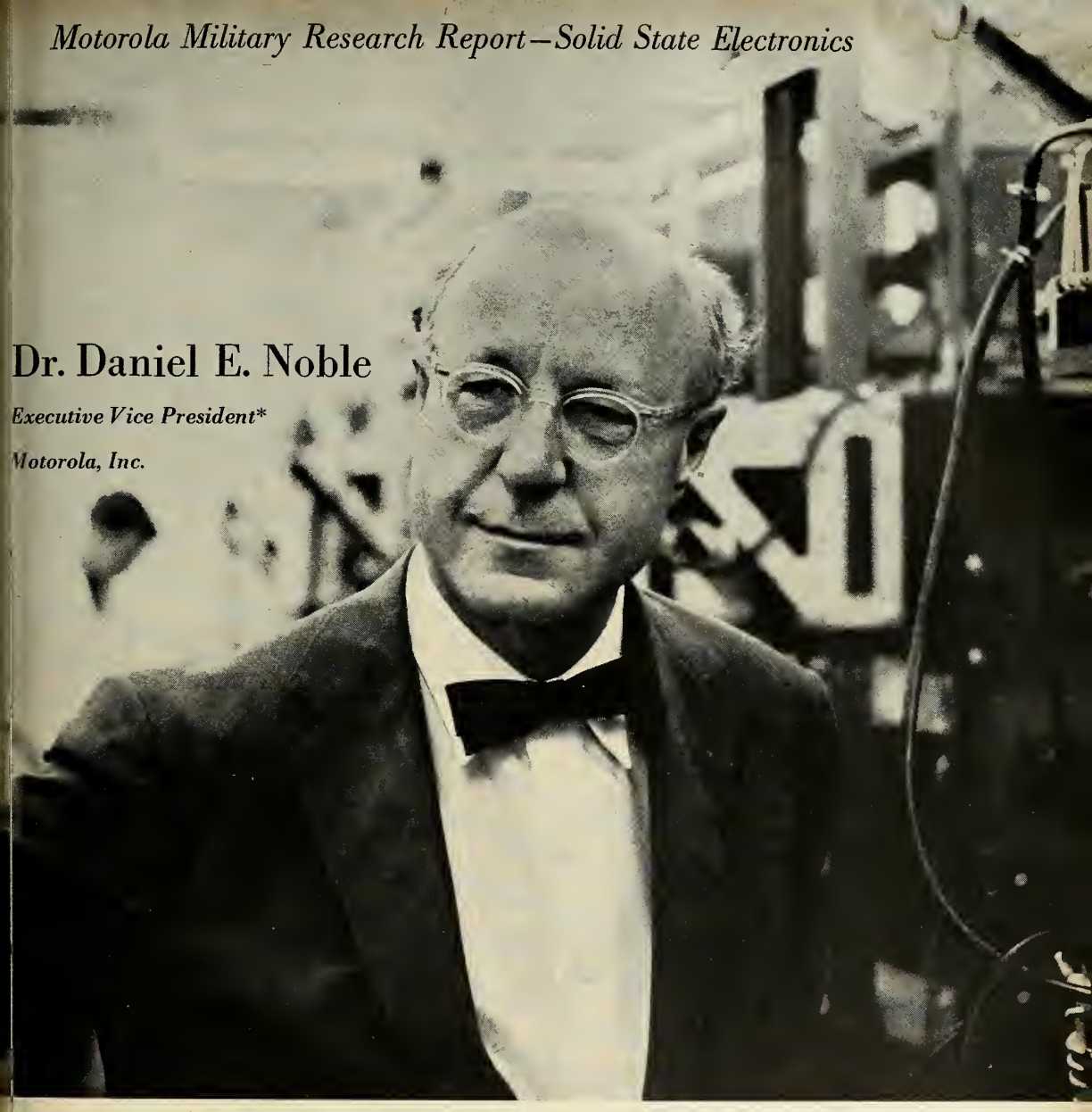
SOME OF the reactions that occur when materials are exposed to gamma rays an fast neutrons. Generally, the result is increase in strength.

Capabilities of High-Temperature Materials

ALLOY BASE	MELTING POINT, °F	RECRYSTALLIZATION TEMP. °F	$\frac{T_{RT}}{T_{MP}}$ (°R)	$X=\frac{T_{100hr\text{-}20,000\ PSI}}{T_{MP}}$	ESTIMATED CAPABILITY BASED ON X=0.7in°F
NICKEL	2651	1110	0.51	0.73	
COBALT	2723			0.70	
IRON	1670*	840	0.62	0.82	
NIOBIUM	4474	1800	0.46		2990
MOLY.	4752	2066	0.48		3190
TANTALUM	5425	2327	0.48		3660
TUNGSTEN	6143	2849	0.50		4170

*= α TO γ TRANSFORMATION

Figure 1



Dr. Daniel E. Noble

*Executive Vice President**

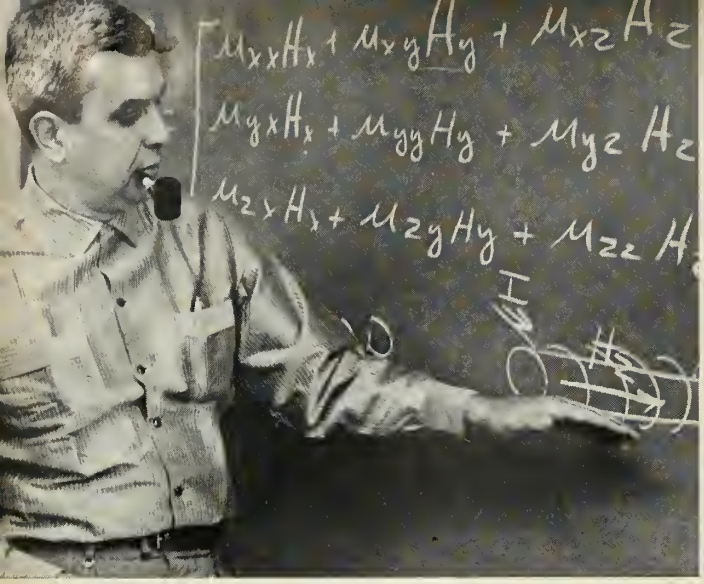
Motorola, Inc.

*DR. NOBLE IS VICE PRESIDENT IN CHARGE OF THE COMMUNICATIONS AND INDUSTRIAL ELECTRONICS DIVISION, THE SEMICONDUCTOR PRODUCTS DIVISION AND THE MILITARY ELECTRONICS DIVISION OF MOTOROLA, INC.

"In this new era, Solid State Electronics will spread its influence to every form of human endeavor and will contribute substantially to scientific achievement in all fields."

Dan Noble

PLEASE TURN PAGE

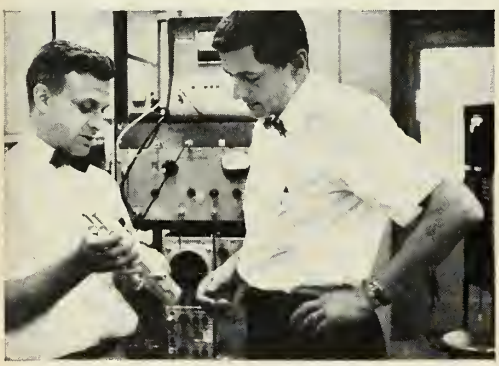


Ferrimagnetic principles are demonstrated by scien tist in charge of Motorola's Solid State progran Dr. H. William Welch, Jr., director of researcl and development, Military Electronics Divisior Dr. Welch as a University of Michigan professo established that school's Solid State laboratory an introduced new curricula in Solid State devices an their applications. He holds an I.R.E. Fellow Awar for contributions to development of solid state device and microwave tubes.



Typical of solid state materials now being offered sale by Motorola are these ferrite rods and bars be examined by Donald L. Fresh, manager of the So State Materials Laboratory.

John C. Cacheris, right, manager of the Microwave Applications Laboratory, and a member of his staff inspect a parametric amplifier, one of several devices now being produced by Motorola's Solid State Dept.



Imaginative leadership plus the most modern of laboratory facili have helped foster a creative environment that is attracting top tal to Motorola. Here, Dr. Arthur L. Aden, associate director of resea and development for Motorola's Military Electronics Division, sh a new member of his staff equipment for photographing printed cuits. Dr. Aden welcomes inquiries from qualified engineers and ph cists who would like to join his department.



James R. Black, manager of Motorola Microelectronics Laboratory, heads work which leads toward the mass production of economical microelectronic components so small that several would fit on the period that ends this sentence.



How Solid State Electronics is shaping the future

MILITARY ELECTRONICS—industry as well—is being radically changed by rapid advances in solid state technology. Predicted for the near future are computers small enough to fit in the palm of a hand, receivers that will detect the weakest signals from distant satellites.

Motorola's highly experienced Solid State Department, in close cooperation with the Semiconductor Products Division, is advancing the state of the art on several fronts, one of the most promising of which is microelectronics.

By making use of crystalline functional circuit elements created in volume quantities by surface etching or film deposition methods, Motorola researchers anticipate they will soon be able to design equipment with component densities of tens of millions per cubic foot.

This high density will result in a great reduction in systems and computer size coupled with a significant increase in reliability, and it will lead to the development of self organizing computers for such complex tasks as the solution of military logistics problems and space guidance.

In microelectronics and in other areas, Motorola scientists, including those of the Semiconductor Division, are investigating the ferroelectrical, ferrimagnetic, piezoelectrical and pyroelectrical characteristics of monocrystalline and polycrystalline solids. New materials possessing these useful characteristics are created and produced in the Materials Laboratory. Typical applications: newly developed ferroelectrical or piezoelectrical materials to be used in transducers for submarine detection.

At present, the Applications Laboratory is making extensive use of ferrites and semiconductors in the development of broad lines of isolators, circulators and parametric amplifiers. The latter device has already demonstrated its worth in satellite-tracking radars, IGY research receivers, uhf television receivers and radio. In the study and design stage are new and advanced ferrimagnetic devices such as microwave switches, ferrimagnetic limiters and semiconductor switches.

Still another research frontier where striking preliminary results have been achieved is a low-voltage facsimile paper for the transmission of teletype and other information. Applications in the fields of combat surveillance, logistics control and other important military programs are foreseen.

Military Electronics Division's expanding capability in solid state electronics is described in a new booklet entitled: "Solid State Frontiers at Motorola." *Request your copy from Technical Data Service, Motorola, Inc., Military Electronics Division, 8201 East McDowell Road, Scottsdale, Arizona.*

MOTOROLA

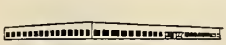
Military Electronics Division / CHICAGO • PHOENIX • RIVERSIDE

Engineers and Physicists interested in career opportunities are invited to write: Motorola, Inc., Military Electronics Division



1450 NORTH CICERO AVENUE
CHICAGO 51, ILLINOIS





8201 EAST McDOWELL ROAD
SCOTTSDALE, ARIZONA





8330 INDIANA AVENUE
RIVERSIDE, CALIFORNIA



A-97-6

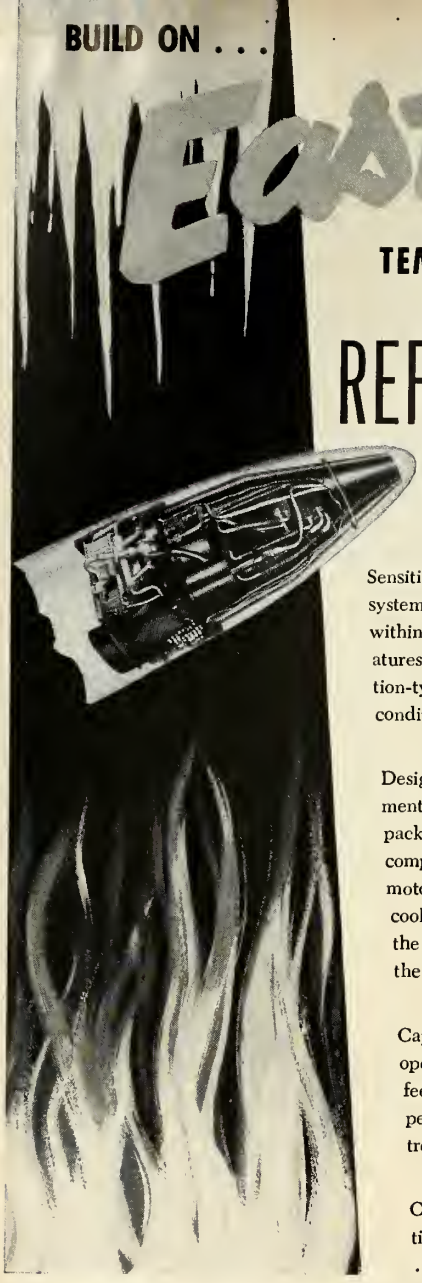
Circle No. 45 on Subscriber Service Card.

BUILD ON . . .

Eastern

TEMPERATURE CONTROL EXPERIENCE

REFRIGERATION COOLING

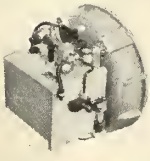


Sensitive aircraft and missile components and systems often require temperature control within close limits — while ambient temperatures fluctuate widely. Eastern refrigeration-type cooling systems are ideal for such conditions.

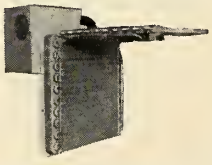
Designed for the strictest military requirements, these vapor-cycle closed-system packages are built around a highly efficient compressor powered by a special 400-cycle motor. Unique condensing and special cooling methods are called upon to meet the most unusual operating requirements, the most demanding specifications.

Capacities range from 100 to 6000 watts; operating altitudes extend to 100,000 feet. Some units, of the "boil-off" type, perform almost without regard for extremes in altitude and temperature.

Call on Eastern for imaginative solutions to *all* avionic cooling problems . . . and write for new Bulletin 360.







other refrigeration units for aircraft and missile electronics



EASTERN INDUSTRIES INCORPORATED
100 SKIFF STREET
HAMDEN 14, CONN.

Eastern AVIATION PRODUCTS

Circle No. 52 on Subscriber Service Card.

As indicated, heat continues as the major environmental problem. High speed re-entry of ballistic and satellite vehicles will require materials capable of retaining structural integrity under heat fluxes of thousands of BTU/sq ft-sec. for possibly several minutes duration. Moderately stressed structures and propulsion systems employed in satellites will require materials whose properties must remain stable for many thousands of hours.

These broad environmental criteria point up the direction for a comprehensive materials research and development program. In addition to the operational high-temperature and long-life requirements, these problem areas include weight reduction, operation within a nuclear and cosmic environment, fatigue, reliability, and availability.

Speaking at the October, 1958, Joint Army-Navy-Air Force Conference on Elastomer R&D, J. R. Townsend, Special Assistant to the Department of Defense Director for Research and Engineering, stated:

"The persistent unreliability of some of our missile systems points to the dearth of materials with good properties in these extreme environments . . . To build reliability into these systems we must develop better materials in the laboratory, convert the laboratory product into a material of controlled properties capable of being shaped, and then design and manufacture the components to exploit fully the advanced properties of the new material."

In addition to the examples cited by Townsend, we can add such immediate problems as the short life of rocket nozzles, the failure of thin-shelled rocket cases, the incompatibility of seals and hoses with various high-energy fuels, and the exorbitant weight

About the Author



Lt. Col. Frederick C. Krug is chief of the Metals and Ceramics Section, Materials Branch, Air Research and Development Command at Washington, D.C. A graduate of Pennsylvania State College, he has been an Air Force officer since 1943.

He has been a weather officer, a liaison officer and, since 1950, a specialist in metallurgy. He has been an Air Force member of the DOD Critical Materials Conservation Committee and the NACA subcommittee on Aircraft Structural Materials. Lt. Col. Krug has headed the Metals and Ceramics Section since 1955.

of nuclear shielding materials.

Therefore, the prime objective of the Air Research and Development Command's applied research program in materials is to provide the leadership necessary to extend significantly the useful range of application of aeronautical materials. The program includes metals, plastics and other synthetics, coatings and coating techniques, and unique methods for developing new materials.

• **Refractory metals**—New metallic materials are required to meet the needs of rocket and hypersonic airframe designers. This is primarily because of severe temperature extremes extending from below –400°F to over 5000°F. The super-alloys composed of such elements as nickel and cobalt give satisfactory long-time service (hours) to near 1700°F; but at temperatures over 2000°F, only several minutes of useful life can be expected. A class of metals known as the *refractory metals* holds potential for greatly extending this temperature limitation.

Four of these refractory metals are shown in Figure 1. Nickel, cobalt, and iron are included for comparative purposes. All have melting points exceeding 4400°F. The potential useful temperature of these metals has been estimated and is shown in the last column. Unfortunately, these refractory metals are subject to severe oxidation at elevated temperature and are brittle. Much research is needed to overcome these problems.

• **Coating techniques**—One approach to the oxidation problem of refractory metals is through the use of protective coatings, which must be impervious, resistant to thermal shock, and capable of withstanding a highly corrosive and erosive environment. The technique of applying such coatings is highly significant since uniformity and adhesion are particularly important.

The flame spray technique, which uses an arc plasma jet, is considered by many to be an outstanding metallurgical achievement of 1958. The temperature generated by an arc jet is so intense (15,000°F) that it can vaporize all known materials. Selected materials can thus be condensed as a coating on the component requiring protection. The potential of this arc plasma jet coating technique has yet to be fully exploited. With further development, for example, protection of nose cones and hypersonic leading edges may be greatly facilitated.

A direct development from the Air Force's program has been the "troweled" coating technique. By this procedure, heat-insulating coatings are laid up by hand-troweling of the ceramic material over a steel wire reinforcement.

Engineers

NES cordially invites your confidential inquiries regarding the many new professional positions that have been created by the continued growth of a number of its principal clients.—

NES IS RETAINED AS AN ENGINEERING STAFFING CONSULTANT BY HUNDREDS OF A TO AAAA FIRMS, TO ASSIST THEM IN FINDING TECHNICAL AND TECHNICAL MANAGEMENT PERSONNEL OF OUTSTANDING PROFESSIONAL COMPETENCE. NES IS PAID FOR ITS CONSULTING SERVICES BY THE ORGANIZATION IT SERVES. IT RECEIVES NO REMUNERATION FROM THE CANDIDATES.

There are openings far engineering managers and far systems, projects, and development and design engineers, both electrical and mechanical. Opportunities are available in radar, displays, receivers, transmitters, micrawave, analog devices, digital devices, servas, computation, IF devices and data reductian.

ASK FOR

MR. E. F. MISCHLER
(SR. MEMBER IRE)

MR. D. D. SEGAL
(MEMBER AIEE)

or send resume to

National Engineering Service *a division of* NESINC

ENGINEERING EXECUTIVE SEARCH ENGINEERING STAFFING

1108 16th ST. N.W., WASHINGTON, D.C. EX. 3-7065

Circle No. 53 on Subscriber Service Card.

high-energy fuel briefs from Callery

Callery opens office in Los Angeles—Fuel and propellant users on the West Coast can now contact Dr. Robert G. Brault, Callery's Manager, Western District, for helpful technical service. He has opened an office at 3141 Century Boulevard, Inglewood, California. Telephone: ORegon 8-9382. Dr. Brault was formerly Research Coordinator of the Project Zip high-energy fuel program at Callery's R & D Laboratories.

Diborane as fuel for rockets, ramjets, and turbojets—With a heat of combustion of 31,300 Btu/lb. and extremely good combustion properties, Diborane is an attractive fuel for air-breathing engines. Diborane, a gas at standard conditions, can easily be liquified (boiling point –134°F). With modern insulating methods, it should be storable for long periods. Its specific gravity at a temperature slightly above its melting point (–265°F) is 0.56, so that it contains more Btu/gallon than JP fuels. Diborane has excellent heat-sink capabilities.

Recent calculations, based on the most recent thermodynamic data, show Diborane-LOX to have an I_{sp} of 349 sec. (1000/14.7 psia, shifting equilibrium). With its higher density and boiling point, it may be superior to hydrogen for some applications. Diborane will soon be available in tonnage quantities. Write for Technical Bulletin C-020 for detailed information.

HiCal® fuel now available—Since Callery's production of HiCal, high-energy fuel, will exceed immediate military test-program requirements for the next few months, substantial quantities of HiCal-3 are now available for authorized users with suitable security clearance. If you have been waiting to test HiCal-3 in engines or components, write now for specific information. Our HiCal-3 Handling Bulletin C-1100 is available on request.

New specific-impulse calculations—Specific-impulse data for several combinations of boron-containing fuels with various oxidizers have recently been calculated and tabulated. Most of these data are confidential, but Callery representatives would be pleased to discuss them with you on a classified basis.

Fire-fighting films on HiCal and pyrophoric fuels—The HiCal film shows the relative ease and safety with which a stable mechanical-foam blanket can extinguish burning HiCal fuels. Another 15-minute film illustrates the techniques available for combating fires of Trialkyl Boranes.

For information or loan of films, write to Defense Products Dept., Callery Chemical Company, 9600 Perry Highway, Pittsburgh 37, Pa.



CALLERY

CALLERY CHEMICAL COMPANY

9600 PERRY HIGHWAY PITTSBURGH 37, PENNSYLVANIA

Dr. Robert G. Brault
Manager
Western District
Callery Chemical Company

Circle No. 54 on Subscriber Service Card.

The Air Research and Development Command is very much interested in coating development for oxidation and erosion protection of the refractory metals and graphites up to and beyond 5000°F.

• **Thermal protection**—As mentioned earlier, the Air Force has requirements for both long- and short-time thermal protection techniques. An example of the long-time requirement is the leading edge of a hypersonic system such as a boost glide vehicle. The short-time requirement is represented by ballistic nose cone and satellite re-entry. The refractory alloys hold promise for satisfying the leading edge and hot-spot structural problems of boost glide systems. However, much development combined with application studies are needed. Oxidation protection coatings will be required and a high degree of thermal shock resistance will be needed in the refractory bodies. At the present time, the potentially useful materials all appear to have limitations. These include low strength above 2500°F, lack of protective coating development, and lack of fabrication experience. Much work is required to overcome these deficiencies.

Designers and developers of nose cones for high-speed re-entry of the earth's atmosphere have been faced with one of this decade's most challenging technical problems. Obviously some sort of a protective shield is required. Fundamental to a solution is complete thermophysical materials property data. Lack of such data continues as one of the major limitations to design and development of Air Force weapons.

Based on the data available, several thermal systems show promise for applications in such an extreme heat flux environment; for example, systems based on the heat sink or ablation characteristics of materials. Comparatively, ablative materials consume up to 20 times as much heat per pound of material as can be absorbed by heat sink materials. An ablating system is depicted in Figure 2. As the material is exposed to progressively higher temperatures, large quantities of heat are consumed in the phase transformations that take place.

• **Beryllium materials**—Beryllium has many outstanding properties that make it an exceedingly attractive air weapon material. The element with atomic number 4, it is lighter than aluminum yet stiffer than steel. It is one of the best heat sink materials known. One of the most promising applications for beryllium is in guidance systems, which require a very light and strong material, dimensionally stable over a wide temperature range. Beryllium has provided the answer at a significant increase in

performance as well as weight savings over its steel predecessor.

As an example of weight savings, a 13-lb. beryllium nose cone has the same heat sink capability as a copper cone weighing nearly 100 lb. Beryllium, or some beryllium compounds, offer potential as leading edge material for weapons exposed to severe aerodynamic heating.

Why, then, hasn't this potential of beryllium been exploited? The metal has been avoided because of its brittleness, scarcity, cost and toxicity. Adequate and effective techniques for joining (welding, brazing, etc.) have also been lacking. The Air Force is currently sponsoring development of beryllium alloys and fabrication techniques. With successful development of a ductile beryllium alloy or composite, a superior material will be available for many specialized applications. Furthermore, because of this metal's exceptional strength-to-weight ratio, it should find application in satellite and space weapons in which weight savings are vital.

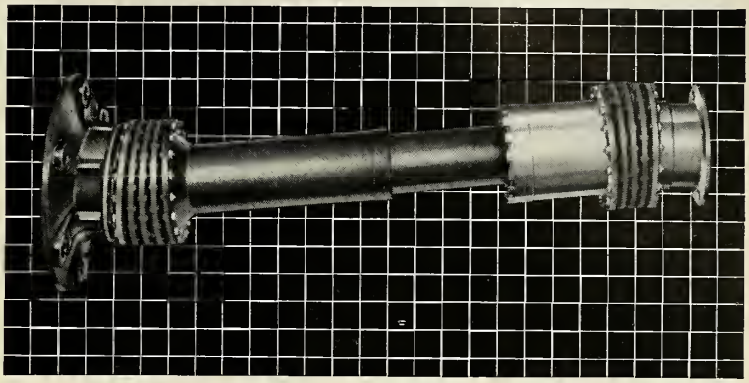
• **Plastic materials**—Plastics have solved many Air Force problems. Their substitution for glass in aircraft gave significant weight savings; they contributed outstandingly to airborne radar. These uses are dwarfed by the potential of plastics in future weapons.

Plastics are practical as nose-cone material because of their outstanding ablation characteristics. In a simulated re-entry environment such as rocket blast or the plasma arc, reinforced plastic materials have shown superior performance to ceramics and high-temperature metals. While the original polyester plastics were limited to structural applications below 200°F, the development of heat-resistant silicone and phenolic resins has extended the maximum long-time operating temperature to 700-800°F. This temperature capability combined with the excellent strength-to-weight properties of plastics have provided the weapon designer with a highly versatile structural material from which rocket chambers, pressure vessels, and sandwich structures can be built.

Future Air Force weapons will need plastics with significantly extended strength and temperature ranges. For example, for rocket thrust chambers the present strength-to-weight ratio of reinforced plastics should be doubled.

• **Emissivity coatings**—Many Air Force weapons of the future will not enjoy the natural protection of the earth's atmosphere and will be exposed to the total radiant energy of the sun. Temperature control of such vehicles will be highly dependent upon the materials of construction. The balance reached between absorbed solar energy

BENDIX FLEXIBLE POWER DRIVE SHAFT SOLVES MISALIGNMENT PROBLEM



POSSIBLE IN-USE DEFLECTION of a *Model 19E29-3 Flexible Drive Shaft. This standard 20-inch-long unit weighs 12 pounds, is rated 42.5 h.p. at 2800 RPM to 11,000 RPM, and includes a torque limiting clutch.*

Transmission of power to accessories mounted remotely from aircraft engines is no problem when one of Bendix Utica's flexible drive shafts is used.

High speeds are possible . . . because of symmetrical shaft design. Two constant velocity ratio flexible joints, made up of high alloy steel diaphragms, permit up to plus or minus 10° intermittent deflection and plus or minus 5° continuous deflection while maintaining rotational balance in the shaft at any speed.

High operating temperatures won't affect efficiency of a Bendix Utica shaft. Unique joint design permits continual operation at maximum speed, at any temperature up to 600° F.

No lubrication is required for flexible torque carrying members. The flexing diaphragms transmit load, with no rubbing or sliding surfaces. They generate no frictional wear and little heat, resulting in long shaft service life.

We can solve virtually any power take-off problem using one of our standard or special design flexible shafts. Special designs can be engineered for unusual applications involving almost any degree of misalignment and power speed requirements.

A mechanical disconnect can be provided integral with the shaft to disconnect driven accessories from the driving source.

No matter what your aircraft power transmission problem, you'll get the best answer to it from Bendix Utica.

OTHER PRODUCTS MANUFACTURED BY BENDIX UTICA FOR THE AIRCRAFT INDUSTRY

- Air Turbine Driven Accessories
- Air Conditioning Systems and Components
- Air Pressurization and Ice Eliminotion Equipment
- Engine Starting Equipment
- Geor Boxes
- High Pressure Fibre Glass Bottles
- Speciol Test and Ground Handling Equipment
- Variable Displacement Hydroulic Pumps

plus Technicol Publications ond Service Schools

West Coast: 117 E. Providencia, Burbank, California
Canada: Aviation Electric, Ltd., 200 Laurentien Blvd., Montreal, Quebec
Export Sales and Service: Bendix International, 205 E. 42nd Street, New York 17, N. Y.

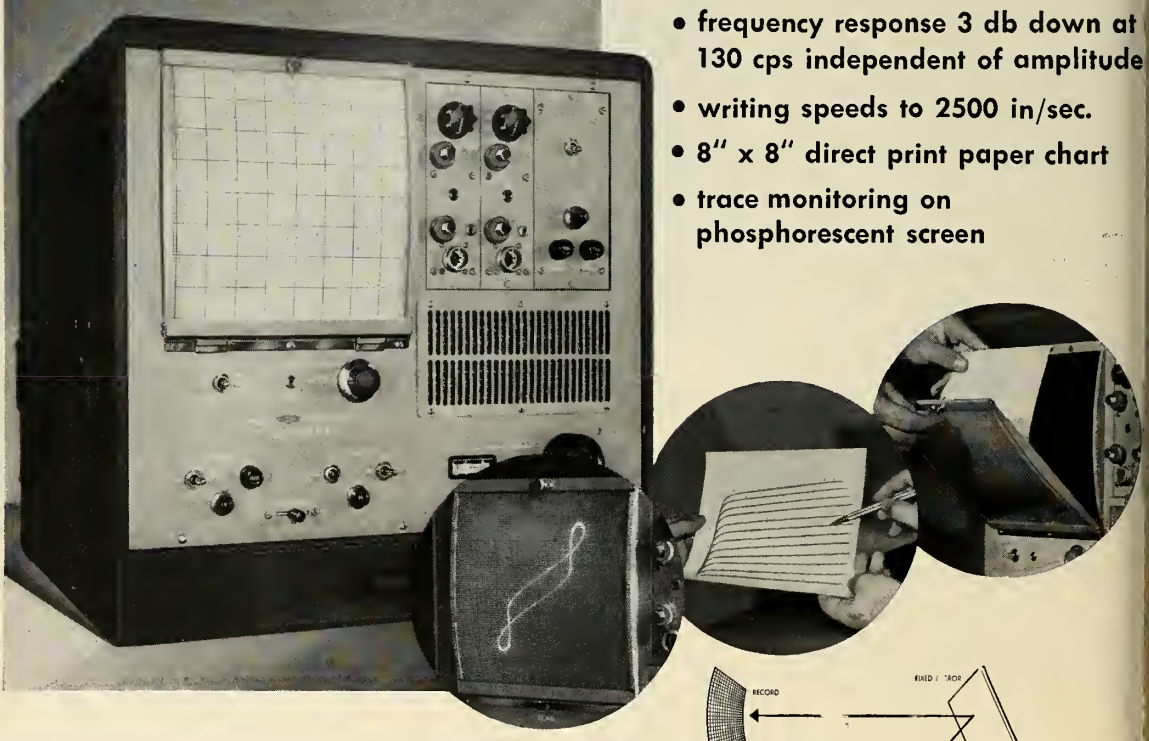
Bendix Utica Division
UTICA, NEW YORK

Bendix AVIATION CORPORATION

Circle No. 55 on Subscriber Service Card.

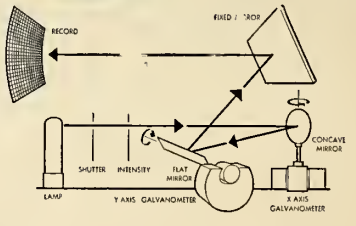
100 CPS X-Y RECORDING

with immediate readout



THE NEW SANBORN MODEL 670 OPTICAL X-Y RECORDER HAS

- 1% linearity
- frequency response 3 db down at 130 cps independent of amplitude
- writing speeds to 2500 in/sec.
- 8" x 8" direct print paper chart
- trace monitoring on phosphorescent screen



X-Y RECORDING never before possible with electro-mechanical instruments can now be done with the new Sanborn Model 670 X-Y Recorder. Direct writing on ultraviolet-sensitive recording paper by a beam deflected by optical galvanometers makes possible the combination of fast writing speed and 130 cps frequency response not found in any other X-Y recorder. Transistor characteristics, acceleration and vibration of mechanical parts and events of similar short duration can be recorded with linearity of *1% of full-scale* and at trace speeds as fast as *2500 inches per second*. Square wave response exhibits no greater than ½% overshoot *at any amplitude;* sensitivities as high as 62.5 uv/inch (depending on preamplifier used).

PLOTS OCCUPY AN 8" x 8" RECORDING AREA and can be previewed or monitored on the instrument's phosphorescent screen. An Axis Record switch to print X and Y axes on the record, and a Beam Intensity Control to assure maximum trace clarity, are among the front panel controls provided. An 8" x 8" sheet of the ultraviolet-sensitive chart paper (stored in drawer at base of cabinet) is easily placed on the back of the hinged screen. Brief post exposure in normal room light is the only developing process.

OPTIONAL INTERCHANGEABLE PREAMPLIFIERS for each axis presently include the Model 850-1300B DC Coupling and Model 850-1200 Phase Sensitive Demodulator; a Carrier Preamplifier, High Gain Preamplifier and a time base generator are now in development. Driver Amplifiers are compact, fully transistorized plug-in units with single-ended input and output. Galvanometers are low resistance, low voltage units of rugged, enclosed construction; sensitivity and damping are independent of coil temperature. Accessible, unitized circuitry also extends to the power supplies—a front-panel plug-in for both preamplifiers and a second supply for both driver amplifiers. A built-in blower provides constant, forced filtered air cooling. The Recorder can be rack mounted in 15¾" of panel space, or housed in its own 20" x 20" x 21¼" optional portable cabinet.

Ask your local Sanborn Soles-Engineering Representative for complete information on the Model 670 X-Y Recorder, or write the Industrial Division in Waltham, Mass.

SANBORN COMPANY

INDUSTRIAL DIVISION

175 WYMAN STREET, WALTHAM 54, MASS.

and re-emitted infrared radiation will determine the skin temperature. It should be noted that the materials' properties of emissivity, absorptivity, and reflectivity are vitally important to the heat balance. To illustrate, consider the following: Metals are normally excellent reflectors, but poor emitters, of long wave length radiation (infrared), while paints are generally poor reflectors but good infrared emitters.

What this boils down to—and has been verified by actual measurement—is that the equilibrium skin temperature of painted surfaces will be much lower than polished metal surfaces. Although such coatings may provide excellent thermal balance, they will make infrared detection correspondingly easier. Therefore, an optimum coating is needed which protects the vehicle thermally and also from infrared or radar detection.

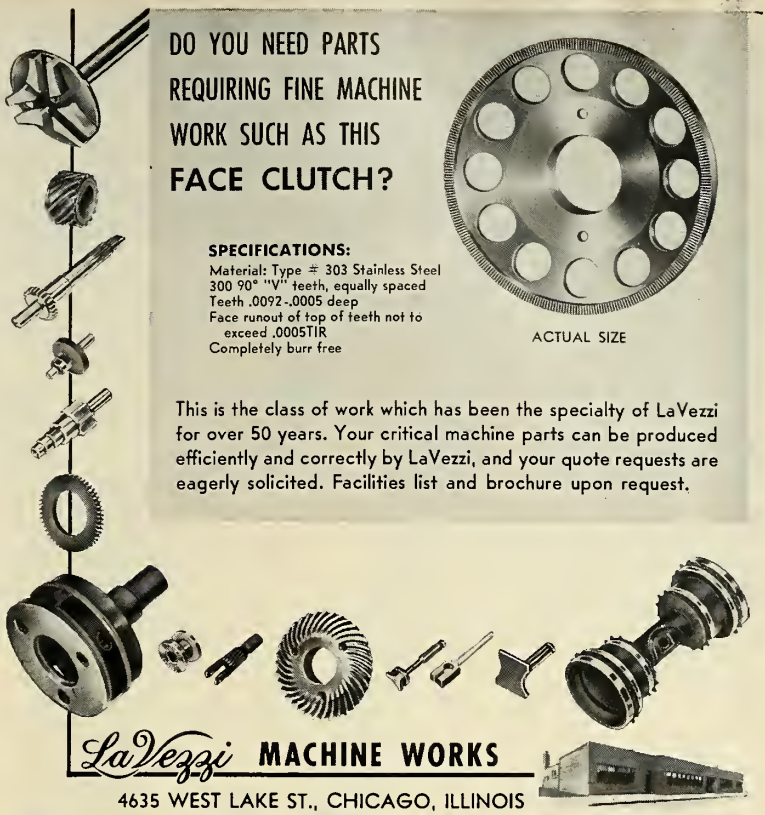
Although it appears that careful selection of coating material can provide good temperature control, several other considerations introduce an element of caution into such a conclusion. First, these temperature calculations ignore internal heat; and, second, abrasion or other surface attack may drastically alter the material properties of emissivity, absorptivity, and reflectivity.

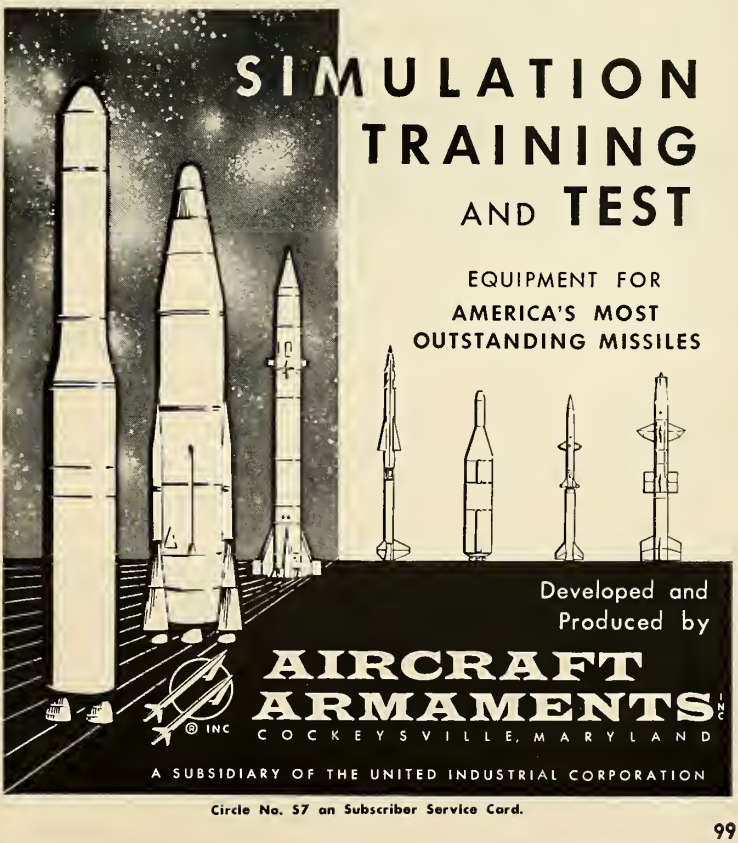
• **Tailoring materials**—Gone are the days when the empirical approach of "cut and try" could be relied on to yield improved materials. Furthermore, the inherent qualities of natural materials such as rubbers and greases are inadequate for advanced weapon designs. Therefore, the trend to synthetically tailored materials has been greatly accelerated. The Air Force's materials program has pioneered in molecular engineering through its plastics and elastomeric (synthetic rubber) applied research efforts.

The fluorinated silicones were tailored for heat-resistant applications. Even these materials, however, have only modest temperature capability with limited nuclear radiation and high-energy fuel resistance. As an approach to significant improvement, materials engineers are attempting to tailor (polymerize) rubber-like materials that employ a metallic constituent, such as tin or boron.

Another urgent Air Force objective is compatibility of seals, gasket, and hose materials with high-energy fuels. Hydrazine, for example, seriously degrades many of the best available elastomers. Applied research is therefore being directed toward tailoring elastomeric materials that will be compatible with new propellants.

• **Radiation damage**—Engineering materials for future Air Force weapons must be capable of survival in a nuclear environment, not only where







Here is a man you should know
he's a DELAVAN FUEL INJECTOR SPECIALIST

His name is Roger W. Tate. He did his doctoral research in the field of pressure atomization at the University of Wisconsin, has taught reaction kinetics, and worked on process improvements for petroleum refining.

Dr. Tate is Director of Research at Delavan. He has developed many atomizing devices and uniquely accurate test equipment for Delavan. He is widely known for his research on spray analysis and fuel injection.

Specialized talent like Dr. Tate's is the main reason for Delavan's leadership in fuel injection. If fluid metering and atomization are part of your product, take advantage of Delavan's specialized experience and ability to deliver aircraft quality. Send specifications to the address below for free recommendations.

DELAVAN Manufacturing Company

West Des Moines, Iowa

World's largest nozzle specialist

Circle No. 58 on Subscriber Service Card.

nuclear power plants may be employe but also where exposure to cosmic o Van Allen radiation is anticipated. I radiation studies of components, suc as radio receivers, motors, capacitor have shown that resultant damage is direct function of the resistance of th materials of construction.

Gamma rays and fast neutrons ar the prime triggers of radiation effect in materials. The illustration on pag 90 shows some reactions when ma terials are exposed to these radiation Atomic displacement and ionization oc cur in metals. Generally, the result i an increase in strength and hardnes but a decrease in ductility. This is nc considered serious. The exception t this conclusion is in solid-state device made of the semi-conductor element such as germanium. In such device even slight atomic disturbances can not be tolerated.

Nuclear radiation can drasticall alter non-crystalline materials such a rubbers, lubricants and adhesives. Th chemical bonds between atoms of thes materials are quickly destroyed o changed. Greases may turn to gum adhesives and rubbers may harden an crumble. In such cases, the radiation i actually polymerizing or depolymeriz ing the materials. Therefore, supe imposed upon the Air Force's require ment for much improved thermal, co rosion, and erosion resistant material is significantly improved nuclear radi ation resistance.

Although additives (anti-rad) rais somewhat the radiation tolerances o some lubricants and polymers, this ap proach does not appear to offer signifi cant advancements. We must develo materials that are intrinsically stable t nuclear radiation. It was proven i 1958 that polyphenol ethers for or ganic fluids are many times superio to those lubricants containing addi tives. Concurrent with these develop ment efforts, we must continue a extensive testing program to study an evaluate the effects of a nuclear en vironment on all classes of air an space vehicle materials.

This has been a very brief look a the requirements, scope and directio of the Air Force's materials program At the 1958 ARDC Materials Sym posium, Maj. Gen. Marvin C. Demle now Director of Research and Deve opment, Hq USAF, stated, ". . . . ma terials research and development, stim ulated by the free thinking and creativ imagination which only a democrati society such as ours encourages, wi contribute significantly to Air Forc weapon supremacy." The resulting ma terials can significantly raise the lim itations now imposed by weight, ex tremes of heat, corrosive and erosiv environment and nuclear radiation.

on the countdown
split-second communication for split-second *action*









Launching today's highly complex missiles demands an unprecedented degree of "team" cooperation. Hundreds of scientists, technicians and specialists must be kept constantly informed during the all-important countdown. Instant action-getting voice communications is the best answer.

An urgent call for a key man . . . an important change in fueling requirements . . . a broken control cable—all require *and get* instant action over a DuKane "job-engineered" communications system. DuKane systems are today providing these vital functions at Patrick Air Force Base, Fort Churchill, and White Sands.

DuKane's advanced engineering group, backed by more than 36 years of specialized experience in the communications field, is available to help you plan your system. Their experience is your guarantee of the best in communications.

For any missile base ground communications need, write or wire DuKane Corporation, Department MR-5, St. Charles, Illinois.

And, if you specify electronic equipment, ask for DuKane's Electronic Equipment Symbols wall chart . . . no obligation of course. DuKane products are installed and serviced by a nationwide organization of factory-trained experts.

DuKane
CORPORATION
St. Charles, Illinois

Job-engineered sound installations . . . Flexifone intercom systems . . . Private automatic telephone systems . . . Hospital communications systems . . . Ionovac hi-fi tweeters and ultrasonic generators . . . Sound slidefilm projectors for education and industry . . . Electronic production facilities for industry and for defense.

Circle No. 47 on Subscriber Service Card.

R/M PYROTEX® REINFORCED PLASTICS ... DEVELOPED TO ENDURE THE FIERY REALM OF THE ROCKET

Light, strong, heat resistant . . . for low-cost, precision fabricated rocket parts— both structural and aerodynamic



High heat resistance makes R/M Pyrotex the ideal materiel for rocket sliver traps, igniter tubes, and tube covers. Pyrotex parts exhibit high strength retention after repeated exposure to 5000-6000° F.

Looking for a material that will withstand the elevated temperatures generated by missiles and rockets—internally from burning propellants, externally from aerodynamic heating? Must this material have good insulation and thermal properties, chemical and water resistance, and take a smooth finish? If so, one of R/M's family of Pyrotex reinforced plastics may be the solution to your problem.

The many outstanding thermal and structural features of R/M Pyrotex have led to its use on almost every U.S. missile. It has been fabricated into parts such as nose cones, fins, igniter tubes, rocket throats and sliver traps. Its exceptionally good dimensional stability makes possible mass production to precision standards. And it is low in cost. Write for additional information.

RAYBESTOS-MANHATTAN, INC.

REINFORCED PLASTICS DEPARTMENT, Manheim, Pa.

FACTORIES: Manheim, Pa.; Bridgeport, Conn.; Paramount, Calif.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Asbestos Textiles • Laundry Pads and Covers • Engineered Plastics • Mechanical Packings • Sintered Metal Products • Industrial Rubber • Rubber Covered Equipment • Brake Linings Brake Blocks • Abrasive and Diamond Wheels • Clutch Facings • Industrial Adhesives • Bowling Balls

Circle No. 59 on Subscriber Service Card.

Sperry Duplicates FBM Sub Navigational Control

SYOSSET, L.I., N.Y.—An exac replica of a *Polaris* missile launchin submarine's navigational control cente has been put into laboratory operatio by **Sperry Gyroscope Co.**

For the first time, navigational in struments that will guide all Nav *Polaris* submarines are being system tested in a control center identical t that aboard a submarine.

Officially called the "Ashore *Polari* Navigation Center," it is more com monly referred to as the "Navigatio Island" by Sperry engineers. It is th nucleus of a test, integration an evaluation program assigned Sperry b the Navy, to assure performance fro this equipment before it takes to th open sea, under a schedule to hav *Polaris* operational by 1960.

The ashore test program is house in Sperry's new 52,000-square-foo Syosset, L.I., **Marine Division** plan which supplements existing productio facilities. Mission of this laboratory center is to solve the assembly an operating problems of a combine complement of advanced navigation equipment.

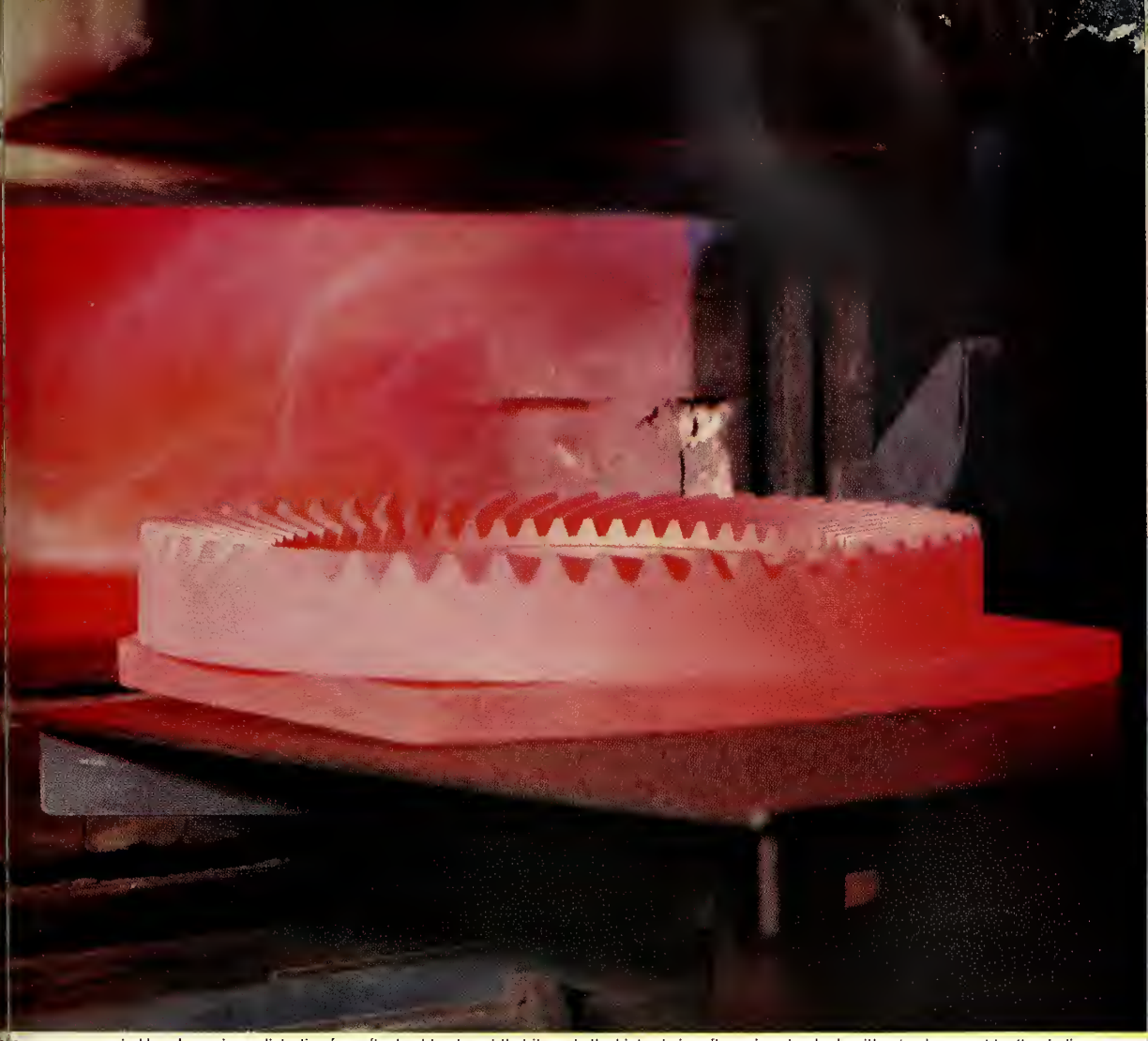
Sperry has had the responsibilit for developing inertial and other na igation systems since the beginning o the *Polaris* program, together with th responsibility for integrating all of th seagoing navigation systems. The te program is now operating for the fir year of a three-year period under $1,570,000 contract.

Among the major instruments an systems to be tested in the Ashor *Polaris* Navigation Center are NAVDAC (The Navigation Data A simulation Center, a master computer SINS (the Ship's Inertial Navigatio System), the Type 11 Stabilized Per scope System (permitting celestial na igation while submerged) and othe classified systems.

The dimensions, shape and cablin of the sub's navigation control cent have been reproduced exactly in th ashore test facility. The simulated hu section is a duplicate of the sub's na igation center.

Although much of this equipme has been used on other ships (i.e inertial navigators and NAVDA aboard Navy's test ships Observatio Island and Compass Island) this wi be the first time that all of the instr ments will be working in concert a a complete system in the confined are available on a submarine.

Sperry will develop casualty co trol procedures for emergency oper tion in the event of an injury to perso nel or damage to equipment.



arge concave spiral bevel gear is so distortion free after heat treatment that it meets the highest aircraft gearing standards without subsequent tooth grinding.

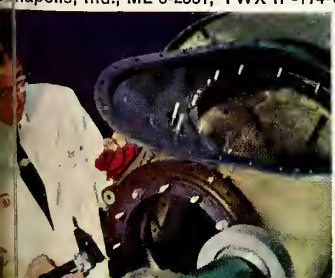
Precision is our only product!

In the rapidly changing field of aeronautical technology, the word "precision" becomes more and more common in use. At Indiana Gear, however, precision has always been more than a word. It is a way of thinking . . . a method of working always beyond the fringe of the state of the art.

IGW

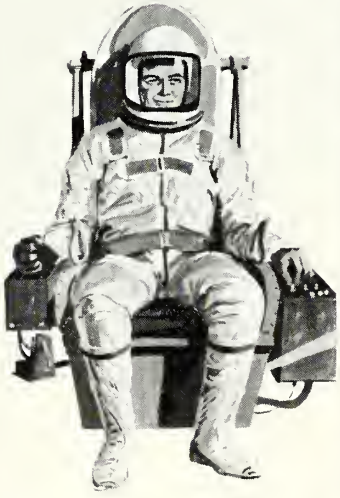
INDIANA GEAR WORKS, INC.
INDIANAPOLIS 7, INDIANA

napolis, Ind., ME 8-2331, TWX IP-174-U • Redondo Beach, Cal., FR 5-7597, TWX 7856-U • Westport, Conn., CA 7-0262, TWX 486-U









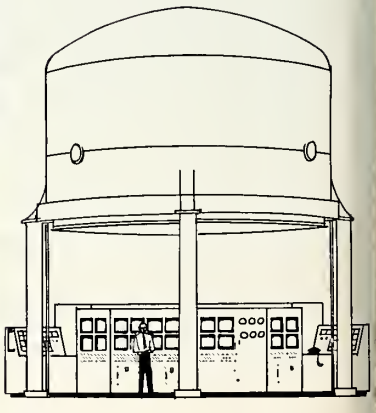
The man:

...a U.S. airman-engineer—carefully selected through rigorous test procedures from Military personnel. He will have the combination of mental acuity, superb physical condition and emotional stability necessary for pioneering in space exploration.



The mission:

...satellite observatory—a vehicle arrangement similar to this could orbit a three-man astronomical crew for several weeks. Empty fuel tank is used for living quarters. Nose section serves as re-entry vehicle for return to earth. The astronomical telescope is gimbal-mounted. External equipment shown is mounted after orbit has been attained.



The means:

...Space projects are accelerated by research equipment like the Douglas high-altitude chamber at Tulsa, largest in the U.S. In it, space environment problems can be worked out under near-operational pressure conditions, shortening the time required for development.

Depend on **DOUGLAS**

The Nation's Partner in Space Research

Diborane Applications Sought by Callery

Callery Chemical is negotiating for use of part of the U.S. Sunflower Ordnance Works, Lawrence, Kan., to develop, test and produce new high-energy rocket propellants—among them diborane.

The company said the Sunflower works offers facilities for exploring possible applications of diborane, which has 2½ times the density impulse (with LOX) of liquid hydrogen. Liquid diborane is 5 to 6 times as dense as liquid hydrogen, with a boiling point of −133°F, compared to −423°F for liquid hydrogen. Callery also will use the plant for advanced work on monopropellants, bipropellants and solids.

Aerojet-General and **National Research Corp.,** Cambridge, Mass., have worked out an agreement for commercial, large-scale production of solid fuels. Aerojet will use certain vacuum processes, equipment and techniques developed by NRC.

For NASA's *Scout,* **Hercules Powder** has come up with third- and fourth-stage motor cases fabricated from plastic, reportedly light as magnesium and strong as steel. Third stage of the $500,000 rocket weighs 2200 pounds and the fourth stage weighs 500. Both are solid-fueled motors.

New Rocket Steel

Jones & Laughlin Steel Corp.'s Stainless and Strip Division, Youngstown, Ohio, has been awarded a contract by Aerojet-General to develop an extremely high-strength strip steel for missile and rocket components. Specs call for mechanical properties "far in excess" of available commercial strip.

Hardware for NASA's Wallops Island project to measure high-altitude radiation is **Aerolab Development Co.** *Javelin.* The first 49-foot, 7400-pound vehicle boosted a 45-pound instrumentation payload to 750 miles July 7. Six more firings are scheduled before year's end.

The solid-fueled four-stage sounding rockets are composed of modified *Honest John, Nike* and *Vanguard* components. Last four firings will be with a 60-foot model weighing 13,000 pounds and capable of carrying similar payload to 1650 miles.

Contracts & Companies

Development and evaluation contract for $36,000 has been awarded **Ultrasonic Testing & Research Laboratory,** Van Nuys, Calif., by WADC. Object: find non-destructive techniques for detecting defective areas in solid-propellant motors . . . BuOrd has contracted with **Clevite Corp.'s** Mechanical Research Division to investigate property modification of materials such as tungsten for ultra high-temperature missile applications . . . At Hicksville, L.I., **Radar Measurements Corp.** is at full operation in a new plant . . . **American Bosch Arma** has acquired **Ensign Carburetor,** Fullerton, Calif., a maker of fuel injectors and similar products . . . **Ford Aeronutronics Division** *Shillelagh* (tank-launched missile for close-in troop support) may be rechristened *Pentomic* . . . More expansion for **Raytheon** is in the works. The company which a few weeks ago announced new plants at Lewiston, Maine, and Portsmouth, R.I., now says it will build a wholly integrated electronic warfare center at Santa Barbara, Calif. The plan calls for expanding its existing operation there by 220,000 square feet of space and employing a total of 1700 persons by 1964.

TRW Acquires Magna

Thompson Ramo Wooldridge has purchased controlling interest in **Magna Products Inc.,** Santa Fe Springs, Calif., a specialty chemical and electronics firm which recently won a Navy solid propellant research contract . . . Air Force logistics manager for the as yet unchristened **Douglas** ALBM (WS-138A) is the Ogden Air Materiel Area, Hill AFB, Utah . . . **Packard-Bell Electronics Corp.** stock was listed on the New York and Pacific Coast Stock Exchanges last week for the first time . . . **Transval Electronic Corp.,** Culver City, Calif., now has Washington representation—Jack Campbell . . . For more missile assembly space, **Horkey-Moore Associates** is constructing a new 13,500-square foot building at Torrance, Calif. . . . At Gardena, Calif., the **Jetstream Fastener Corp.** is moving into a new 14,000 square-foot building . . . and **The United States Chemical Milling Corp.** has acquired **Darco Industries Inc.,** missile component producer with plants at Glendale and El Segundo.

IN THIS MULTIPLE UNIT



SUB-MINIATURE PULSE TRANSFORMERS

Designed and Built by Forbes and Wagner in Co-operation with One of the World's Largest Computer Manufacturers

Up to five sub-miniature pulse transformers are packaged in a single assembly for use in the IBM 7070 Computer. This unit measuring 1.80" x 1" x .312" is an excellent example of modular design. Skilled operators plus modern equipment are required to handle the extremely fine wire sizes which comprise the toroidal windings and very minute cores of the pulse transformers. Forbes and Wagner sub-miniaturized multiple packaging provides worthwhile dividends in simplification and economy.

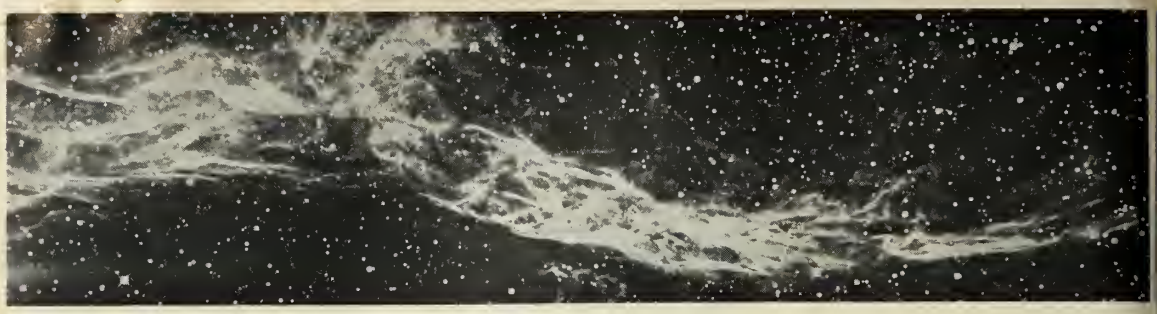
Let us help YOU with YOUR Electronic Problems

We design and produce both simple and complex components and assemblies, Electronic, Electro-Mechanical and Mechanical for Commercial and Military applications in Radio, Television, Tele-communications, Computers, Radar, Guided Missilies and allied fields. Write for brochure giving complete information.

Growth Opportunity for Electrical Engineers. To meet the growing demand for our services, we offer steady employment, high base salary plus profit sharing, paid vacation, group life and hospitalization insurance, sick leave policy, retirement program, etc. Located on shore of Lake Erie. Fishing, boating, swimming at your doorstep. Ideal community life. Thirty minutes from Buffalo via thruway. Replies held in strict confidence.

forbes and wagner, inc.
348 CENTRAL AVENUE
SILVER CREEK, N.Y. • TELEPHONE 650

Circle No. 81 on Subscriber Service Card.



Space Technology Laboratories' new corporate symbol represents a bright history in a stimulating age. ✶ STL *has provided the over-all systems engineering and technical direction for the Air Force Ballistic Missile Program since it was assigned the highest national priority in* 1954. *Five years of accelerated effort produced epic advances in science and technology, and propelled the art of missilery through three distinct generations of progress.* STL *contributed technical leadership to the science/government/industry team which has built this solid, expandable foundation for future advances in space, and is daily adding new strength to our national security.* ✶ *In addition to its major management functions,* STL *also conducts advanced space probe experiments for the Air Force at the direction of such agencies as* NASA *and* ARPA. ✶ *To those scientists and engineers with capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology, and other related fields and disciplines,* STL *now offers unique professional opportunities. Inquiries regarding staff positions at* STL *are invited.*

a new symbol
for a new era of
technology

Space Technology Laboratories, Inc. P. O. BOX 95004, LOS ANGELES 45, CALIFORNI



Aluminum Bar Cuts Aluminum Weld Costs

A new type aluminum back-up bar or metal inert gas-arc welding of luminum is cutting costs and speeding roduction at the **Reynolds Metals ompany** missile plant at Sheffield, Ala.

The new back-up bar is of a ma-ineable aluminum alloy and has an asily replaceable T-shaped stainless eel insert. Previously, the back-up welding bars used in the plant were made entirely of stainless steel.

Charles M. Jenkins, production superintendent at the missile ballistic shell plant and leader in the development of the new back-up bars, said they offered two major advantages over conventional all-stainless bars:

One is that the aluminum bar dissipates the welding heat much more quickly than the stainless bars, making unnecessary the water jackets in use on some production stake welders. And faster heat dissipation keeps weldment distortion to a minimum.

The other major advantage is that the stainless steel inserts are cheap enough to be discarded after their grooves become burned and pitted.

Plant Manager M. C. Duke said the inserts can be replaced for less than half the average cost of repairing the all-stainless back-up bars previously used. There's also a definite saving in down time in the welding department.

Production is also speeded, Mr. Duke said, because inserts of different groove sizes for different sheet thicknesses can be put in much more quickly than was the case when the entire back-up bar had to be switched.

Reynold's missile plant has been using the new back-up bars for more than a year. It has not been necessary to replace any of the aluminum bars which hold the stainless steel inserts.

The aluminum bars and the stainless inserts can be produced either by extrusion or machining, plant officials said.

The Reynolds plant makes aluminum missile shells and tail sections for the *Redstone* and *Jupiter-C* vehicles. It also supplies aluminum in many forms for ABMA's *Jupiter* and many other rockets.

Circle No. 235 on Subscriber Service Card.

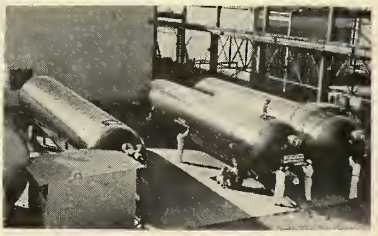
World's Largest Fly-Away uel Tanks Built for *Thor*

In a brand new hospital-clean dust-ee alloy manufacturing plant in the ntral manufacturing district of Los ngeles, more than 300 employees of **andard Steel Corp.** are building giant etal vacuum bottles for storage of uid oxygen, fuel for the Air Force's *hor* missile.

Installed at Vandenberg Air Force se in California, and flown to other *hor* launching sites around the world, ese tanks represent one of the most acting alloy fabricating jobs ever empted.

Standard Steel Corp. delivers the nks to **Douglas Aircraft Co.,** Santa onica, Calif., through the **Cambridge rp.** Designed to hold 13,500 gallons liquid oxygen at 297.4° below zero, ey have a high-strength (type 5086) minum outer jacket and a stainless steel (type 321) inner shell. Unusual fabrication techniques were developed so that the huge tanks, 52 ft. long and nearly 9 ft. in diameter, would be light enough to support 135,000 lbs. of liquid oxygen when full. They weigh 32,000 lbs. when empty. All of the ground support equipment for operational units of the Air Force *Thor* program is being built for fly-away shipment.

In Standard's new alloy fabricating plant, assembly of the vacuum bottle tanks is done in a dust-controlled room kept under slight pressure to prevent infiltration of dust. Concrete floors have been completely sand blasted and a special surface hardener applied to discourage dust accumulation. These floors are continuously vacuumed. All structural members, ceiling and walls are painted white. Welders and other skilled workmen don white uniforms, and special rubber-soled shoes have to be worn when working inside the stainless steel and aluminum shells.



After complete assembly and thorough cleaning, the tank is positioned on Standard's testing pad located at the new plant. Liquid oxygen fills the tank to the ¼ mark and is held for 72 hours to check vacuum readings. Final pressurization is done with dry nitrogen before the tank, supported by a trailer undercarriage, goes to Vandenberg or a nearby airport.

Circle No. 236 on Subscriber Service Card.

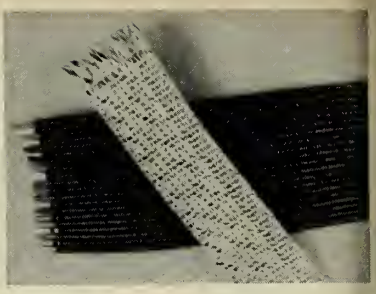
'Ribbon' Cable Has Specialized Applications

Multi-conductor cables in flat "ribbon" configurations for use in specialty and tight locations are now being produced in quantity by **Tensolite Insulated Wire Co., Inc.**

The cables are flexible in one plane, making it simple to run them around corners or around the inside edge of a container. This flexibility also makes them especially valuable for use with drawer pull-out type printed circuit assemblies.

One user has the cable installed on a spring-loaded spool which unrolls the cable as the board is slid out. Most major connector manufacturers make suitable ribbon cable connectors for the interconnection of these printed circuit boards.

The cables are frequently woven on looms similar to those used in the textile industry. Yarn ends—Teflon, Nylon, Fiberglass, Dacron, cotton or other textile fibers—form the "warp" and the "woof" or "filling." The wires would be analogous to the "stuffer" yarns in a carpet. They lie lengthwise in the ribbon cable. The interlocking, or weaving, of the "warp" yarns and "filling" yarns bind the wires in place.



Metallic "woofs" such as silver-plated copper, tinned copper and stainless steel are also available. Primary insulation of the wire can be either Teflon or PVC. Any number of twisted multi-conductors, coaxial cables, and single conductors as small as 36 AWG may be used. It is not necessary that the individual wires be of the same gauge. Color coding is possible on each individual conductor.

Circle No. 237 on Subscriber Service Card.

Resin Retains Strength After Exposure to 600°F.

A silane modified phenol-formaldehyde resin, which retains its strength after exposure to temperatures of 600° F for hundreds of hours, is available in commercial quantities from **Monsanto Chemical Company's Plastics Division.**

The new material, tradenamed Resinox SC-1013, was developed especially for use with fibrous glass and asbestos reinforcements to make radomes for supersonic aircraft. Because of its excellent performance in the 500 to 600° F temperature range, it is expected to be used in other applications where such temperatures have prohibited the use of plastics.

Radomes must be lightweight and "transparent" to radar beams, yet strong enough to withstand the high temperatures produced by a combination of high speed friction and the high-frequency radar impulses passing through them.

According to Thomas W. Sears Jr., sales manager for industrial resins, this is a critical problem area for which there has not been a satisfactory material. "Resinox SC-1013 has high frequency electrical properties and high temperature performance characteristics several times better than conventional phenol-formaldehyde resins and



In the deadly game of chance we call the cold war, there's no room for guesswork. We must know, every hour of every day, *exactly where our potential enemies' strength lies.*

Electronic Reconnaissance today is one of our major defensive weapons—incredible "eyes" with which we can not only detect enemy radar and missile guidance signals, but determine with precise accuracy the location, type and capability of the signal source as well.

The Hallicrafters company has been engaged actively in top priority research and development of Electronic Reconnaissance Equipments since 1952.

Looking for a challenging new opportunity? Recent increases in major contract work have created new openings for qualified engineers at all levels. For full details in confidence, contact William F. Frankart, Director of Engineering.

hallicrafters

4401 W. Fifth Avenue, Chicago 24, Illinois

Circle No. 61 on Subscriber Service Card.



DEPENDABILITY

another outstanding attribute of

DIMAZINE®

unsym-Dimethylhydrazine, UDMH

THE STORABLE FUEL

Performance data on DIMAZINE-powered rocket engines in military missiles and satellite launching vehicles shows DIMAZINE to be a highly reliable rocket fuel.

DIMAZINE provides fast, dependable hypergolic starts followed by smooth, stable combustion and easier shutdowns. Dependable instant readiness is assured for years by its outstanding stability during storage in missiles. It also has high performance, high thermal stability, low freezing point, low shock sensitivity, minimum susceptibility to contamination and high compatibility with almost all metals and appropriate sealing materials.

These manifold advantages combine to make DIMAZINE *the outstanding storable fuel.* We will be pleased to work with you in evaluating DIMAZINE and to supply detailed data on its properties and handling.

Putting Ideas to Work

fmc
FOOD MACHINERY AND CHEMICAL CORPORATION ®

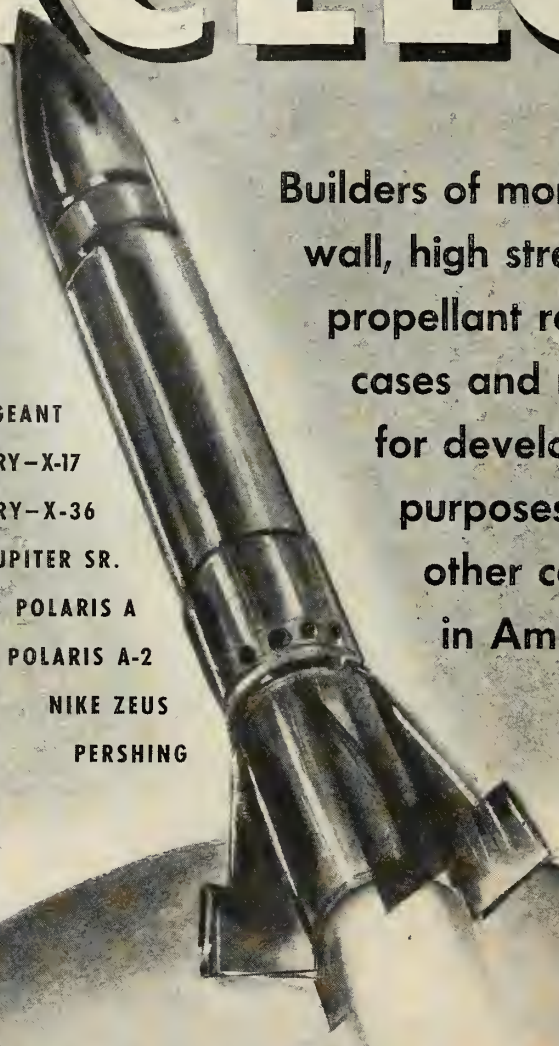
FOOD MACHINERY AND CHEMICAL CORPORATION

Westvaco Chlor-Alkali Division

General Sales Offices:
161 E. 42nd STREET, NEW YORK 17

Circle No. 82 on Subscriber Service Card.

EXCELCO



Builders of more large, thin wall, high strength solid propellant rocket engine cases and nozzles for development purposes than any other company in America.

RV-A-10 SERGEANT
AIR FORCE—RE-ENTRY—X-17
POLARIS—RE-ENTRY—X-36
JUPITER JR. JUPITER SR.
POLARIS O POLARIS A
POLARIS A-1 POLARIS A-2
NIKE HERCULES NIKE ZEUS
MINUTEMAN PERSHING

AND MANY OTHER CLASSIFIED PROJECTS

A small experienced organization geared to handle your development and prototype requirements for static and flight tests in the shortest possible time.

Call or write

EXCELCO DEVELOPMENTS

MILL STREET • PHONE 101
SILVER CREEK, NEW YORK

Circle No. 83 on Subscriber Service Card.

we believe that it will make important contributions to the development and use of high-speed radar domes," he said.

Late last year the company announced the development of a special phenol-formaldehyde resin, Resinox SC-1008, to protect missile nose cones against the super high temperatures, well above 10,000°F, generated by friction during the short period they are plunging through the earth's dense atmosphere from high altitudes.

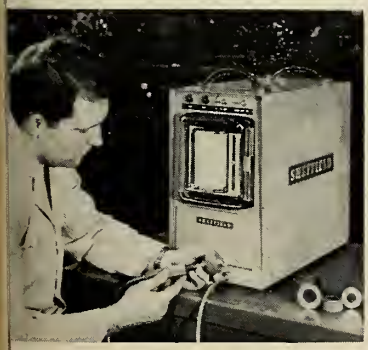
Both products are the results of a special research program to develop materials for aircraft, missile and rocket parts and components at the company's resin products laboratories.

Circle No. 238 on Subscriber Service Card.

Instrument Air Gages and Records Simultaneously

Data gathering for dimensional quality control charts or a chartered record to serve as a size certificate can be made faster and to machine accuracy with a new gaging and recording instrument recently developed by **The Sheffield Corporation.**

The new instrument, which uses hand or fixture-type air gage tooling, makes an automatic record showing a part's plus or minus deviation from nominal size on a 4" wide strip chart



during gaging. The standard model is supplied with continuous chart drive and will inspect a single dimension.

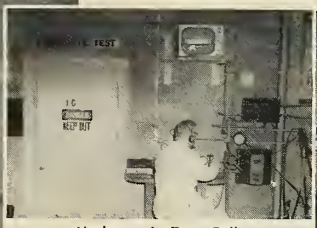
Where desired, the Air Gage Recorder can be obtained also to check two dimensions as well as being equipped with optional features such as maximum and minimum signal lights, and an index drive to move the chart approximately 1/8 of an inch on each gaging operation.

Back-pressure type air gage tooling is used as the size-sensing elements, including Open-jet, Balljet, and Blade jet spindles, Air Snaps and Air Rings,

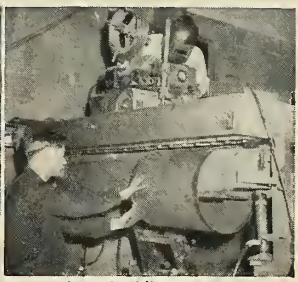
MISSILE HARDWARE
by NEWBROOK

- MOTOR CASES (Solid and Liquid Propellants)
- PLENUM CHAMBERS
- JATO CASES
- BLAST TUBES
- NOZZLES
- FUEL INJECTORS

The newest addition to the Quality Control facilities at Newbrook is the Hydrostatic Test Cell illustrated below. All controls are on the outside. A T.V. Camera inside the cell enables the engineers to watch the test on a T.V. screen. This is only one of many projects at this modern plant manned and equipped to produce the finest in missile components.



Hydrostatic Test Cell

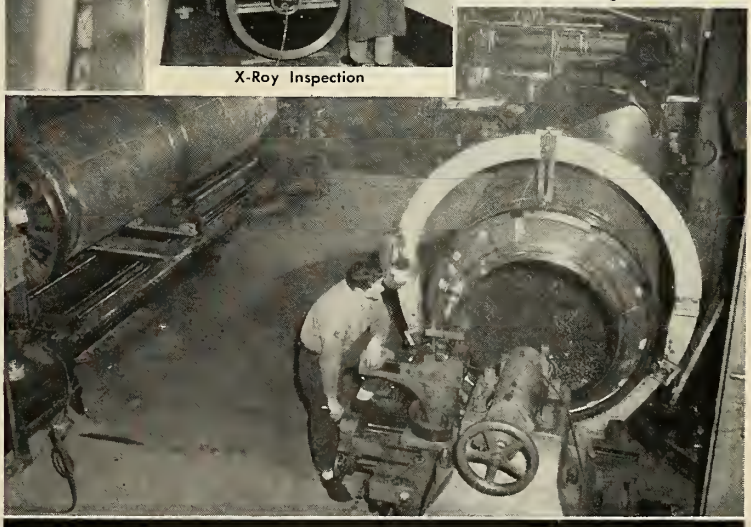


Finest Welding Facilities
Certified Welders



X-Ray Inspection

Below: Machining Motor Cases



Newbrook
MACHINE CORPORATION

45 MECHANIC ST. Phone: Yellowstone 4-2644 SILVER CREEK, N. Y.

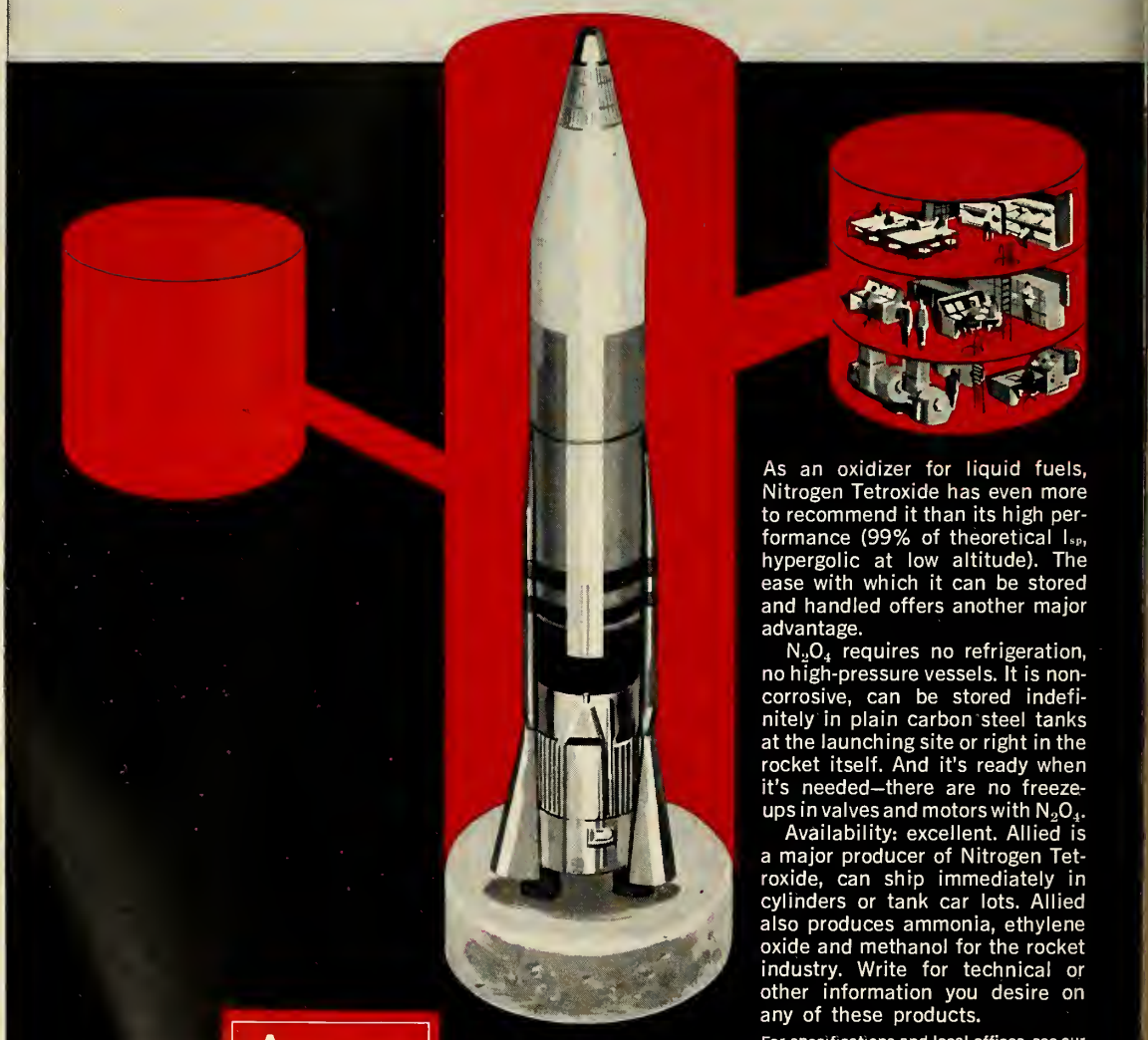
Circle No. 62 on Subscriber Service Card.

all you need

to store NITROGEN TETROXIDE

is a rocket

This liquid-fuel oxidizer needs no refrigeration, causes no freeze-ups



As an oxidizer for liquid fuels, Nitrogen Tetroxide has even more to recommend it than its high performance (99% of theoretical I_{sp}, hypergolic at low altitude). The ease with which it can be stored and handled offers another major advantage.

N_2O_4 requires no refrigeration, no high-pressure vessels. It is noncorrosive, can be stored indefinitely in plain carbon steel tanks at the launching site or right in the rocket itself. And it's ready when it's needed—there are no freeze-ups in valves and motors with N_2O_4.

Availability: excellent. Allied is a major producer of Nitrogen Tetroxide, can ship immediately in cylinders or tank car lots. Allied also produces ammonia, ethylene oxide and methanol for the rocket industry. Write for technical or other information you desire on any of these products.

For specifications and local offices, see our insert in Chemical Materials Catalog, pages 435-442 and in Chemical Week Buyers Guide, pages 35-42.

BASIC TO AMERICA'S PROGRESS

Allied Chemical

NITROGEN DIVISION
Dept. NT 5-12-1, 40 Rector Street, New York 6, N. Y.

and Plunjet gaging cartridges. Existing flow-type tooling up to 2000 to 1 amplification generally can be modified to suit the instrument.

The new inspection-recording device is the approximate size of a portable TV set, measuring 9½" wide x 19½" deep x 17" high. It connects to the regular factory air line and 110 volt, 60 cycle ac. The back-pressure gaging unit, air pressure regulator, and pen and ink strip chaet recorder are housed in the modular-type unit which has a Plexiglass window at the front for viewing the chart.

The present non-automatic "hand and eye" method, in which the "eye" notes the gage reading and the "hand" writes the figure down on a tally sheet, has a number of inherent weaknesses. For example, production-conscious personnel may not make the actual number of checks required for a true statistical sample.

Data tally sheets can be filled out by checking just a few parts and then extending the trend or by writing in similar figures for the rest. Also, hand written figures are often illegible, hard to read, subject to error in transcribing, and they can be changed. As a result, the success or failure of a quality control program may depend, in final analysis, on the accuracy with which the original gage data is recorded.

Circle No. 239 on Subscriber Service Card.



High Stability Claimed for Carbon Resistor

A unique deposited-carbon resistor filled with silicone oil and hermetically sealed for maximum stability under heat and high voltage is announced by **Key Resistor Corp.**

Soldering is done by an exclusive fluxless machine process which permits filling the units with oil. Resistors are 100% X-ray inspected and seal tested. This construction insures long life under load, plus extreme stability under heat and high voltage.

Resistance elements are up to 52%

countdown: canaveral

One of our century's most significant events is the countdown at Cape Canaveral. Participation in the countdown, in the planning and preparation that precedes it, and in the test data collection and evaluation that follows, is one of the jobs of the Pan Am engineer.

Our Guided Missiles Range Division assists the Air Force in management, operation and maintenance of the 5000-mile Atlantic Missile Range. Thus each member of our technical staff has a unique opportunity to play an intimate, vital role in the nation's major missile test and space exploration activities.





[redacted]

For an investigation of your future in the space age with Pan Am, send a brief resume in confidence to Mr. J. B. Appledorn, Director of Technical Employment, Pan American World Airways, Inc., Patrick Air Force Base, Florida, Dept. B-9.

PAN AM

Guided Missiles Range Division
Patrick Air Force Base, Florida

Circle No. 63 on Subscriber Service Card.

This is one of a series of informative messages to acquaint engineers and scientists with the projects of RCA Moorestown.

RCA MOORESTOWN AND THE WORLD'S MOST ACCURATE RADAR

At its Moorestown Engineering Plant, RCA has developed an instrumentation radar that has created an entirely new order of precision in radar tracking. Standardized by the Secretary of Defense for use on operational and training ranges of all three services, the AN/FPS—16 is acknowledged to be the world's most accurate radar.

The AN/FPS—16 provides accuracies even far beyond those obtainable with precision optical devices at moderate distances and under favorable atmospheric conditions. A higher magnitude of performance is combined with immense versatility and capability for instant reduction of data to visual display and recording in graphic or digital form.

The AN/FPS—16 uses amplitude-comparison monopulse tracking, rather than conical-scan tracking. The success of this radar has helped to establish RCA Moorestown as the leader in the field of precision monopulse trackers. The performance of this radar cannot be explained merely by the inherent advantages of monopulse technique. Behind this performance lies a record of imaginative conception and planning, thorough theoretical analysis, and expert electrical and mechanical design.

Engineers, scientists and managers interested in contributing to the advanced projects now underway at RCA Moorestown are invited to address their inquiries to Mr. W. J. Henry, Box V-13G.

EQUAL JOB OPPORTUNITY For All Qualified Applicants

RCA

RADIO CORPORATION of AMERICA

MISSILE AND SURFACE RADAR DIVISION

MOORESTOWN, N. J.

Circle No. 64 on Subscriber Service Card.

larger in area than on conventional types, and hence run cooler.

Units are designed for use in circuits requiring small size and high reliability. These resistors meet all Mil. Specs., including MIL-R-10509C, Characteristic B. Available in all military sizes, plus ⅛ watt and ⅒ watt . . . in resistance values from 5 ohms to 20 megohms.

Circle No. 240 on Subscriber Service Card.

Advanced Steam Cleaner Has Support Applications

An advanced steam cleaner, designed initially for missile ground support equipment application, has been put into production by the **Kelite Corp.**

Designated the Mark IV, the new unit may be used to clean and phosphatize large structures such as missile launching ramps prior to painting. The steam gun design which supplies hot cleaning and phosphatizing solution at 600 gallons per hour, is reported to eliminate the disadvantages of former syphon gun equipment. The machine may also be used for high-capacity



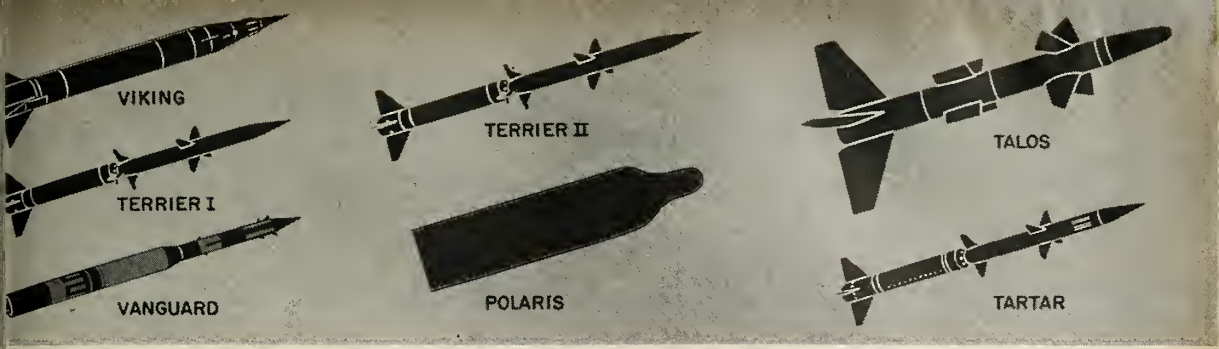
steam cleaning operations and/or high-pressure water rinse.

The Mark IV is available in both direct fired (gas) and fireless models. Latter may be used if a steam source is available. Direct fired model operates on either city or bottled gas. To conserve cleaning solution and personnel time, the gas supply and positive displacement pumps are controlled by a lever at the steam gun.

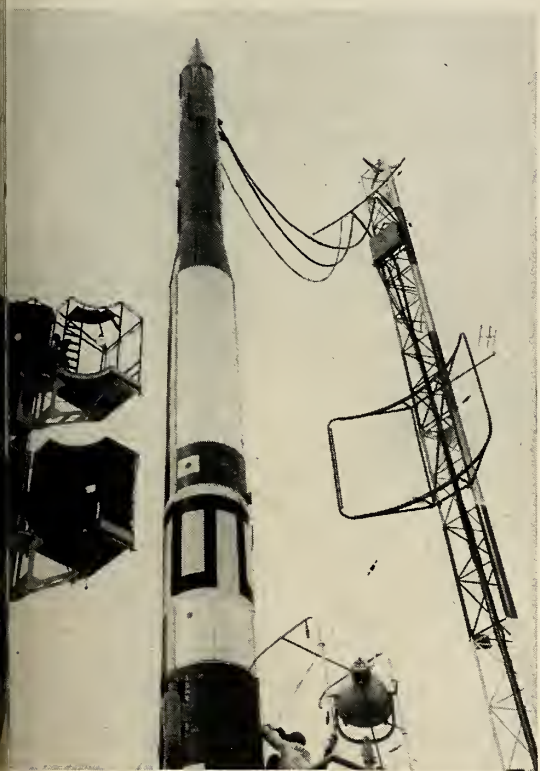
Circle No. 241 on Subscriber Service Card.

High Performance Rating Claimed for New Gyros

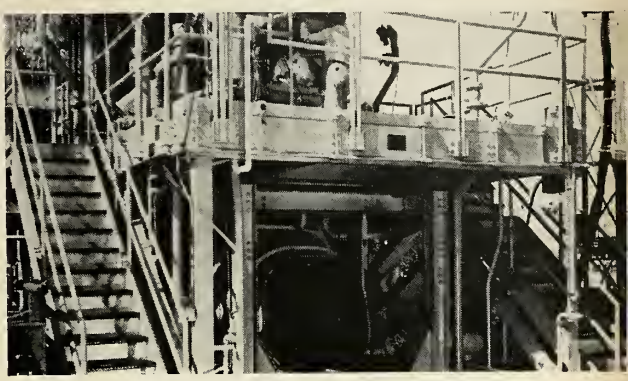
Kearfott Co., Inc. has announced the availability of a new series of high-accuracy miniature floated rate integrating gyros designed specifically for use in missiles or severe missile-like environments.



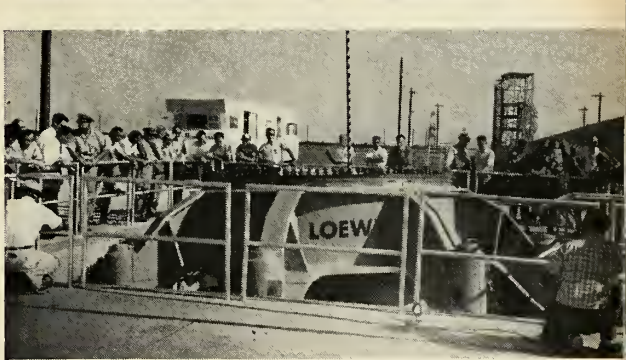
Loewy-Hydropress has been engaged in building handling, stowage and launching systems for these rockets and missiles.



nguard rocket being readied for launching on March 17, 1958.



Testing and firing installation for Viking and Vanguard rockets.



Ship motion simulator for test-firing U.S. Navy's guided missile "Polaris" under seagoing conditions.

Loewy ground handling and launching systems in successful operation and in progress

iant and unusual facilities for handling, testing and launch-g missiles and rockets have been built and put in operation y Loewy-Hydropress for the U.S. Navy's Fleet Ballistic rogram and for the joint IGY Program of the Navy and the ational Academy of Science. These installations have proven eir brilliant effectiveness under the most trying circumstances.

Loewy-Hydropress has also been chosen to design systems r the protection, handling and launching of surface-to-air personic missiles and missile components for the Navy's rst nuclear-powered cruiser, *Long Beach.*

Another Loewy system is in development for supersonic missiles which will be installed on Navy aircraft carriers.

Loewy engineers build all kinds of handling, stowage and launching facilities for guided rockets and missiles of various sizes and operating ranges.

They also specialize in the design and construction of radio telescopes and related space communication systems.

Avail yourself of the experience and ingenuity of the Loewy organization, which coordinates all other B-L-H divisions that are actively engaged in the specialized fields. Just write us at Dept. S-7.

Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

1 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

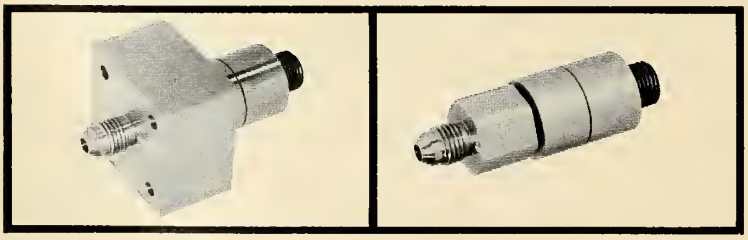
BALDWIN BLH LIMA-HAMILTON

Circle No. 85 on Subscriber Service Card.



HIGH-TEMPERATURE PERFORMANCE TODAY

First with an operating 700°F pressure pickup, CEC is now extending high-temperature capabilities throughout its complete line of outstanding pressure pickups. Soon *all* pressure transducers will have the capability of continuous operation at 700°F. Now on the threshold of exciting new high-temperature developments, CEC is testing extended-range instruments for rocket- and jet-engine test stands, lunar probes, and space vehicles. Hundreds of CEC High-Temperature Pressure Pickups were used to test this country's first supersonic bomber...thousands will continue to perform in critical advanced projects. Your inquiry is invited...call your nearest CEC sales and service office or write for Bulletin 1308-X9.



Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / 360 sierra madre villa, pasadena, california

FOR EMPLOYMENT OPPORTUNITIES WITH THIS PROGRESSIVE COMPANY, WRITE DIRECTOR OF PERSONNEL

Circle No. 65 on Subscriber Service Card.

...new missile products

Two inches in diameter and 2¾ inches long, these components consist principally of a gyro motor, a torque motor, a signal generator, and a constant damping device. Unique design combines the torque motor and the signal generator in a single unit, or "torsyn," together with a restraint-trimming tertiary winding.

The gyros are said to exhibit performance characteristics that are superior to those of any other unit of comparable size now in use. Designed for maximum adaptability to precision mass productions methods, these gyros can be produced having a variety of performance characteristics tailored to specific applications.

There is said to be no limit to the altitude at which these components operate, and no performance deterioration with altitude.

Performance Characteristics: Mass unbalance, 1°/hr. max. untrimmed (along input and spin axes); Restraint: 0.5°/hr. max. untrimmed; Standard deviation (short term); azimuth—.05°/hr.; vertical—.03°/hr.; Max. drift rate: .015°/hr./g^2 steady accel.; .008°/hr./g^2 vibratory accel.; Damping: input-output angle ratio - 0.2; Characteristic time: .0035 sec. or less; Gimbal freedom: ±3° minimum; Warmup time: 10 minutes from –60°F; Weight: 0.7 lbs.; Life: 1000 hrs.

Circle No. 242 on Subscriber Service Card.

Simplified 5 Volt Recording System Produced

A simplified 6- or 8-channel direct writing oscillographic recording system has been developed by **Sanborn Company** specifically for computer readout, telemetry recording, dc monitoring and similar applications requiring no preamplification.

The Sanborn Model 358-5480 system consists of a 6- or 8-channel control panel for input signal control and a 6- or 8-channel recorder-amplifier unit.

System linearity is 0.5% of full scale (max. chart width 50 divisions); sensitivity is 0.1 volt/division; frequency response is 3 db down at 150 cps at 10 division peak-to-peak amplitude. The system has hysteresis of less than –0.1 division and gain stability better than 1%.

The control panel provides position, smooth gain and attenuator controls, and an internal calibration signal. Single-ended input connections of 100,000 ohms impedance can be made either on the front or the rear of the cabinet.

MAKE IT

NEWAY

For Your Running Gear Requirements on Ground Handling and Support Equipment

Designers and Manufacturers of Running Gear Systems for

Missile Launchers
Missile Refuelers
Air-Borne Trailers
Ordnance Refuelers
Tank Retrievers

* * *

Air Suspension Systems

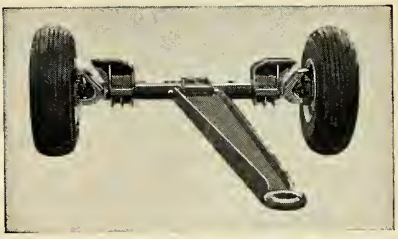
*

Spring Suspension Systems

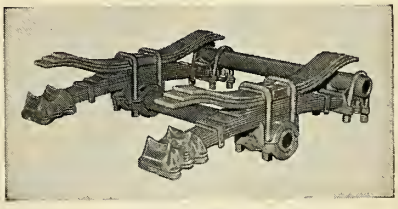
*

Walking Beam Systems

For Your Prototype Development Requirements Or Production Needs



L.O.X. Steering Suspension Assembly



Transerector Spring Suspension



100,000 lb. capacity Air Suspension

NEWAY EQUIPMENT COMPANY
MUSKEGON, MICHIGAN • U. S. A.

PRINTED IN U.S.A.

Circle No. 86 on Subscriber Service Card.

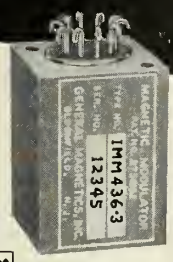
Engineers! Designers!

THERE IS NO SUBSTITUTE FOR RELIABILITY!

Specify—

PERFORMANCE PROVEN "MAG MOD"

MAGNETIC MODULATORS



Actual Size

GM INC.

For complete specifications and application data on "Mag Mod" Miniature and Standard Components, call or write.

Miniaturized design permits engineers to employ these new components in transistorized printed circuit assemblies and wafer type structures. All models offer maximum reliability, fully ruggedized construction and conform to MIL-T-27A specifications.

- COMPLETE RELIABILITY
- INFINITE LIFE
- FASTER RESPONSE TIME
- NEGLIGIBLE HYSTERESIS
- EXTREME STABILITY (Ambient Temp. Range from −75° to +135°C)
- COMPACT SIZE
- LIGHTWEIGHT

Typical circuit applications for Magnetic Modulators are algebraic addition, subtraction, multiplying, raising to a power, controlling amplifier gains, mechanical chopper replacement in DC to fundamental frequency conversion, filtering and low signal level amplification.

GENERAL MAGNETICS • INC

135 BLOOMFIELD AVENUE
BLOOMFIELD, NEW JERSEY

Telephone: Pilgrim 8-2400

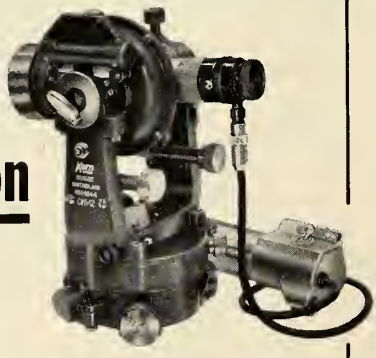
Circle No. 66 on Subscriber Service Card.

INERTIAL GUIDANCE

Represents one of many applications of

Autocollimation

to solve Alignment Problems of a highly precise nature.



The KERN DKM2

When equipped with the new No. 356 Autocollimating Eyepiece, this famous one-second theodolite has a total magnification of 23x and an operating range from zero to at least 100 feet for autocollimation.

Write for technical data and specifications. No. 12

Kern SWISS

The FINEST in SURVEYING EQUIPMENT

KERN INSTRUMENTS INC.

120 Grand St., White Plains, N. Y.

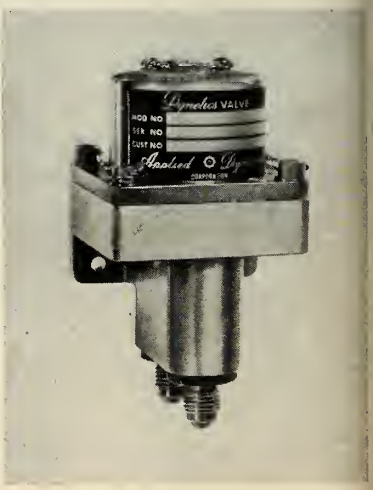
Circle No. 67 on Subscriber Service Card.

...new missile products

The 17½" fully transistorized recorder-amplifier-power supply package has current-feedback amplifiers and velocity feedback damping. Galvanometers are rugged, low impedance, low voltage units with enclosed construction. The recorder features inkless recording in true rectangular coordinates. Displaying a full eight inches of chart, it loads easily from the front and has a built-in paper footage indicator and take-up. There are nine electrically controlled chart speeds selected by push-button, or the recorder can be remotely controlled.

The entire 358-5480 system, complete with power panel, wiring harness and built-in blower, occupies only 57 5/8" of panel space. The recorder assembly, control panel and master power panel may be purchased separately for individual 19" rack mounting.

Circle No. 243 on Subscriber Service Card.



Pressure Regulator Has Integral Relief Valve

The development of Model 30-301 Dynectics Pressure Regulator with a built-in relief valve has been announced by the **Applied Dynamics Corporation.** Typical applications of the unit include airborne or ground electronic system pressurization, air or gas system pressure control.

The model 30-301 regulator is designed for control of system pressure. Function of integral relief valve is to prevent pressure build-up due to thermal expansion of air or line surges.

The regulator is designed for: an inlet pressure of 40 to 60 psig and an outlet pressure of 15 to 30 psig, a burst pressure of 500 psig at inlet and 80 psig at outlet, a pressure variation

SYSTEM DEVELOPMENT CORPORATION

urrently seeking scientists and engineers in various skill areas. part of this effort, I have been given the opportunity to tell you ething about our organization.

t me begin by giving you some general facts about the Corporation: C is a non-profit organization chartered to work in fields aining to public welfare, the advancement of science, and onal defense. The Corporation's name implies its function—the elopment of systems. Specifically, we are concerned with large, plex information processing systems with a high degree of mation. Development of these systems is accomplished through application of knowledge in the areas of applied mathematics, ineering, and psychology, to problems of over-all system design, processing techniques and optimum man-machine relationships.

ur work is system-oriented, rather than concerned with the ign or manufacture of hardware components. As a result of this of specialization, we have assumed major responsibilities in the elopment of systems such as the SAGE (Semi-Automatic und Environment) Air Defense System and the world-wide itegic Air Command Control System, and in the integration of functional responsibilities of these systems with other military tronic support systems.

cause the scope of our activities is rapidly increasing, we are anding our staff. In this message I am specifically addressing ng engineers with advanced training and proved analytical ity in the areas of weapons system analysis, noise and rmation theory, ECM, electromagnetic intelligence and allied ds. If you are qualified, and our corporate activities sound resting to you, we would like to hear from you. Address inquiries arding our Santa Monica, California facility to Mr. R. W. Frost, 4 Colorado Avenue, Santa Monica, California. Inquiries regarding Lodi, New Jersey facility should be addressed to Mr. R. L. Obrey, 2651, Grand Central Station, New York 17, N.Y. These gentlemen see that your letter receives prompt attention and confidential tment."

David Green

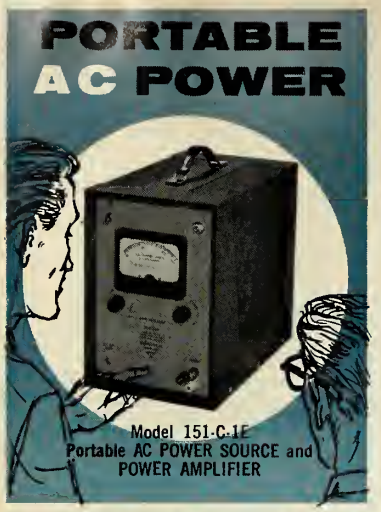
David Green, Assistant Director for Plans, Operations and Management Research Directorate



SDC

SYSTEM DEVELOPMENT CORPORATION

SANTA MONICA, CALIFORNIA · LODI, NEW JERSEY



the BEHLMAN

INVERTRON PORTABLE
INVERTRON AC POWER
INVERTRON PORTABLE
INVERTRON AC POWER
INVERTRON PORTABLE
INVERTRON AC POWER

FIRST CHOICE of Aircraft and Missile manufacturers for RESEARCH and DEVELOPMENT. The Behlman INVERTRON is a completely electronic source of AC Power, for use when and wherever AC Power of frequencies other than that obtainable from the 60 cycle line is required.

Available in capacities ranging from the Portable model upward to installations of multiple KVA ratings.

INVERTRON

PORTABLE

VERSATILE · LOW PRICE

HIGH PERFORMANCE

A LAB NECESSITY

For further information, Write or Call

BEHLMAN ENGINEERING COMPANY
ELECTRONIC · MECHANICS · OPTICS
DESIGN · DEVELOPMENT · PROTOTYPE
2911 WINONA AVENUE
BURBANK, CALIFORNIA

Representatives in all principal cities and Canada

Circle No. 68 on Subscriber Service Card.

...new missile products

at set point of ±1 psig, and reset of relief valve not to exceed 1 psig above set temperature. The regulator operating temperature range is −70 to +175°F, and will withstand salt spray test at 95F for 48 hours.

Circle No. 244 on Subscriber Service Card.

Tiny Radar Device Can Fit Into Attache Case

A miniature radar-like device that detects and measures movements up to thousands of feet away was demonstrated here publicly for the first time today by the **Singer Military Products Division.**

Named the Standing Wave Area Motion Indicator (SWAMI), the device is small enough to fit into an attache case and is virtually impossible to confound with countermeasures.

The SWAMI sensor is a sealed vacuum tube envelope containing an ultra-high-frequency radio oscillator pulsed at a low-frequency repetition rate. This apparatus is shock-resistant, and its service life will compare favorably with that of vacuum tubes used conservatively in more conventional applications.

Any motion in or intrusion into the area under surveillance induces a change in the low-frequency repetition rate which, in turn, is detected by an FM detector. The detector transmits this intelligence to the monitor in a central control station in the form of voltage fluctuation of high amplitude, touching off the alarm.

Any attempt to tamper with the connecting cable leading from sensor to monitor will actuate the alarm.

Power source for the sensor may be either an ordinary household 115-volt outlet or a battery with enough power to supply an ordinary household night light. Any type of battery, wet or dry cell, will serve.

A SWAMI unit has effective range from a few inches to several thousand feet and, operated without auxiliary equipment, is omnidirectional. However, the propagation angle may be reduced by installation of a reflector around the antenna. The practical lower limit for portable, highly mobile units, such as might be carried in the field by light infantry, is approximately 15 degrees.

Restriction of the propagation angle would be desirable, for example, if friendly activities were to be carried on within range of the SWAMI. The instrument would then be focused through a narrow angle covering only the area where a hostile movement is anticipated, but would be screened off in such a way that it would not respond



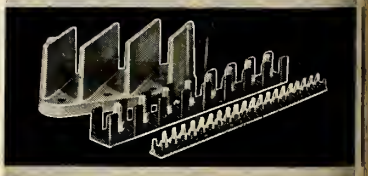
high temperature
PLASTICS



Continuing research in the field of high temperature plastic molding has enabled Olympic to create fiberglass missile components such as nose cones, radomes and heat reflective shields.



High strength, heat resisting structural parts and exhaust deflectors, insulators and nozzles have been produced that perform as high as 5000° F.



Standard electrical terminal strips now adopted as NAS 1066, as well as special design terminal blocks, have been developed to withstand continuous service to 600° F.

OLYMPIC Plastics Company, Inc.
3471 S. La Cienega Blvd., Los Angeles, Calif.

Circle No. 73 on Subscriber Service Card.

to intentional activities elsewhere within the normally effective range of operation.

Relative speed of a target can be determined with a single SWAMI unit, and, if the instrument is positioned to focus directly along the line of motion, it will determine the absolute speed. A unit could be beamed directly along a straight stretch of highway so that traffic is moving directly toward or away from the instrument, and a count of the half wavelengths read as a calibration of absolute speed.

Units positioned within range of one another will act in a complementary way to reinforce the amplitude of each.

In line with a sustained effort to diversify its product line in the military field, Singer-Bridgeport several months ago entered into an agreement with the **Product Development Corporation,** of Boston, an organization which specializes in helping private concerns find new products it can manufacture and sell profitably. Singer-Bridgeport said its acquisition of the right to SWAMI were directly attributable to operations of PDC.

Circle No. 245 on Subscriber Service Card.

New 5000° R&D Furnace Available

A resistance furnace for laboratory use, which operates to 5000°F and costs only 1/3 the amount of comparable furnaces, is available for immediate delivery from the **Curtiss-Wright Corporation.**

The furnace uses an inert gas for interior atmosphere with a graphite heating element and carbon insulation. It can be readily modified for special use for materials testing or processing studies.

The standard Curtiss-Wright unit has a heating chamber 4″ in diameter by 8″ high. The size of the chamber can be varied to meet specific requirements. Large production units have been designed for special processing needs. A hearth lowers out of the heating chamber for easy access to the interior of the unit. Two sighting tubes, at top and side of the furnace, allow sighting for temperature readings and automatic control purposes.

Outside dimensions have been held to a minimum and are only 12″ diameter x 24″ high.

The furnace is available with or without automatic temperature controls. However, power supply, gas control valves, pyrometers and necessary fittings for cooling are included so that the furnace is a self-contained unit. Power input is 15 kilowatts, at a temperature of 4500°F. With standard power supply, a maximum temperature of 5100°F is attainable.

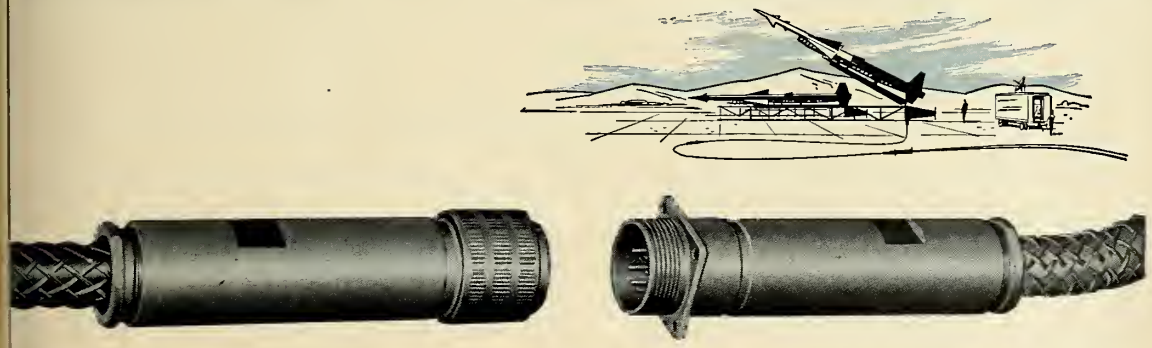
Circle No. 246 on Subscriber Service Card.

Advanced Design Aids Electrical Connectors

New single-conductor plugs and receptacles called Supercon electrical connectors are now available in 50 and 100 ampere ratings for use in portable or stationary power and distribution panels.

According to the manufacturer, **Superior Electric Co.,** Supercons incorporate the first major design changes in this type of connector in many years —a functional positive-grip plug design; simplified, quick assembly; a wide range of colors.

All current carrying parts are of brass, gold-plated for stable electrical



Why it pays you to specify

Bendix QWL Electrical Connectors for use with Multi-conductor Cable

or use with multi-conductor cable on missile launching, round radar, and other equipment, the Bendix* QWL lectrical Connector meets the highest standards of design nd performance.

A heavy-duty waterproof power and control connector, the WL Series provides outstanding features: • The strength f machined bar stock aluminum with shock resistance and ressurization of resilient inserts. • The fast mating and isconnecting of a modified double stub thread. • The esistance to loosening under vibration provided by special apered cross-section thread design. (Easily hand cleaned hen contaminated with mud or sand.) • The outstanding esistance to corrosion and abrasion of an aluminum surface ith the case hardening effect of Alumilite 225 anodic nish. • The firm anchoring of cable and effective waterroofing provided by the cable-compressing gland used ithin the cable accessory. • The watertight connector ssembly assured by neoprene sealing gaskets. • The additional cable locking produced by a cable accessory designed to accommodate a Kellems stainless steel wire strain relief grip. • Prevention of inadvertent loosening insured by a left-hand accessory thread. • The high current capacity and low voltage drop of high-grade copper alloy contacts. Contact sizes 16 and 12 are closed entry design.

These are a few of the reasons it will pay you to specify the Bendix QWL electrical connector for the job that requires exceptional performance over long periods of time. *TRADEMARK

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Affiliates: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Factory Branch Offices: Burbank, Calif.; Orlando, Florida; Chicago, Ill.; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

Scintilla Division
Sidney, New York

Bendix
AVIATION CORPORATION

Circle No. 70 on Subscriber Service Card.

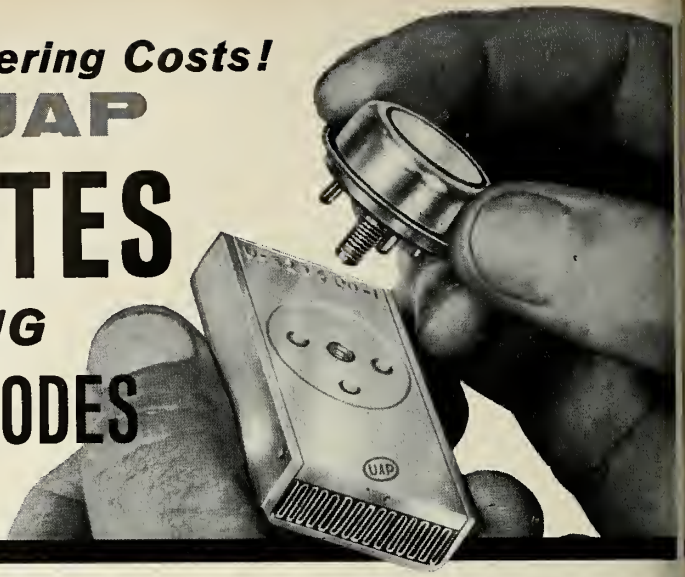
Save Design/Engineering Costs!

USE STOCK UAP

COLD PLATES

FOR COOLING

TRANSISTORS/DIODES

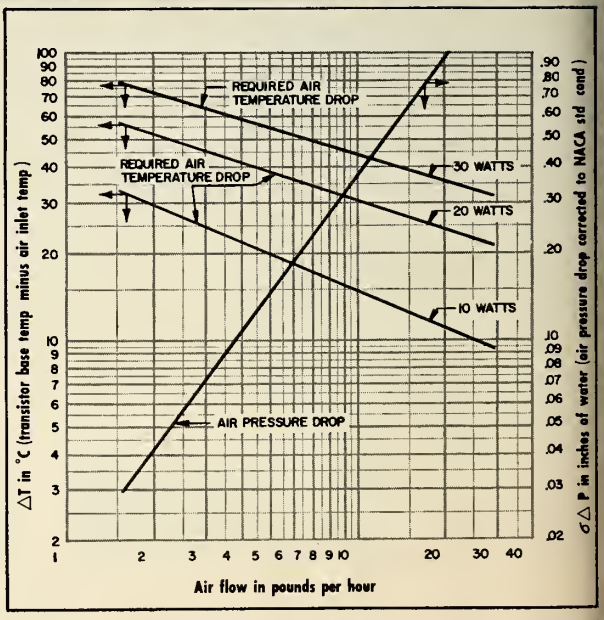


JEDEC* Nos. Transistors TO-3; TO-6; TO-10; TO-13; TO-14; TO-15; TO-26; TO-31; Diodes DO-4; DO-5.
**Joint Electronic Device Engineering Council*

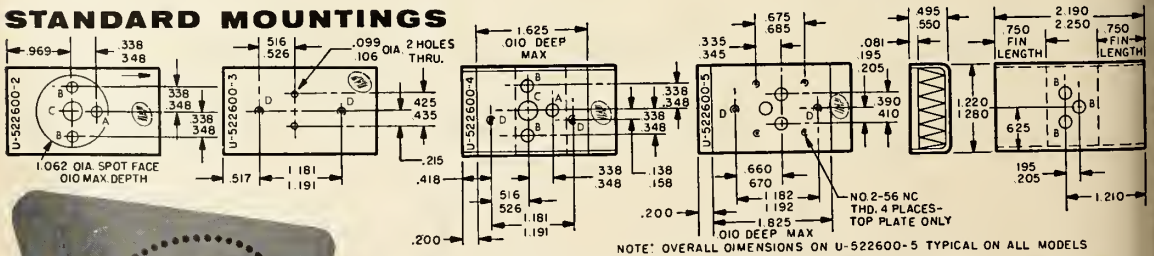
Now, you can use *stock* UAP aluminum cold plates to control heat generated by power transistors and diodes used in electronic circuits. Heat is transferred by conduction through the mount to cooling air forced through the cold plate. Cooling air can be ducted from any suitable source.

Adaptability of this cold plate to specific cooling requirements can be easily determined. The maximum allowable transistor or diode base temperature and dissipation must be known or calculated. Then, using any one of the three parameters on the curve, the remaining conditions are indicated. Example: Using a transistor base temperature of 71°C at a dissipation of 20 Watts, and assuming air inlet temperature of 36°C, gives a △ T of 35°C, an air flow of 6.4 lbs./hr., with .20 inches of water pressure drop.

Overall envelope dimensions are 2.250″ length, 1.280″ width, .550″ depth. Weight, approximately 1 oz. Finish, alodine. For complete information on prices and delivery, call, wire or write direct to UAP.



STANDARD MOUNTINGS



NOTE: OVERALL DIMENSIONS ON U-522600-5 TYPICAL ON ALL MODELS

Hole "A" .185—.197 dio., top plote only; Hole "B" .185—.197 dia., both plotes; Hole "C" .279—.291 dio., both plotes; Hole "D" 5—40NC thds., top plate only.

a famous family of aircraft essentials since 1929

UNITED AIRCRAFT PRODUCTS, INC.

Dept. 02, 1116 BOLANDER AVENUE, DAYTON, OHIO, *Phone BAldwin 4-3841*

Circle No. 87 on Subscriber Service Card.

Expanding the Frontiers of Space Technology in

FLIGHT TEST

■ Flight testing is conducted by Lockheed Missiles and Space Division in a unique manner. All components and sub-systems of a new project are initially tested on known-performance, production missiles. Thus, when the final system is ready for first flight, its individual components already possess flight-tested reliability.

This new concept of flight testing is of major significance and has enabled Lockheed to produce extremely complex missile systems in record time and at greatly reduced expense.

Actual testing is conducted at Cape Canaveral, Florida; Vandenberg AFB, California, and Alamogordo, New Mexico. Underwater launch tests for the Navy POLARIS FBM—including studies of cavitation, wave simulation and skip motion—are carried on at the Sunnyvale facility and at the Navy test base on San Clemente Island. In addition, structural and certain restricted flight tests are performed at Hunter's Point Naval Shipyard, San Francisco.

ENGINEERS AND SCIENTISTS

Lockheed Missiles and Space Division programs reach far into the future and deal with unknown and challenging environments. If you are experienced in one or more of the above areas, or have background in related work, we invite you to share in the future of a company that has an outstanding record of achievement and make an important individual contribution to your nation's progress in space technology. Write: Research and Development Staff, Dept. G-3-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed

MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO • HAWAII

...new missile products

contact and resistance to corrosion. Plastic parts are molded of durable nylon for high dielectric strength and excellent resistance to corrosive chemicals, oil and grease, abrasion and impact, chipping and cracking.

Both plugs and receptacles are available in red, white, blue, black, yellow and green. For maximum flexibility, plug wiring can be either by soldering or by fastening with two cable fastening screws. Socket plug grips are of a simple, two-piece threaded construction for quick assembly. Pin plugs are assembled by a single nut after cable connection.

Receptacles have color-matching caps and bodies to permit more rapid and accurate circuit identification in front and back of panel.

Circle No. 247 on Subscriber Service Card.

'One-Way' Mercury Switch Now Available

A new type of mercury switch has been announced by **American Designed Components, Inc.** Because of its novel construction, the Type UZW switch controls mercury flow in such a way that a momentary wipe contact is produced when tilted 10 degrees or more in one direction, with no contact upon return to original position.

Using this basic orifice principle and inserting additional electrodes permits the company to offer a variety of circuit arrangements. For example, two wipe contacts and two make/break contacts may be incorporated into a single switch.

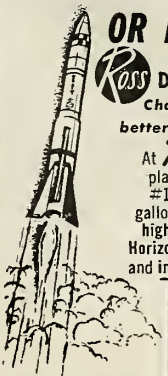
A standard-size switch measures less than 2¾" in length, less than ½" in diameter. It is capable of carrying 5 amp at 115 v, with inrush overloads of up to 10 amp. Even smaller sizes and tilt angles are available to suit specific requirements. The switch is unusually low in cost for this type of circuit arrangement; average list price is $2.

AM-DE-CO mercury switches offer several unique advantages. By using a special hard glass and solidly fused-in ceramic spark shields, operating capacities of up to 100 amp and inrush overloads to 500 amp may be handled, at temperatures up to 250°F. Being hermetically sealed, these switches offer positive precision control for many types of equipment.

Typical examples are paint sprayers, washing machines, waste disposal units, oil burners, pumps and compressors, textile machinery, welding apparatus, motors and generators.

Circle No. 248 on Subscriber Service Card.

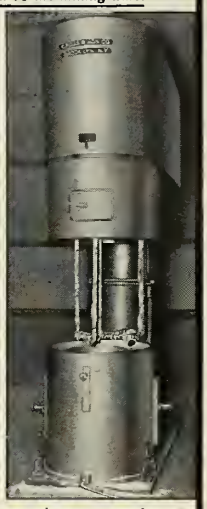
FOR PROPELLANT___ OR PLASTISOL*



ROSS DOUBLE PLANETARY

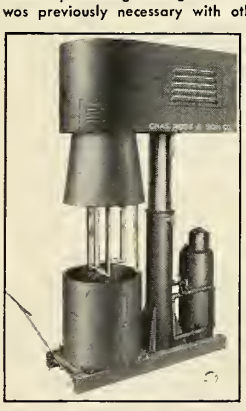
Change Can Mixers give better mixing in less time!

At *Thiokol*® solid propellant plant in Elkton, Md., this Ross #130CDM variable speed 100 gallon Mixer produces the same high quality mix as obtained in Horizontal Double Arm Kneaders, and in ⅓ the mixing time.



With no bearings or stuffing boxes in the product zone, stationary con, completely enclosed mix, and remotely controlled roising ond lowering device, the Mixers ore os sofe in operotion os they ore efficient. Mixers hove low originol ond mointenonce cost, ore eosy to cleon, ond extremely versotile in operotion.

Lower illustrotion shows on 85 gollon #130-CDM Double Plonetory Chonge Con Mixer furnished a leoding concern for mixing plostisols of severol types ronging up to 200,000 centipoises. Customer reports Mixer in operotion 24 hours/doy with mixing time per botch only 15-20 minutes; while the quolity of mix ond dispersion is so high thot the final product is obtoined in the Mixer olone — without further processing through o Three Roll Mill os wos previously necessary with other Mixers.



Jocketed cons for heoting or cooling moteriol during mixing, dolly trucks, gotes on cons for dischorge, ond vocuum tight covers con be provided.

*___or ony other heovy poste moteriol. On points, inks, phormoceuticol products, coulking compounds, ond other similor moterials, the Ross Double Plonetory Chonge Con Mixers mix ond disperse up to 30 times faster thon other Mixers.

Mixers ovoilable in 1, 2, 3, 4, 6, 8, 12, 20, 25, 65, 85, 125 ond 150 gollon sizes. *Write* for complete informotion on these or other types of Ross mixing, grinding or dispersing equipment!

CHAS. ROSS & SON CO., INC.

Leading mfgrs. of wet or dry grinding Mills, Kneaders and Mixers of all types — since 1869.

148-156 (M) CLASSON AVE., BROOKLYN 5, N. Y.

Circle No. 71 on Subscriber Service Card.



periscopes for canaveral's bunkers

With their viewing heads protruding from the domed bunkers at Cape Canaveral, Kollmorgen bunkerscopes provide a vital visual link between the launching pad and the observer. These instruments, used during launching operations and static tests, present images in true color, offer dual magnification and allow detailed observation in complete safety. They are ruggedly constructed to resist blast forces. Easy to operate, personnel need little if any special training in their use. Bunkerscopes require virtually no maintenance. Also, initial costs are generally lower than with other types of remote viewing systems. These instruments are easily adapted to photography and television purposes.

Working with optics, mechanics and electronics, the Kollmorgen Optical Corporation designs and manufactures many different types of remote viewing, inspection and testing instruments and systems. For a new illustrated brochure write Dept. 107.

KOLLMORGEN
optical corporation
NORTHAMPTON, MASSACHUSETTS

Circle No. 74 on Subscriber Service Card.

...new missile products

Potentiometer Uses Carpenter's Level Bubble

Hamlin, Inc. announces the introduction of a new EP 1012, Gravity Sensing Electrolytic Potentiometer which provides operation dependent upon the motion of an air bubble in a curved glass tube, similar to that found in a carpenter's level.

Three electrodes are sealed in a curved glass tube which is partially filled with an electrolytic solution. Electrodes are arranged so that when unit is in a horizontal position, the resistance from the two operational electrodes to the common electrode is equal. When unit is tilted, air bubble moves, causing resistance to increase on one operational electrode and decrease on the other.

If the EP 1012 is used as one-half of a bridge circuit in a 1000 Ohm bridge, with 12v applied, zero output results at the horizontal position. Tilting the unit ¼°, 4v of output results and at ½°, 8v. Designed to give an error signal with a small amount of deviation from the horizontal, unit reaches saturation at approximately ¾°.

Circle No. 249 on Subscriber Service Card.

Hydraulic Actuators Have Support Applications

A new line of rotary power hydraulic actuators has been introduced by **Vard, Inc.,** a subsidiary of **Royal Industries, Inc.,** Pasadena, Calif.

The actuators have an unusually high torque/inertia ratio and are designed especially for critical ground applications. They provide power for rotary vibration testing, angular load testing and high-powered angular positioning in flight simulation tables and missile exercise launching and handling equipment.

Model 30-87-120 is in depth 8" x 8½" wide and has a dry weight of 36 lbs. Its stall torque at 3000 psi in 8700 in-lb. and its internal leakage is .20 gpm. There is no internal snubbing in this model and its frequency response is rated at 0-200 cps.

The stall torque of Model 30-100-90S is 10,000 in-lb. at 3000 psi. This model, 7¾" x 8⅝" with a dry weight of 50 lbs., has 15-degree internal snubbing, .25 gpm internal leakage and a frequency response of 0-200 cps.

Last in this new series is Model 30-190-120, 10 3/8" x 10", with a dry weight of 80 lbs. Its stall torque at 3000 psi is 19,000 in.-lb. with no internal subbing.

Circle No. 250 on Subscriber Service Card.

Bendix
FRIEZ
offers:
Interesting opportunities for creative
ENGINEERS

in a recently enlarged, ultra modern facility in Suburban area North of Baltimore, Md.

SENIOR LEVEL OPPORTUNITIES...

. . . are available for both MILITARY & COMMERCIAL advanced developments in the following fields:

TELEVISION SYSTEMS—E.E.
Vacuum tube, transistor circuit designs and packaging for low-light level, high resolution military applications.

METEOROLOGICAL SYSTEMS—E.E.
Electronic weather reconnaissance equipment and advanced weather sensors.

ORDNANCE SYSTEMS—M.E.
Electro-mechanical arming and fuzing devices for precise, ultra-reliable missions.

COMMERCIAL CONTROL M.E. OR E.E.
Electronic and electro-mechanical devices for heating, ventilating and air-conditioning systems.

Send us a brief resume.
We will act fast!
ADDRESS REPLIES TO:
MR. D. J. FAUSNAUGH

Bendix
AVIATION CORPORATION
Friez Instrument Division
1400 Taylor Avenue
BALTIMORE 4, MD.

Circle No. 69 on Subscriber Service Card.

NOW!

General Chemical offers Helpful Technical Data on ROCKET FUEL OXIDIZERS



- ✓ Fuming Nitric Acid
- ✓ Liquid Fluorine
- ✓ Chlorine Trifluoride and other Halogen Fluorides

To assist specialists working in the field of rocket and missile propulsion, General Chemical now offers a valuable set of product information bulletins packed with physical and chemical data, tables and graphs. This information is based on General Chemical's extensive experience with these products as America's leading producer of fluorine and fluorine-based chemicals, and one of the nation's primary producers of nitric and other mineral acids. The questions our customers ask most often about these products are answered here.

Here are the specific bulletins offered:

"Nitric Acid, Fuming"—29 pages—Including detailed product description of both red and white fuming nitric acid, chemical and physical properties, corrosion data, directions for storage and handling.

"Fluorine"—21 pages—Including extensive data on the chemical and physical properties of this most powerful oxidizing agent, a description of materials and equipment for handling gaseous and liquid fluorine, safety precautions.

"Chlorine Trifluoride"—35 pages—Including the chemical and physical properties of chlorine trifluoride and other halogen fluorides, recommended materials for use in halogen fluoride systems, directions for safe handling.

Also available are bulletins on:

Handling Elemental Fluorine Gas In The Laboratory
Liquid Fluorine Unloading Procedure
Chlorine Trifluoride Vapor Pressures

Mail coupon now for your free copy of any or all 6 of these valuable technical bulletins.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

GENERAL CHEMICAL DIVISION MI-79
ALLIED CHEMICAL CORPORATION
40 Rector Street, New York 6, N. Y.

Please send the following General Chemical Technical Bulletins:

- ☐ "Nitric Acid, Fuming" (PD-TA-70751)
- ☐ "Fluorine" (PD-TA-85413)
- ☐ "Handling Elemental Fluorine Gas In The Laboratory" (PD-TA-85413A)
- ☐ "Liquid Fluorine Unloading Procedure" (PD-TB-85411)
- ☐ "Chlorine Trifluoride" (TA-8532-2)
- ☐ "Chlorine Trifluoride Vapor Pressures" (DA-85321)

Name_____

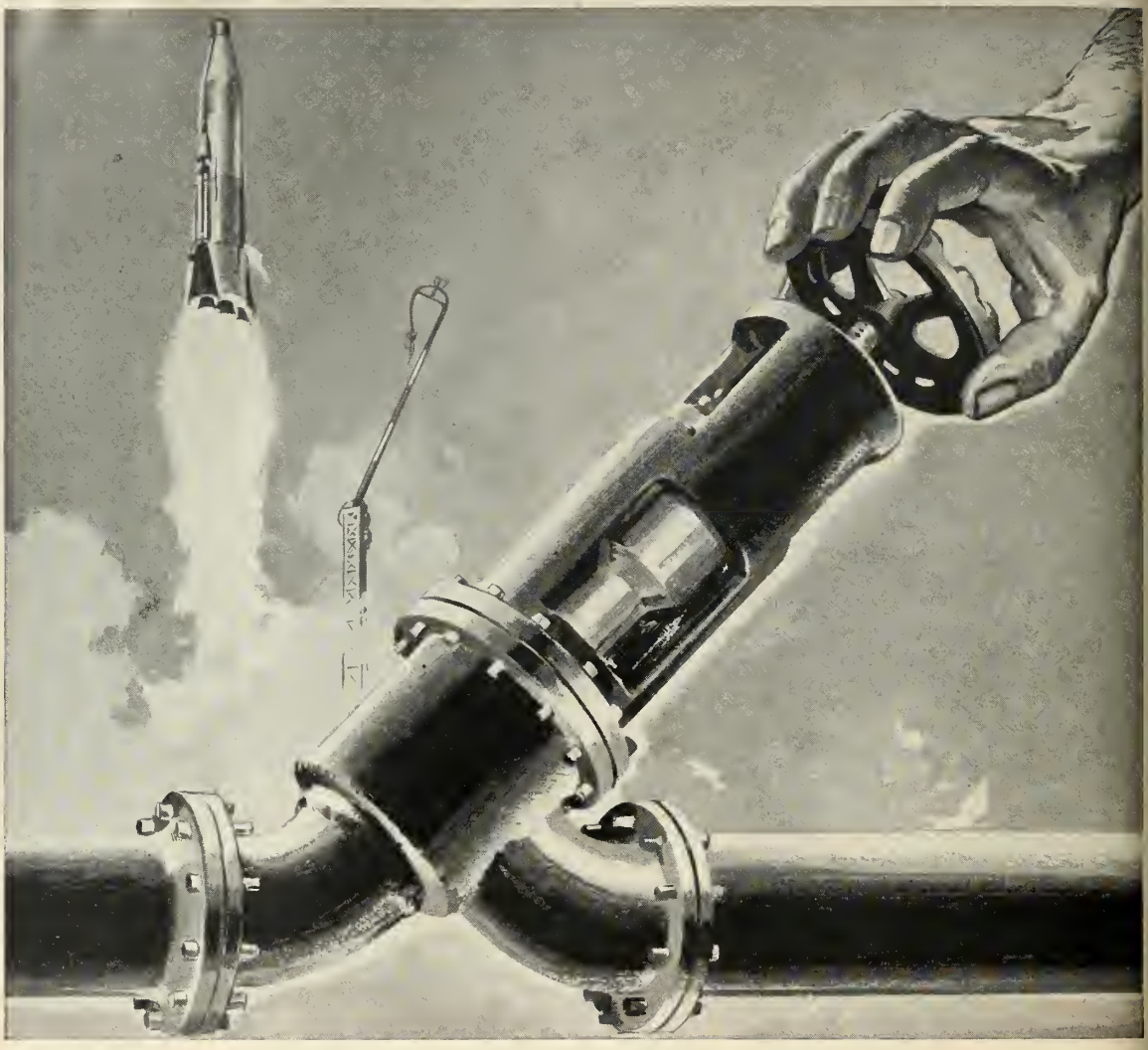
Title_____

Company_____

Address_____

City_____ Zone_____ State_____

Circle No. 89 on Subscriber Service Card.



Flow Before Flight . . . Controlled by Crane

At that critical point in launching preparations when liquid fuel is released to the missile on the pad, the valve that's opened is likely to be a Crane cryogenic globe valve.

Since 1855 it has been traditional with Crane to pioneer in valves for the newest applications in the newest industries. This leadership, together with Crane product quality and dependability, has made Crane the world's largest manufacturer of valves.

Whether your need is for special valves for missile fuel handling—or valves for a more "down-to-earth" application in the control of water, steam and air—Crane can meet all your specifications.

You will find the Crane handbook "Valves for Guided Missile and Rocket Services" very helpful in specifying for liquid fuels, gases, and other fluids used at launching pads, test stations and operating bases. Request your free copy, on your business letterhead, from your nearest Crane branch or write to address below.



Write for this free handbook

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Illinois—Branches and Wholesalers Serving All Areas

HYDRO-AIRE Division, Burbank, Calif.—Controls for Every Basic Air-Borne System

Circle No. 88 on Subscriber Service Card.

contracts

ARMY

$7,309,594—**Hughes Aircraft Company**, Fullerton, Calif., for 12 months' development work to improve the Missile Monitor antiaircraft defense system.

$1,937,078—**The Martin Company**, Orlando, Fla., for fire intergration equipment in conjunction with the Missile Master system.

$1,002,477—**Minneapolis-Honeywell Regulator Co.**, Hopkins, Minn., for a classified project.

Dynatronics, Inc., Orlando, Fla., has received a "more than a quarter of a million" dollar contract for research, development and production of a complex camera timing system to be used on the Atlantic Missile Range.

$600,000—**Avion Div., ACF Industries, Inc.**, Paramus, N.J., for production of radar beacons (subcontract from **Radio Receptor Co.**).

$59,800—**Strand Engineering Co.**, Ann Arbor, Mich., for data recorder.

NAVY

$6,000,000—**The Martin Co.**, Orlando, Fla., for production of *Bullpup* air-to-surface missiles for the Air Force.

$539,100—**Dale Benz, Inc.**, San Diego, for construction of *Nike-Zeus* test facilities, Point Mugu, Calif.

$392,499—**Atlantic Research Corp.**, Alexandria, Va., for research to design a rocketsonde system.

$385,295—**Minneapolis-Honeywell Regulator Co.**, Minneapolis, for 160 altitude control kits for M-1 autopilots.

$144,086—**General Mills, Inc.**, Minneapolis, for research on defense against ballistic missiles.

$136,532—**Technical Operations, Inc.**, Burlington, Mass., for research on defense against ballistic missiles.

$129,750—**Consolidated Systems Corp.**, Monrovia, Calif., for telemetry data processing system.

$100,761—**Industrial Research Associates, Inc.**, Baltimore, for research on defense against ballistic missiles.

$97,191—**Fairchild Engine & Airplane Corp.**, Alexandria, Va., for engineering services, facilities and materials necessary to conduct studies of the Pacific Missile Range.

$93,895—**Chance Vought Aircraft Inc.**, Dallas, for study of Roosevelt Roads Guided Missile Training Range.

$80,000—**University of Michigan**, Ann Arbor, for research on hypersonic flow with dissociation and ionization.

AIR FORCE

Radiation, Inc., Florida Division, has received a "multi-million" dollar contract for an advanced digital telemetering system for the *Minuteman* missile program (subcontract from **Boeing Airplane Co.**).

$[illegible],667,000—**Ryan Aeronautical Co.**, San Diego, for production of the advanced version of the *Firebee* target missile.

$8,000,000—**Airborne Instruments Laboratory, Div. of Cutler-Hammer, Inc.**, for 20 pieces of equipment designed to eliminate unwanted interference on radar screens used in the SAGE air defense system.

$6,500,000—**Vitro Laboratories, Div. of Vitro Corp. of America**, N.Y., for operation and maintenance of the Eglin Gulf Test Range for the Air Proving Ground Center.

$5,000,000—**Hoffman Laboratories Div., Hoffman Electronics Corp.**, Los Angeles, for production of specialized test equipment to be used with TACAN.

$1,017,028—**Del Mar Engineering Laboratories, Inc.**, Los Angeles, for target system, external tow, rocket and missile, type A/A 37U-2, 66 each, technical and engineering data and related spare parts.

$209,000—**RCA**, Moorestown, N.J., for one real time data handling system and ancillary equipment and data.

$102,540—**Continental Electric Co.**, Geneva, Ill., for various electron tubes (two contracts).

$84,000—**Eitel-McCullough, Inc.**, San Carlos, Calif., for various electron tubes.

$71,250—**Sylvania Electric Products, Inc.**, N.Y., for various electron tubes.

$58,000—**University of California**, Berkeley, for research on "tolerance and adaptability of the brain to environment imposed by space flight."

NASA

Hercules Powder Co., Philadelphia, has received a contract to supply fuel and plastic case for the third and fourth stages of Project *Scout* rocket (amount not disclosed).

MISCELLANEOUS

$2,250,000—**Federal Pacific Electric Co.**, New York City, for 5 kv metal-clad switchgear, control consoles and low-voltage controls for diesel generating units for missile launching and tracking facilities.

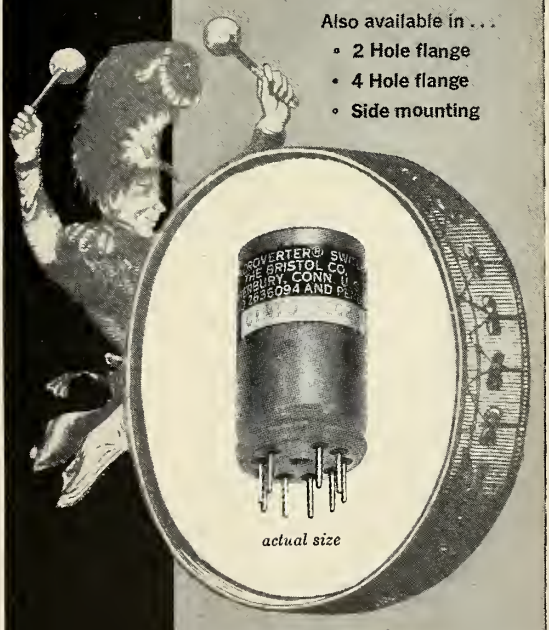
$642,986—**Microwave Associates, Inc.**, Burlington, Mass., contracts include one from the Navy for study and development in the field of Varactor diodes and parametric amplifiers, and two from the Air Force for design and development of a parametric amplifier for radio-astronomy use and microwave switching tubes.

$250,000—**Hallamore Electronics, Division of The Siegler Corp.**, Los Angeles, for design and production of a complex radio frequency signal generator for use in an advanced air-to-air missile (subcontract from **Hughes Aircraft Co.**).

BRISTOL
miniature
DPDT
chopper
C1430 Series

- Excellent tracking
- Miniature size
- Phase stability with temperature
- High vibration rating
- High contact rating
- Long life
- Reliability
- Versatility

Also available in . . .
- 2 Hole flange
- 4 Hole flange
- Side mounting



actual size

For complete specifications, write:
Aircraft Components Division,
The Bristol Co.,
150 Bristol Road,
Waterbury 20, Conn. 9.19

BRISTOL FINE PRECISION INSTRUMENTS FOR SEVENTY YEARS

Circle No. 80 on Subscriber Service Card.

airborne . . .
and
ground . . .

THE NEWEST
and the BEST in
TELEMETRY
COMPONENTS

DATA-CONTROL
SYSTEMS, INC.

Test Oscillator GTO-3



Occupies only 7 inches of rack space. Provides 18 simultaneous, precise calibration frequencies for standard IRIG channels, five frequencies within each subcarrier channel. Upper 5 channels may be adjusted by front panel control for 7.5% or 15% deviation. All solid-state, no moving parts, programmed action, provision for automatic print-out.



VOLTAGE-CONTROLLED OSCILLATOR AOV-3

Miniature subcarrier oscillator. Transistorized construction permits use to 125° C. Ultra linear. Single supply voltage. Controls available for operator convenience. All IRIG channels. 1⅞" x 1⅞" x 1½".

DCS DATA-CONTROL SYSTEMS, INC.
Danbury, Connecticut

ENGINEERS: Career opportunities! Write Mr. Fred Haslam, Personnel Dept.

Circle No. 77 on Subscriber Service Card.

propulsion engineering

Missile applications of flame-plating . . .

are spelled out for M/R by H. V. Mosby, new products department, **Linde Company** division of **Union Carbide Corp.** (See this column, March 30.) Among the propulsion applications, Mosby suggests combustion chamber plating, pump seal coatings, valve coatings, fuel injector rings. Here are details on these "Plasmarc" applications:

Liquid-fuel combustion chamber . . .

can be plated internally with tungsten carbide or other metallic carbides to reduce erosion and oxidation, improve performance and reliability. The plasma arc process can apply aluminum oxide coatings to high-performance engines to cut down overheating and reduce problems caused by corrosive fuels.

Turbine pump shaft seals . . .

plated with tungsten carbide can operate at high rpm in hot gas environments. Mosby says parts flame-plated with tungsten carbide operate up to five times longer than chrome-plated parts.

Valves . . .

plated with aluminum oxide show considerable improvement in controlling hot gas flow.

Fuel injector rings . . .

can be flame-plated with tungsten carbide to eliminate localized hot spots that develop during ignition and cut-off. Without plating, fuel injector rings often are scarfed by impingement of oxygen or fuel mixtures rich in oxygen.

Tungsten carbide and aluminum oxide . . .

are only two of the coatings that can be applied by the flame-plating process. Actually, Mosby says, coatings can be made from almost any material that does not decompose on melting. Some materials available now include tantalum, molybdenum, palladium, platinum, rhenium, zirconium diboride. Also, some of these combinations can be flame-plated: tungsten alloyed with chromium, molybdenum, rhenium; tungsten blended with zirconia, alumina and other metal oxides. Linde Company says its scientists are making rapid progress on many other types of high-temperature coatings.

Plasma arc coating . . .

works this way: Oxygen and acetylene are fed into a special "gun." Powdered particles of the desired coating are then fed in and suspended in the mixture. Following ignition, detonation takes place, the detonation wave carries the particles at 10 Mach through the gun barrel to the surface to be plated. At the same time, the detonation heats the particles to plasticity. When they hit the surface to be plated, the particles embed themselves in the surface, and a small welding action takes place at the site.

Temperatures are reasonable . . .

although temperatures inside the equipment or "gun barrel" reach 6000°F, the surface temperatures seldom exceed 400°F. This means that the material to be coated gets hot enough to do the job—to embed and adhere—but the surface under treatment does not get hot enough to warp or to change its properties. Linde says this about finishes produced by the technique: "Flame-plated coatings have an as-coated smoothness of 125 microinches rms, and can be finished down to better than one microinch rms." Coatings have a porosity of less than 1%.

Tools for the industry . . .

will be made better, also thanks to the plasma arc technique. Tools can be made temperature-resistant, harder, corrosion-resistant with flame-plated coatings. Examples: Spindles, bushings, gages, mandrels, dies, and core rods.

—letters

Praise for Reporting

To the Editor:

In your June 22 issue, the article "Prospects for Thermoelectricity" by Hal Gettings is of extreme interest to my department here at **Westinghouse, Aircraft Equipment Department,** Lima, Ohio. I would like to reproduce this article for the education of our Sales and Engineering personnel.

Incidentally, in my personal opinion the article is more comprehensive than any I have read to date on this subject. Please accept by sincere congratulations on a fine piece of reporting.

Stan McNair
Advanced Systems Application
Department, AED Sales
Westinghouse Electric Corp.
Lima, Ohio

Units—Another Viewpoint

To the Editor:

There seems to be much concern about the use of units in astronautics (M/R, April 27, p. 21). This is of course not a new situation—it has indeed been with us in physics, chemistry and technique for a long time.

Basically, there are two ways to develop a system of units:

1. The "naive" way—you just want to give factual information regarding velocity, time, place, etc.

Here any accepted and well-defined unit is sufficient. The metric systems are in this class—the use of nonmetric systems should be recommended, because their definitions are often unprecise (knot, foot, etc.)

Furthermore, convenience is the only other criterion—avoid all philosophy. So we demand such simple conversion factors as one, or powers of ten. The metric system again is clearly superior to the nonmetric systems.

2. The "theoretical" way—the number shall give ready information about the nature of the measured phenomenon. Mach number is an outstanding example.

In astronautics the analogue to the velocity of sound seems to be the parabolic speed. As this is a strong function of distance, and ill-defined in practical multi-body problems, its scientific meaning is not very pronounced. Therefore, besides the statement that a certain velocity is clearly hyperbolic, etc., no system of units should be built around parabolic velocity.

Reference to the speed of light is not to be recommended at all because of the uncertainity of the unit. "Einstein-Numbers" can be defined in various ways, but are obviously of little concern today. If one wants to use them, clear definitions as to coordinate system and way of measurement are mandatory. Summarizing, it is my feeling that in this fundamentally less-precise Class Two we do not need more than the elliptic, etc., velocity, or for very advanced work some kind of well defined Einstein number.

Sometimes of course the nature of the phenomenon being considered forces us to use a special set of units, because the knowledge is better in this set than in any other. A good example is the distance-measure "Astronomical unit" within the solar system: This of course disguises only lack of knowledge, because whenever this situation arises, the unit itself is not well known. Still it may be practical to use the "natural units" (Astronomical Unit, year, etc.), but then again there is no speculation about the "best system of units." This question has meaning only for one particular problem, eg. motion is the solar system.

There is only one basic weakness of the metric system of units—the units of time are nonmetric. As it seems to be extremely difficult to change this because of its world-wide use, there appears to be no room for a better system. Just another system will only add to the confusion without improving the situation.

Difficulties arising from units of mass and force, and some others in the electromagnetic field, have their source partly in inconvenient names, and partly in lack of training or understanding.

"To get small numbers by convenient units" is of course a fallacy, as meaningless digits can always be expressed as an exponent of a convenient base, usually

We are **FIRST** in

ROKIDE

Applications on the WEST COAST

—and the best evidence we can give you is the following list of customers who have used our services for years:

- **MARQUARDT • AEROJET • CONVAIR**
- **THIOKOL • NORTH AMERICAN**
- **DOUGLAS • ROCKETDYNE**
- **AIR RESEARCH • AUTONETICS**
- **GRAND CENTRAL ROCKET**

—and R & D ROKIDE Coatings, as well as all Ceramic Coatings on Missiles Produced in This Area, Including:

- **Polaris • Hawk • Terrier**
- **Minute Man • Aerobee • Sparrow**
- **Vanguard • Titan • Bomarc**
- **Super Bomarc • Genie**

and many others.

Send TODAY for your Copy of "Metallizing in ALL Its Phases"—then you'll have the complete picture of our services and facilities.

Yes, Just Another FIRST by

METLA METALLIZING CO. of Los Angeles

1233 So. Boyle Ave., Los Angeles 23, Calif.

Circle No. 75 on Subscriber Service Card.

NEW GENISCO MINIATURE ACCELEROMETER

Weighs only 3 ounces; measures just 1 1/16" x 1" x 1 7/8"!

The new Model GMA Accelerometer is a fluid damped, potentiometer output instrument, particularly suited for flight and fire control and telemetering applications. Now in production.

Brief Specifications

Range: ±0.5 g to ±100 g's
Natural Frequency: 12 cps to 75 cps
Linearity: ±1% of full scale
Damping: Nominally 0.7 of critical at 75°F.
Temperature: Operates to specifications between −20°F and +185°F.
Vibration: 10 g's, 10-20,000 cps, any axis
Shock: 50 g's for 7 ms, any axis



MODEL GMA

Send for complete specifications to the Instrument Division:

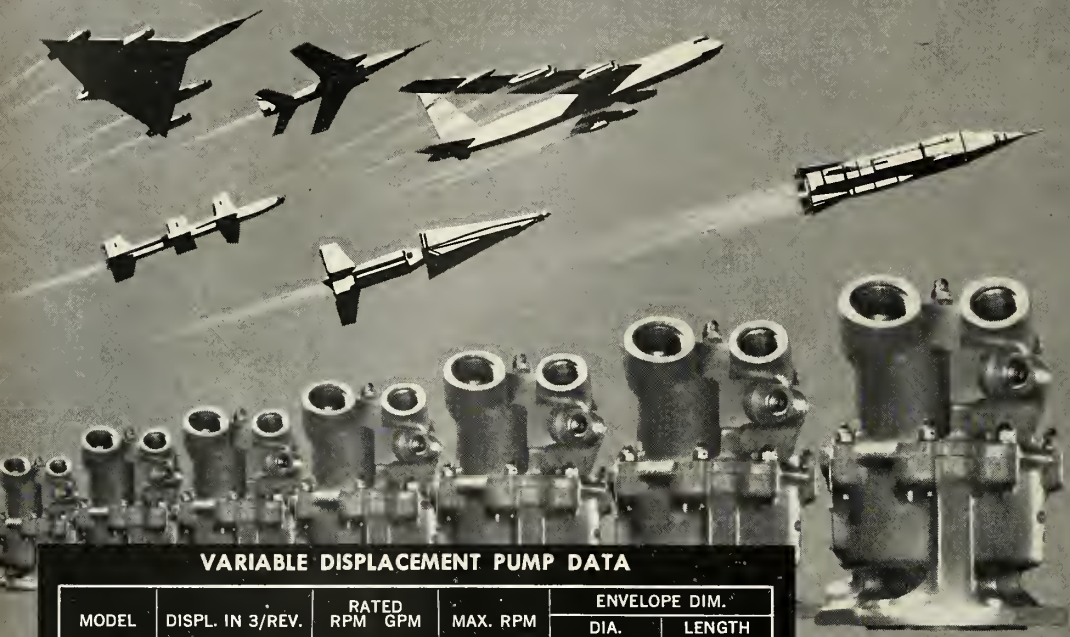
Genisco INCORPORATED

2233 Federal Avenue, Los Angeles 64, California

Circle No. 76 on Subscriber Service Card.

YOU ASKED FOR IT . . .

FOR MISSILE AND AIRCRAFT SYSTEMS . . .



VARIABLE DISPLACEMENT PUMP DATA

MODEL	DISPL. IN 3/REV.	RATED RPM	RATED GPM	MAX. RPM	ENVELOPE DIM. DIA.	ENVELOPE DIM. LENGTH
P175	1.750	4000	29.4	5000	5.750	8.320
P105	1.050	4000	17.3	6000	5.250	7.250
P56	.568	6000	13.9	8000	4.687	6.625
P16	.163	12000	7.9	16000	3.000	4.250
P11	.115	12000	5.5	16000	2.750	3.625
P064	.064	12000	3.1	18000	2.125	3.125
P044	.044	12000	2.1	18000	2.125	3.062

A NEW FAMILY OF BENDIX CONSTANT AND VARIABLE DISPLACEMENT HYDRAULIC PUMPS

SMALLER • LIGHTER • FEWER PARTS • SYMMETRICAL ENVELOPE • COMPACT • RUGGED DESIGN

INHERENT HIGH SPEED CAPABILITIES • SUPERIOR CONTAMINATION TOLERANCE • HIGH RELIABILITY

The rugged, simplified construction of Bendix® hydraulic pumps plus precision production and quality control experience provide pumps with increased reliability for missile and aircraft systems. Smaller envelopes permit interchangeability with existing installations and compact packaging for new applications. Thousands of hours of endurance, qualification and flight testing have proven the Bendix family of hydraulic pumps will exceed all existing customer and military requirements.

Pumps are furnished as separate components or as an integral part of complete sub-systems. Standard pumps are furnished with forged aluminum housings for temperatures up to 400°F. and pressures up to 4,000 psi. Previous qualification of pumps for 550°F. assures you of high reliability for lower temperatures and availability of proven pumps for high temperature systems.

Advanced engineering, laboratory, precision manufacturing and complete service facilities are available for producing and servicing Bendix hydraulic pumps. This assures you of a quality pump manufactured specifically for your application.

All pumps are assembled and tested in a new air conditioned, humidity-controlled, dust-free area assuring contaminate-free pumps as delivered.

MAJOR PRODUCTS—aircraft and missile hydraulic pumps; hydraulic components and sub-systems; engine fuel pumps and fuel system components; precision bellows and bellows assemblies; thermostats and related sub-assemblies; and sub-contract manufacturing and brazing.

Hamilton Division

HAMILTON, OHIO

Bendix

AVIATION CORPORATION

ten, and the meaningful digits have only to do with the accuracy of the information, and not with the unit.

Harry C. Ruppe
Lunar and Interplanetary Flight Unit, S & M Lab
ABMA
Redstone Arsenal, Ala.

Inverted Silo Data

To the Editor:

Can you refer us to a source of information regarding the inverted launching silo mentioned in your May 4 editorial? We would like to know whom to contact regarding the requirements of construction.

A. P. Brietzke
Professional Engineer
Northern Engraving & Mfg. Co.
La Crosse, Wis.

Air Force Ballistic Missile Div., Los Angeles 45, Calif., and the Los Angeles District Corps of Engineers . . . Ed.

Operation Skycatch

To the Editor:

We were quite pleased with the fine treatment you gave us on the index page of your May 18 issue on our "Operation Skycatch" concerning the *Polaris* launching system.

I did want to point out one small error in the caption, however, in case any of your sharp-eyed readers should pick it up. In the last sentence of the caption, you indicated that **Westinghouse** was the prime contractor under **Lockheed** for the launching system. Actually, Westinghouse is prime contractor under the Navy for the development of the launching system for the *Polaris*.

R. V. McGahey,
Manager
Technical Publicity
Westinghouse Electric Corp.
Pittsburgh, Pa.

Facing the Facts

To the Editor:

I should like to express my appreciation of what may be called the "boldness" of information given through M/R. Information concerning the rocket field offered by our daily newspapers seems to be a playing ground and training ground for little would-be Joe Goebbelses particularly ambitious to ignore dangerous performances of the people behind the Iron Curtain. M/R, however, gives the impression that your people keep their eyes open and that there are men to strain their brains and financial resources in order to keep and come abreast and to overtake THEM.

E. Jaeger, ing. diplômé
6 Hettlerstrasse
Weiningen ZH
Switzerland

Objection Overruled

To the Editor:

In the news item concerning the scientists' protest against secrecy (June 22, p. 39), M/R used the phrase "consensus of opinion." This is incorrect English; correct usage is "consensus of 17 Nobel . . .," or "opinion of 17 Nobel . . ."

E. St. Thomas
Patrick AFB, Fla.

Webster says "consensus of opinion," while still objectionable to some, is now generally considered to be correct usage.

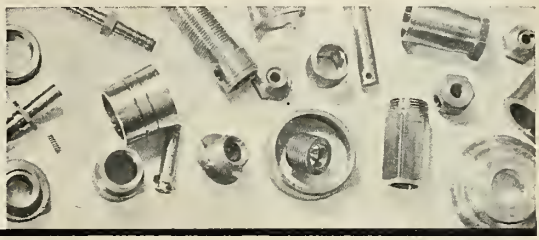
RECYCLING REFERENCE

To the Editor:

Your article on space feeding (June 15) seemed to strike a chord but it has taken me some time to track down the quotation. With reference to the paragraph commencing "Water Recovery" I would suggest you read . . . II Kings, Chap. 18, Verse 27 . . .

F. H. Smith
Librarian
The Royal Aeronautical Society
London

When you need parts like these . . .



SHOP AT THE WEST'S ONLY **SUPERMARKET FOR MACHINED PARTS**

SHOP AT **SCREW PRODUCTS CORPORATION...**

largest and best equipped screw machine plant in the west



ONE-STOP SERVICE FOR:
Screw machine products
Shaping • Grinding
Threading • Milling
Drilling • Tapping
Broaching • Stamping
Tooling • Tap and gauge grinding • Buffing
Sanding • Finishing

FEATURING:
Prototypes • Mass production • 103 automatic screw machines (up to 6" capacity)
368 different machine tools at your service • Light assembly • 76,000 sq. ft. of manufacturing area • $1,000,000 worth of tools & dies on hand
500,000 parts produced per day



Our 30th Anniversary 1929 1959
COMPAS SERVICE QUALITY SINCE 1929

SCREW PRODUCTS
Corporation of America

Here, you can get all your machining operations under one roof... with highly skilled engineers and operators, complete production and quality control, accuracy, quality and "on-time" prompt delivery...precision "know-how" backed by 30 years of service to the West Coast...true economy by elimination of "re-work" through proper planning, preparation and control. Mass production and prototype work especially invited. Prototype department efficiently organized, staffed, and with high-precision special purpose machines to work from the blueprint, through prototype, and out to production. **Write today on your letterhead for 36-page facilities brochure in full color.**

5211 SOUTHERN AVENUE, SOUTH GATE, CALIFORNIA, TELEPHONE LORAIN 6-5141

Circle No. 78 on Subscriber Service Card.

Circle No. 90 on Subscriber Service Card.

NOW..

HIGH PRESSURE HOSE FOR AIRCRAFT AND MISSILES

STRATOFLEX

SUPER "T-HP" Teflon* HOSE

with
medium pressure "SUPER-T" RELIABILITY



Withstands tests more severe than MIL-H-8788

- High Temperature Spectrum tests exceed MIL-H-8788 in both impulse and temperature requirements and fully qualified to ARP 604.
- Positive lock fitting through elimination of socket hex.
- Available with swivel elbows that can be rotated without disturbing the wire grip lock.
- Stratoflex High Pressure Fitting combines the exclusive Pressure Activated Gland Seal and the assurance of crimp design.
- Shelf life practically unlimited.
- Available in two styles of high temperature fittings. Combination of stainless steel and carbon steel, or corrosion resistant all stainless steel fittings.

Hose assemblies are factory assembled from stock with straight, 45° and 90° fittings. Other angles or connections are made to your specifications. WRITE FOR BULLETIN S-7 TODAY!

*Teflon is a registered DuPont trademark

SF7-9

STRATOFLEX Inc.

P.O. Box 10398 • Fort Worth, Texas
Branch Plants: Los Angeles, Fort Wayne, Toronto
In Canada: Stratoflex of Canada, Inc.

A KENDAVIS INDUSTRY

SALES OFFICES:
Atlanta, Chicago
Cleveland
Detroit, Fort Wayne
Fort Worth
Houston, Kansas City
Los Angeles
New York, Philadelphia
Pittsburgh
San Francisco, Seattle
Toronto, Tulsa

New Contracts to Push Thermoelectric Research

WASHINGTON—Contracts totalling over $1 million for continuing research work in thermoelectricity were awarded during the last quarter of FY '59 by Navy Bureau of Ships, coordinator for the armed services program in this field.

About half this amount is for two five-kilowatt generators. The balance is for development of new semiconductor materials and high-temperature research. A number of additional contracts are expected to be awarded this month after the beginning of FY '60.

New contracts listed include the following:

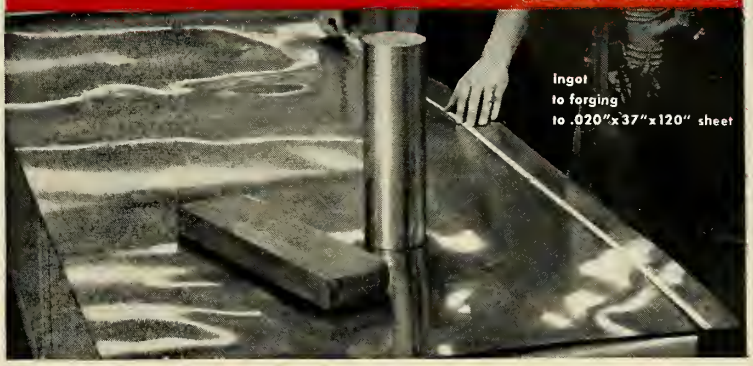
- Naval Engineering Experiment Station, Annapolis—$25,000/year
- Naval Boiler and Turbine Laboratory—$50,000/year
- **RCA** (Laboratories Division, Princeton)—$147,000
- RCA (Sarnoff Research Center)—$77,000
- **National Carbon Company**—$240,000
- University of Pittsburgh—$17,000
- **Carrier Corporation**—$194,000
- **Westinghouse Electric**—$342,475

Earlier efforts in this field, under the supervision of BuShips, have already produced significant results (M/R, 22 June). Most of these efforts have been in the so-called Areas B and C—the temperature range below 1500°K. For useful applications in missile and satellite auxiliary power, however, which require radiation cooling of the cold junction, this range must be extended up to the 2000°K mark. At higher temperatures the common semiconductors used in the successful work to date cannot be used: they melt, become bipolar-conductive, or oxidize. Thus, progress apparently depends upon finding new and better materials.

As mentioned, the highest temperature requirements are in the radiation-cooled systems. Here, fortunately, power per pound is more important than efficiency and very low thermal conductivity is not desirable. According to calculations, a space vehicle generator operating at an acceptable two percent efficiency could deliver a 10-amp current and would weigh somewhere between 45 and 208 pounds per kilowatt.

Considerable work is also being done on the reverse of thermoelectric power generation: Peltier cooling. Applications have already been made in infrared detector cooling and a wide field of electronic temperature control is being explored.

2 MORE FANSTEEL SPACE-AGE ALLOYS with High Strength-To-Weight at HIGH TEMPERATURES



FANSTEEL 80 METAL

Alloy—Columbium-zirconium

Melting Point—4350°F.

Density—
8.6 groms per cc (0.311 lb. per cu. in.)

Tensile Strength—
Anneoled 70°F.; 47,000 psi.

Stress-To-Rupture—
100 hr. 2000°F.
(argon) 18,800 psi.
500 hr. 2000°F.
(argon) 11,000 psi.

Other Praperties—Ductile to brittle transition temperotures in anneoled state are well below room temperoture.

Advantages ond Uses—Extremely high strength-to-weight ratia for high temperoture opplications. Excellent weldability, ductile welds with little or no tendency to frocture in heot affected zones. Easy fabricotion at raom temperature, os warked or annealed. For missiles, rockets, spocecroft, other high heat applicatians.

FANSTEEL 82 METAL

Allay—Columbium-tantalum-zirconium

Melting Point—4550°F.

Density—
10.26 groms per cc (0.371 lb. per cu. in.)

Tensile Strength—
Anneoled 70°F.; 55,000 psi.
2000°F. in oir; 29,600 psi.
2400°F. in air; 11,700 psi.

Stress-Ta-Rupture—
100 hr. 2000°F. (orgon) 17,500 psi.
500 hr. 2000°F. (argon) 13,500 psi.

Other Properties—High oxidation resistonce compared to pure refroctory metols. Oxide film is tenacious, non-volotile, tends to form protective caoting. 16-hour, 2000°F. tests in flowing oir show remarkobly law scaling of 0.01 cm.

Advontoges ond Uses—Exceptionally suitable for oir-frames ond certain missile opplications. Provides desirable strength-to-weight odvantages ot higher temperatures plus the same workability, weldobility ond ductility of Fansteel 80 Alloy.

AVAILABLE in ingots, forgings, bor, rod, plate, sheet ond fobricated ports.
Write for lotest technicol bulletins.

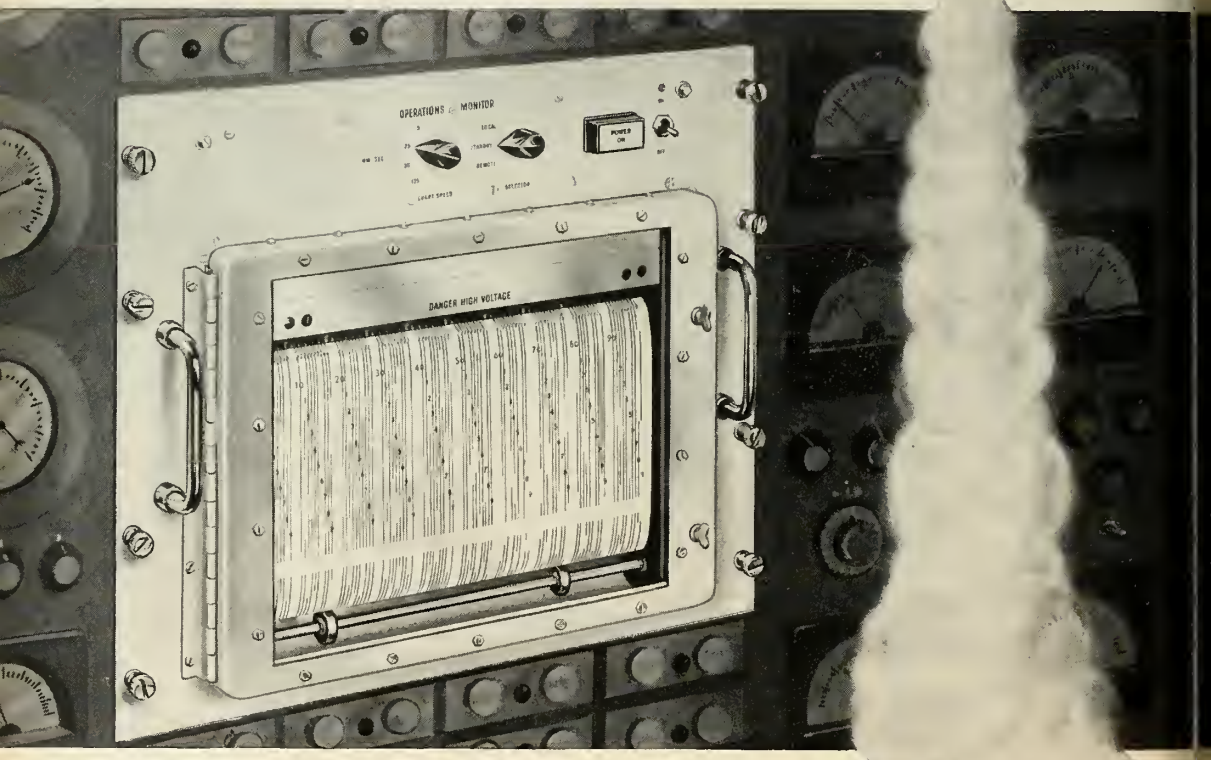
FANSTEEL — HIGH TEMPERATURE METALS

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

Circle No. 72 on Subscriber Service Card.

BUILT TO MIL SPECS...

one Brush Monitor records 100 countdown operations simultaneously!



Built to military specifications and performing to extremely rigorous military requirements, the Brush Operations Monitor can prevent aborts and destructs costing millions of dollars.

For quick, accurate and immediately visible go and no-go information, 100 operations are recorded simultaneously on a 500′ moving chart only 12″ wide. You have an *immediate* picture of an entire situation with each event shown in a time relationship to all other events. It is now being used for major check-out of propulsion systems, electrical test racks, fault isolation programmers and launch control vehicles.

Brush is now in production on this Mil Operations Monitor and prompt delivery can be made to your requirements. Phone or wire Brush for complete information and application assistance.

WRITE FOR FREE BOOKLET... "Brush Operations Monitors for Supervisory Analysis and Control." Contains specifications and application data.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS | CLEVITE | CLEVELAND 14, OHIO

—when and where—

JULY

The American Rocket Society, Propellants and Combustion Committee, "Propellants, Thermodynamics and Handling Conference," Ohio Union, Ohio State University, Columbus, July 20-21.

Second Annual Institute on Missile Technology, Chief of Research and Development, U.S. Army, University of Connecticut, Storrs, July 26-Aug. 7.

The Denver Research Institute of the University of Denver, 6th Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 30-31.

AUGUST

Institution of Investigation of Biological Sciences, sponsored by Air Force Office of Scientific Research-Aeromedical Div., and World Health Organization. Montevideo, Aug. 2-7.

Association of the U.S. Army, Annual Meeting, Sheraton Park Hotel, Washington, D.C., Aug. 3-5.

American Astronautical Society, Second Annual Western Regional Meeting. Ambassador Hotel, Los Angeles, Aug. 4-5.

William Frederick Durand Centennial Conference, The Problems of Hypersonic and Space Flight, Stanford University, Stanford, Calif., Aug. 5-7.

Aircraft Structural Fatigue Symposium, sponsored by ARDC'S Wright Air Development Center, Wright-Patterson AFB, Dayton, Ohio, Aug. 11-13.

Institute of Radio Engineers' Professional Group on Ultrasonic Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

Institute of Radio Engineers, Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 18-21.

AFOSR/Propulsion Research Division, Directorate of Aeronautical Sciences Office of Naval Research, Office of Ordnance Research & National Aeronautics and Space Administration, Symposium on "The Dynamics of Ionized Cases," Northwestern University, Evanston, Ill., Aug. 24-25.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare (classified), San Diego, Aug. 24-26.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

Army-Navy Instrumentation Program, Annual Meeting, Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Aug. 31-Sept. 2.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkeley, Calif., Sept. 2-4.

Air Force Association and Panorama: send reservations to AFA Housing Bureau, P. O. Box 1511, Miami Beach. Sept. 3-6.

AFOSR/Directorate of Aeronautical Sciences, Office of Naval Research, National Science Foundation, Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Sept. 9-11.

Institute of the Aeronautical Sciences, Western Regional Meeting on Frontiers on Science and Engineering, Los Angeles, Sept. 16-17.

Standards Engineering Society, Boston Section Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, Conference, and Exhibit, Chicago, Sept. 21-25.

Industrial Nuclear Technology Conference, sponsored by Armour Research Foundation of Illinois Institute of Technology, Nucleonics Magazine and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

Institute of Radio Engineers, 1959 National Symposium on Telemetering, Civil Auditorium, San Francisco, Sept. 28-30.



BRONZE POWDERS FOR FINER FILTERS

The critical operating conditions of today's jet aircraft and missiles could not be met without the dependable, ultrafine filtration of fuels, propellants, lubricating and hydraulic fluids provided by modern, porous metal filters.

These porous metal filters—fabricated from MD bronze powders that meet the most exacting physical and metallurgical requirements—may well be the answer to your own fine filtration problems. MD makes only the filter powder, not complete filters, but we will be glad to send you a comprehensive list of filter fabricators.

ALUMINUM POWDERS OF CONTROLLED PARTICLE SIZE

Aluminum powders of controlled particle size also play an essential role in the missile and rocket program. MD has 44 years of experience in producing these powders. We will welcome the opportunity to discuss your requirements.

OTHER METAL POWDERS AVAILABLE FROM MD ARE

ANTIMONY • BISMUTH • CADMIUM
COPPER • IRON OXIDE • LEAD • MANGANESE
NICKEL • SOLDER • TIN • TITANIUM • ZINC

Remember—for metal powders your best source is Metals Disintegrating Company, world's largest manufacturer of finely divided metals.

METALS DISINTEGRATING COMPANY, INC.

GENERAL OFFICES: Dept. Y, Elizabeth B, N. J.
Circle No. 79 on Subscriber Service Card.

Circle No. 91 on Subscriber Service Card.

FIREBEE···THE HIT OF PROJECT WILLIAM TELL

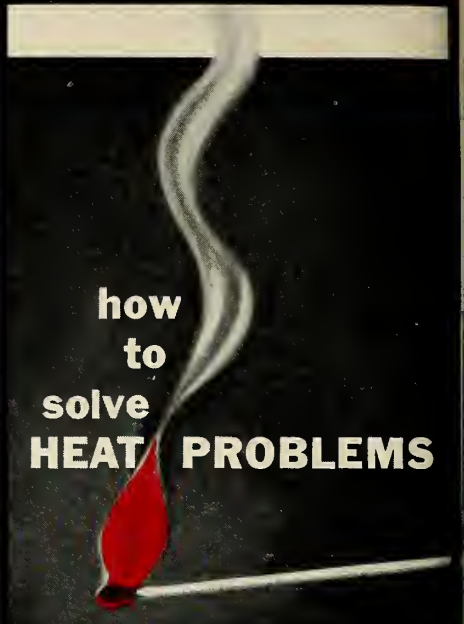


"I'll never want to fire at towed targets again!"

That's the typical reaction of Air Force interceptor pilots after they fired at Ryan Firebee jet targets during the recent "Project William Tell" Weapons Meet.

78 Firebees, launched off the Florida coast, brought combat realism to the 10-day meet. Acting as "enemy" jet bombers, the free-flying Firebees streaked in at over 500 mph, from 14,000 to 42,000 feet, and flew an average of 31 minutes each.

Air Force pilots and weapons systems crews met this realistic test with the most impressive teamwork and skill ever displayed at a weapons meet.



Fastest way to solve space age heat problems of aircraft and missiles is to put Ryan to work for you.

Ryan has spent 20 years in applying advanced metallurgy to production techniques with 35 high-temperature alloys ...has fabricated them into critical hot parts for many major power plants...has put them into volume production.

Ryan hot parts are giving outstanding service in turbo-jets, afterburners, prop-jets, ramjets, rockets, and piston engines. That's why Ryan has the answers to high-temperature problems—from hot parts to complete engine packages.



Sharp new eye for navigation

Six major types of Navy aircraft will be equipped with Ryan continuous-wave Doppler navigation systems under an initial $20-million contract awarded by the Navy to Ryan's Electronics Division.

Developed in cooperation with the Navy, these advanced electronic systems are the lightest, simplest, most compact, most reliable of their type.

This new order, one of the largest of its kind, further emphasizes Ryan's leadership in electronic navigation and guidance systems.

Ryan offers outstanding challenges to engineers

RYAN BUILDS BETTER

AIRCRAFT • POWER PLANTS • ELECTRONICS

Ryan Aeronautical Company, San Diego, Calif.

Circle No. 92 on Subscriber Service Card.

Third Annual

GUIDED MISSILE ENCYCLOPEDIA

1959

An Exclusive Weapon System Roundup for Industry
Compiled and Written by
MISSILES & ROCKETS' Editors
Directed by James J. Haggerty, Jr., M/R Contributing Editor

Copyright, 1959, by
American Aviation Publications, Inc.

Some of the specifications and performance figures given for the missiles and rockets in this encyclopedia have been calculated and have not necessarily been officially confirmed.

U.S. AIR FORCE

Atlas 138
Titan 139
Thor 140
Snark 141
Mace 142
Matador 142
Bomarc 143
Falcon 144
Genie 145
Hound Dog 146
Quail 146
Missiles of the future 147

U.S. ARMY

Jupiter 148
Redstone 149
Corporal 150
Sergeant 151
Honest John 152
Little John 153
Lacrosse 154
Nike-Ajax 155
Nike-Hercules 155
Hawk 156
Missiles of the future 157

U.S. NAVY

Polaris 158
Regulus 159
Weapon Able 159
Talos 160
Terrier 161
Sidewinder 162
Sparrow III 163
Zuni 164
Bullpup 165
Missiles of the future 166

GREAT BRITAIN 167

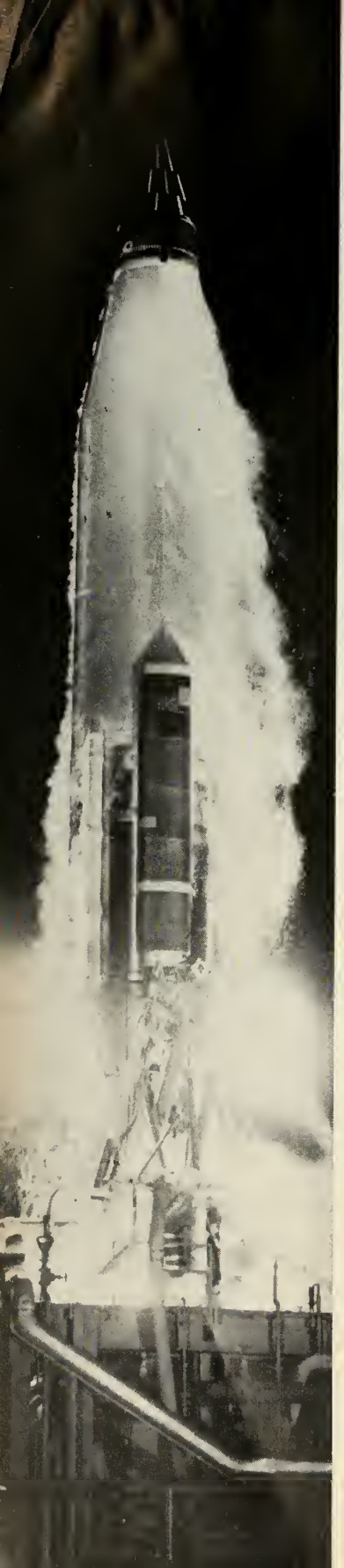
FRANCE 169

ITALY 171

SWEDEN 171

SWITZERLAND 171

SOVIET UNION 172

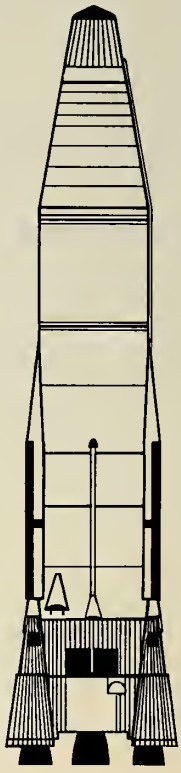


ATLAS *U.S. AIR FORCE Surface-to-Surface*

The first United States intercontinental ballistic missile, *Atlas* is going through the final stages of its development and is rated by the Air Force as having "initial operational capability." Missiles are being delivered to the first operational user, the 576th Strategic Missile Squadron at Vandenberg Air Force Base, Calif.

Also known as *WS-107* and *SM-65*, *Atlas* has been fired about 30 times since its first flight in June, 1957, with varying degrees of success. A full-range flight of more than 6300 statute miles was made in November, 1958. The following month, an *Atlas* was launched into orbit as part of the USAF's space research program.

Designed to impact a target more than 5500 nautical miles distant with an error of less than two-tenths of one per cent, *Atlas* is guided over approximately the first 10% of its flight. Three liquid-propelled rocket engines generate launch power. The two boosters drop away after about two minutes blast output and the missile continues on the power supplied by its lower thrust sustainer. Two verniers located on the lower portion of the body supply roll control and thrust adjustment throughout second-stage flight.



SPECIFICATIONS

DESIGNATION: SM-65 (WS-107A-1)
PRIME CONTRACTOR: Convair (Astronautics) Div. General Dynamics Corp.
STATUS: Development and initial operation
RANGE: 5500 nautical miles plus
VELOCITY: 17,000 mph
FRAME
- Stages: 2
- Manufacturer: Convair
- Length (Overall), ft: 81
- Diameter (Body), ft: 10
- Weight (Gross), lb: 260,000
- Material (Major): Steel

GUIDANCE
- Manufacturer: GE/Burroughs; Arma
- Type: Radar-Doppler Command (later models all-inertial)

POWERPLANTS
- First Stage (Booster)
  - Manufacturer: Rocketdyne
  - Propellants: Liquid oxygen and kerosene
  - Type & Number: Regenerative liquid (2)
  - Thrust, lb: 150,000 each
- Second Stage
  - Manufacturer: Rocketdyne
  - Propellants: Liquid oxygen and kerosene
  - Type & Number: Regenerative liquid (1)
  - Thrust, lb: 60,000

WARHEAD
- Type: Nuclear

GROUND SUPPORT MAJOR CONTRACTORS
- Launcher: Consolidated Western Steel, National Steel
- Fueling: AiResearch Mfg. Co., Reaction Motors
- Radar & Ground Control: Norden, A Div. of United Aircraft
- Handling & Services: Goodyear Aircraft
- Transport Vehicles: Goodyear Aircraft
- Checkout Equipment: Radio Corporation of America, Consolidated Systems Corporation, Minneapolis-Honeywell

*LAUNCHING of *Atlas 10B* sent into orbit on Dec. 18, 1958, largest U.S. satellite

TITAN *U.S. AIR FORCE Surface-to-Surface*

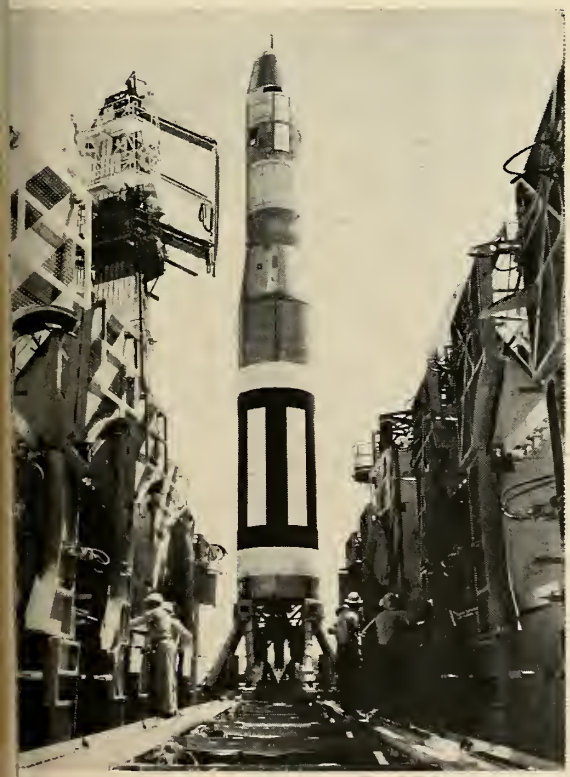
The second part of the USAF's *WS-107* intercontinental ballistic missile project, the *SM-68 Titan* made its first test flight on Feb. 6, 1959, at the Atlantic Missile Test Range and has had several tests since.

A complement, rather than a duplicate of *Atlas, Titan* employs a different flight technique than its companion ICBM. A two-stage missile, it is launched initially by a 300,000-pound-thrust booster. At burnout, the first stage separates from the remainder of the missile and a second liquid engine pushes the nuclear payload to high speed and altitude. The second stage also drops after burnout and the nose cone coasts the rest of the way in a free-fall path without power or guidance.

Titan, though larger than *Atlas,* is also lighter. It will be based in "hard sites," with underground silos providing protection from weather during storage period and from blast effect in combat. Initial contract of $384,000,000 was awarded Martin for design, fabrication and testing.

SPECIFICATIONS

DESIGNATION:	SM-68 (WS-107A-2)
PRIME CONTRACTOR:	Martin
STATUS:	Development
RANGE:	5500 nautical miles plus
VELOCITY:	15,000 mph
FRAME	
Stages:	2
Manufacturer:	Martin
Length (Overall), ft:	90
1st stage length, ft:	54
2nd stage length, ft:	37 (incl. nose cone)
Diameter, ft:	8
Weight (Gross), lbs:	220,000
Material (Major)	Aluminum
GUIDANCE	
Manufacturers:	Bell Telephone Laboratories Remington Rand UNIVAC
Type:	Initially, radio inertial; later, all inertial
POWERPLANTS	
First stage (booster)	
Manufacturer:	Aerojet-General
Propellants:	Liquid oxygen and JP-6
Thrust, lbs:	300,000
Second stage:	
Manufacturer:	Aerojet-General
Propellants:	Liquid oxygen and JP-6
Thrust, lbs:	80,000
WARHEAD	
Manufacturer:	AVCO
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Kaiser Steel, Baldwin-Lima-Hamilton, Space Corp.
Fueling:	Air Products
Radar and ground control:	Hallamore Electronics
Transport vehicles:	North American



READY for static testing, *Titan* is framed by its erector.



HURTLING spaceward, a *Titan* passes first test at the Cape.

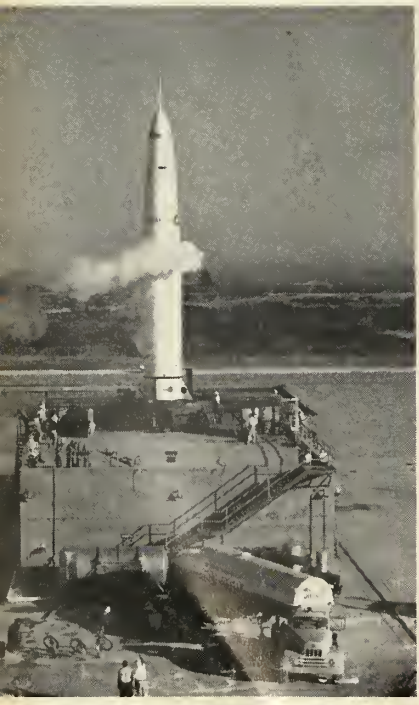
THOR *U.S. AIR FORCE Surface-to-Surface*

The first American intermediate range ballistic missile to achieve operational status, *Thor,* or *WS-315A,* was deployed to Europe in September, 1958, under an agreement whereby the United States furnished a number of the IRBM's to the United Kingdom.

Thor is a single-stage missile capable of being transported by air on a transporter-erector trailer which also serves as the missile erecting arm.

Thor has been used as the main propulsion system for several space experiments. It is the primary vehicle in the *Discoverer* program and was used to launch the lunar probe of Oct. 11, 1958.

Power is supplied by a Rocketdyne 150,000-plus-pounds-thrust engine which burns liquid oxygen and RP-1, a high-grade kerosene. Thrust adjustment and roll control are obtained by two vernier engines at the base of the missile; the sustainer is also provided with gimbaling action.



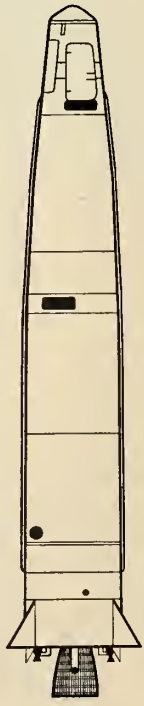
PREPARING for launch of versatile *Thor.*



TAKE-OFF with 150,000 lbs. thrust.

SPECIFICATIONS

DESIGNATION:	WS-315A (SM-75)
PRIME CONTRACTOR:	Douglas, Space Technology Laboratories
STATUS:	Production
RANGE:	1500 nautical miles
VELOCITY:	10,000 mph
FRAME	
Manufacturer:	Douglas
Length (overall), ft:	65
Diameter, ft:	8
Weight (gross), lbs:	110,000
Material (major):	Aluminum
GUIDANCE	
Manufacturer:	AC Spark Plug
Type:	Inertial
POWERPLANT	
Manufacturer:	Rocketdyne
Propellants:	Liquid oxygen and RP-1
Thrust, lbs:	150,000 plus
WARHEAD	
Type:	Nuclear
Nose cone:	General Electric
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Food Machinery
Fueling:	Air Prod., Cambridge Corp.
Handling and service:	Douglas, Food Machinery
Transport vehicles:	Food Machinery



SNARK *U.S. AIR FORCE Surface-to-Surface*

A complementary weapon to the ir Force's long range ballistic mis- les, the *SM-62 Snark* is an intercontinental missile of the air-breathing variety, particularly useful in tactical pplications which call for low-altitude rget penetration. It is boosted by a air of solid rockets and sustained in ght by a turbojet engine.

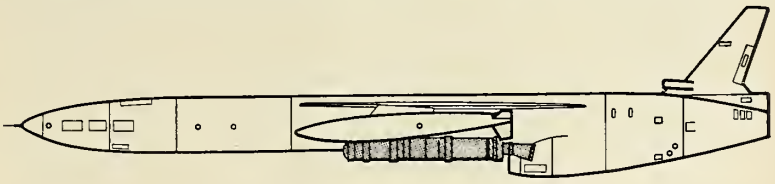
Similar in appearance to a jet ghter, *Snark* has slim fuselage lines ith a high aspect ratio wing mounted ear the top and slightly forward of e center of the fuselage.

For economy in test operations, the '-foot, 30-ton missile is fitted with re- ctable gear to allow landing after st flight.

In the last year, *Snark* has been ed successfully 5000 miles down e Atlantic Missile Range. On one ght, it was fired 1300 miles and turned to land at the launching site. he first production model made a 000-mile test flight on April 7, 1959.

SPECIFICATIONS

DESIGNATION:	SM-62
PRIME CONTRACTOR:	Norair
STATUS:	Production, service use
RANGE:	5500 nautical miles
VELOCITY:	Mach 0.9
FRAME	
Manufacturer:	Northrop
Length (Overall), ft:	67.2
Diameter (Body), ft:	4.5
Span, ft:	42
Weight (Gross), lb:	59,936
Material (Major):	Aluminum, magnesium
GUIDANCE	
Manufacturer:	Northrop
Type:	Inertial
POWERPLANTS	
Booster	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	Cast JATO (2)
Thrust, lb:	66,000 @ 33,000
Sustainer	
Manufacturer:	Pratt & Whitney
Propellants:	Liquid
Type & Number:	J-57 turbojet (1)
Thrust, lb:	11,000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	American Car & Foundry
Fueling:	GFE
Radar & Ground Control:	Hallamore Electronics, Radiophone Co.
Handling & Service:	GFE
Transport Vehicles:	GFE



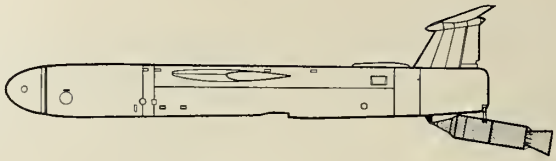


T-TESTED *Snark* **shown awaiting another trial at Patrick AFB, where it has been launched and successfully returned.**



SKY-BOUND *Mace* with flaming booster.

MACE *U.S. AIR FORCE Surface-to-Surface*



Designed to replace *Matador*, the *TM-76 Mace* became an operational weapon in 1959 and was deployed to Germany in the spring with the 38th Tactical Missile Wing.

Mace uses either an inertial guidance system or ATRAN, a map-matching system, depending on its mission. The ATRAN version is *TM-76A*, the inertial *Mace TM-76B*.

A relatively low-cost missile, it ru about $250,000 including Governmen furnished engine, booster and guidan package. *Mace* was first fired in 19 and placed in production in 1958.

SPECIFICATIONS

DESIGNATION:	TM-76
PRIME CONTRACTOR:	Martin
STATUS:	Operational
RANGE:	Over 650 miles
VELOCITY:	Transonic
FRAME	
Manufacturer:	Martin
Length (Overall), ft:	44.2
Diameter (Body), ft:	4.5
Span, ft:	22.9
Weight (Gross), lb:	13,800
Material (Major):	Aluminum, magnesium
GUIDANCE	
Manufacturer:	Goodyear/AC
Type:	ATRAN/inertial
POWERPLANTS	
Booster	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast JATO (1)
Thrust, lb:	100,000
Sustainer	
Manufacturer:	Allison
Propellants:	JP
Type & Number:	J-33-A-41 turbojet (1)
Thrust, lb.	52(
WARHEAD	
Type:	Nucle
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Goodye
Fueling:	Goodye
Radar & Ground Control:	Reeves Instr ments, Kaustine C
Handling & Service:	Goodyear, Tra mobi
Transport Vehicles:	Goodyear, Fou Wheel Drive C

MATADOR *U.S. AIR FORCE Surface-to-Surface*

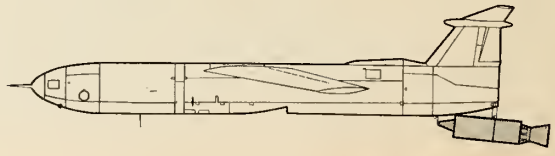
In operational service in Germany since March 9, 1954, *Matador* was the first USAF missile to attain service status. Controlled electronically by ground personnel, *Matador* carries either conventional or nuclear bomb-load. Based in Taiwan and Korea well as in Germany, *Matador* uni will be re-equipped with *Mace*.



STAND-BY *Matador* is being replaced.

SPECIFICATIONS

DESIGNATION:	TM-61
PRIME CONTRACTOR	Martin
STATUS:	Operational
FRAME	
Manufacturer:	Martin
Length (Overall), ft:	39.6
Diameter (Body), ft:	4.5
Span, ft:	28.7
Weight (Gross), lb:	12,000
Material (Major):	Aluminum
VELOCITY:	650 + mph
POWERPLANTS	
Booster	
Manufacturer:	Thiok
Propellants:	Sol
Type & Number:	Cast JATO (
Thrust, lb:	52,0(
Sustainer	
Manufacturer:	Allis(
Propellants:	
Type & Number:	J-33-A-37 turbojet (
Thrust, lb:	46(
WARHEAD	
Type:	Nucle



BOMARC *U.S. AIR FORCE Surface-to-Air*

A supersonic pilotless interceptor, ıe *IM-99 Bomarc* is an intermediate ıngе air defense weapon designed to ttack enemy bomber formations be- ɔre they reach target areas. It was de- gned to be complementary to, rather ıan competitive with, point defense issiles such as the Army's *Nike*.

Bomarc is launched vertically from ı automatically opening launcher- ıelter. Initial power is supplied by a booster rocket; at high speed, two ramjet engines take over for cruise power.

Latest version of the *Bomarc* is the "B" model, with double the previous range and nuclear warhead capability. The "B" employs a Thiokol solid rocket for boost power, instead of the Aerojet liquid booster in the original version. Speed and altitude capability of the "B" model is also greater than the predecessor version.

Boeing, manufacturer of the *Bomarc*, is operating a *Bomarc* training school at Harbor Island in Seattle, and the USAF is setting up another at Chanute AFB, Ill. A total of 16 *Bomarc* sites had been announced prior to 1959 Congressional hearings on the air defense master plan, which might cause revision in *Bomarc* plans. The first site, McGuire AFB, N.J., was scheduled to be operational by fall of 1959.





COMPLETED *Bomarc* **is lowered to the factory floor in Boeing's Seattle plant.**

SPECIFICATIONS

ESIGNATION: IM-99B

IME CONTRACTOR: Boeing

ATUS: Production in service test quantities

ANGE: 400 miles

LOCITY: Mach 2.7

AME

Manufacturer: Boeing
Length (overall), ft.: 46.7
Diameter (body), in.: 35
Span, ft.: 18.2
Weight (gross), lbs.: 16,000
Material (major): Aluminum, stainless steel and magnesium

GUIDANCE

Manufacturer: Westinghouse
Type: Command

POWERPLANTS

1. Booster
   Manufacturer: Thiokol
   Propellants: Solid
   Thrust, lbs.: 50,000
2. Cruise power
   Manufacturer: Marquardt
   Type and number: 24" ramjets (2)
   Thrust, lbs.: 50,000

WARHEAD

Type: Nuclear or high explosive

GROUND SUPPORT MAJOR CONTRACTORS

Launcher: AMF, Food Machinery
Fueling: Minneapolis-Honeywell, Brown Instruments
Radar and ground control: Westinghouse, Remington-Rand
Handling and service: Burns & Roe, Farnsworth Electronics
Transport vehicle: Burns & Roe, AMF

FALCON *U.S. AIR FORCE Air-to-Air*

Falcon is the name of a family of air-to-air missiles for use in conjunction with fighters of the Air Defense Command. Hughes Aircraft has produced five versions to date, the latest being the *GAR-3* and *GAR-4*. Previous versions included *GAR-1*, *GAR-1D* and *GAR-2A*.

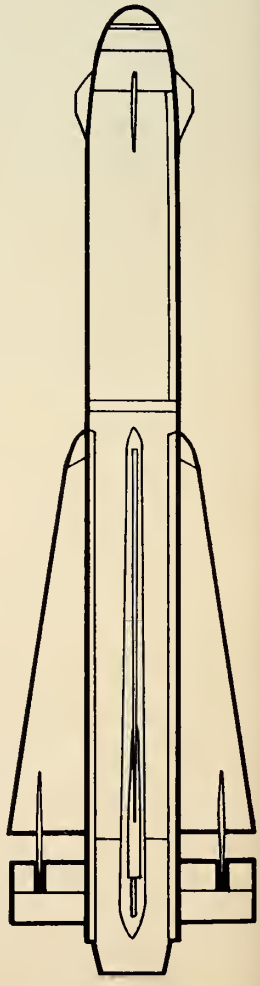
GAR-1D and *GAR-2A*, smallest missiles in the USAF inventory, have been in operational service since 1956 on F-89, F-101 and F-106 aircraft. The *1D* version is radar guided, the *2A* guided by an infrared homing device. The interceptor planes can carry the *Falcons* in mixed loads, permitting selection of either type of guidance.

GAR-3 and *GAR-4* are improved versions of the two *Falcons* already in service. The *GAR-3*, scheduled for early operational service, employs a semi-active radar seeker type of guidance. *GAR-4* will have the infrared system, permitting the same "mix" as with earlier *Falcons*.

The *GAR-3 Super Falcon* features a new solid-propellant engine with greater burning time, providing increased range and speed. Principal external change is a longer and more pointed nose cone which adds several inches to the overall length. The new *Falcon* also has slightly increased wing span and the stabilizers have been extended so they reach beyond the center of the airframe.

Specifications below are for the basic *Falcon*, the *GAR-1D*. By comparison, the *GAR-3* measures 7.1 feet in length and has a wing span of two feet. It is being manufactured at Hughes' Tucson plant.





AT LEFT, *GAR-3*, soon to be operational. Right, *GAR-1D*.

SPECIFICATIONS

DESIGNATION:	GAR-1D
PRIME CONTRACTOR:	Hughes
STATUS:	Operational
RANGE:	5 miles plus
VELOCITY:	Mach 2 plus
FRAME	
Manufacturer:	Hughes
Length (Overall), ft:	6.5
Diameter (Body), ft:	0.54
Span, ft:	1.7
Weight (Gross), lbs:	100
Material (Major):	Magnesium
GUIDANCE	
Manufacturer:	Hughes
Type:	1D, 3—radar 2A, 4—infrared homing
POWERPLANT	
Manufacturer:	Thiokol
Propellants:	Solid
Type and number:	Cast (1)
Thrust, lbs, 1D:	6000
WARHEAD:	High explosive

GENIE *U.S. AIR FORCE Air-to-Air*

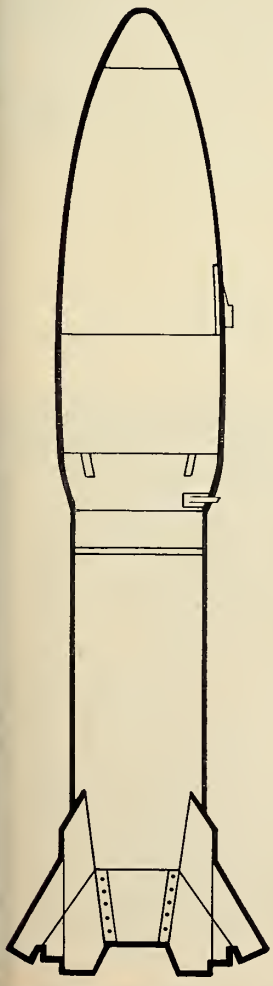
An unguided rocket, the *MB-1 Genie* was the first air-to-air weapon to be equipped with a nuclear warhead. The nuclear head was developed by Los Alamos Scientific Laboratory.

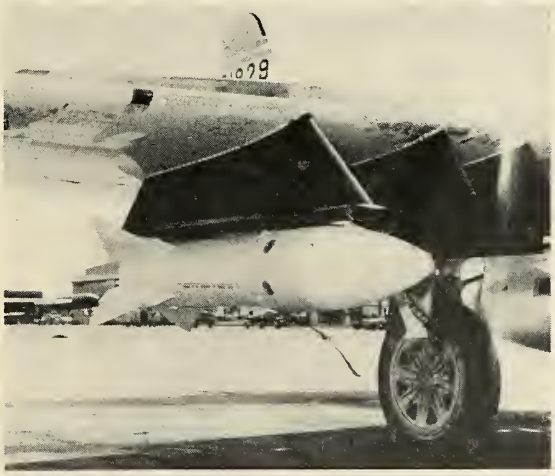
Genie was first fired from an aircraft on July 19, 1957, during Operation *Plumbob* at the Atomic Energy Commission's Nevada test site. It was declared operational and added to the weapons inventory of Air Defense Command in January, 1958, and is part of the armament of F-89, F-101 and F-106 aircraft.

The relatively small missile is powered by an Aerojet-General solid-propellant rocket. An extensive testing program, continued after the weapon became operational, is nearing completion.

SPECIFICATIONS

DESIGNATION:	MB-1	Diameter (Body), ft:	1.25
PRIME CONTRACTOR:	Douglas	POWERPLANT	
STATUS:	Operational	Manufacturer:	Aerojet-General
RANGE:	1.5 miles	Propellants:	Solid
FRAME		Type and number:	Cast (1)
Manufacturer:	Douglas	WARHEAD	
Length (Overall), ft:	8	Type:	Nuclear





F-89 carries *Genie* under wing; F-101, F-106 use bay.



RELATIVELY small, the *Genie* nonetheless is equipped to deliver a nuclear wallop.

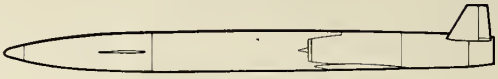
HOUND DOG *U.S. AIR FORCE Air-to-Surface*



TEST MODEL of *Hound Dog* attached to B-52, whose range it will soon be expanding.

Hound Dog is designed to extend the capability of Strategic Air Command's heavy bombers. Designated *GAM-77,* the missile will be able to deliver a nuclear payload on a target more than 500 miles from launch point. It is launched from a B-52.

GAM-77 is powered by a Pratt & Whitney J-52 turbojet, which can push the missile to supersonic speed. It was first tested on a limited range flight from the Atlantic Missile Range on April 23, 1959.



SPECIFICATIONS

DESIGNATION:	GAM-77
PRIME CONTRACTOR:	North American
STATUS:	Development (operational in 1959)
RANGE:	500 plus miles
VELOCITY:	Mach 1 plus
FRAME	
Manufacturer:	North American
GUIDANCE	
Manufacturer:	Autonetics
Type:	Inertial
POWERPLANT	
Manufacturer:	Pratt & Whitne
Type & number:	J-52 jurbojet (
Thrust, lbs:	75(
WARHEAD:	Nucle
PARTICIPATING CONTRACTORS:	AiR search, General Controls, Marquard Stewart Warner, Sundstrand Avi tion, Thompson, Vickers, Bendix-Re Bank

QUAIL *U.S. AIR FORCE Air-to-Surface*

First flight tested in 1958, the *GAM-72 Quail* is a diversionary missile for use by Strategic Air Command. Air-launched from B-57 or B-52 bombers, its purpose is to assist in target penetration by diverting enemy attention from the bombers. A small missile, the decoy is powered by a General Electric J-85 turbojet.

SPECIFICATIONS

DESIGNATION:	GAM-72
PRIME CONTRACTOR:	McDonnell
STATUS:	Development
WARHEAD:	None
FRAME	
Manufacturer:	McDonnell
Length, ft:	13
Wing span, in:	65
POWERPLANT	
Manufacturer:	General Electric
Type and number:	J-85 turbojet (1)
Thrust, lbs:	2000
SUPPORT EQUIPMENT	
Manufacturer:	Bell Aircraft
ELECTRONICS	
Manufacturer:	Ramo-Wooldridge



B-52 launches a *GAM-72 Quail,* designed to confuse the defenses of an enemy

U.S. AIR FORCE Missiles of the Future

ALBM

Following a series of feasibility studies with test vehicles, the Air Force decided to proceed with plans for an Air Launched Ballistic Missile. An important project, the missile is designed for use with B-52 and B-58 bombers, providing mobile aerial launch capability for missiles of 1000 nautical miles range or more. Initial concept called for a solid-fueled missile about half *Polaris* size. Douglas was awarded contract in June, 1959, calling for design, performance and cost study to be completed by year-end.

CROSSBOW

An adaptation of the drone aircraft to combat use, *Crossbow* is an air-to-surface missile designed to attack enemy defenses by homing on ground radar. To weigh about one ton, it will be subsonic with a range of about 200 miles. Power will be supplied by a small turbojet. Radioplane is prime contractor.

DYNA-SOAR

A combination of missile and manned airplane, *Dyna-Soar* is a hypersonic boost-glide bomber in early development stage. It will be boosted by high-thrust powerplants to near-orbital velocity at altitudes of about 100 miles, depending on mission. It has theoretical range of several earth circuits as reconnaissance vehicle, one circuit as bomber, coasting on its initial momentum with assist by small rocket sustainers. After intensive design studies involving a dozen companies, Boeing and Martin sought prime system responsibility.

GAR-9

An advanced version of the *Falcon* family of air-to-air missiles, *GAR-9* will combine the nuclear capability of *Genie* with the *Falcon's* accurate guidance. It is slated to become prime armament for North American Aviation's Mach 3 F-108 interceptor now in development status. North American and Hughes are collaborating on the system development; Aerojet-General will provide the powerplant.

MINUTEMAN

Operational requirements for a long-range missile with more rapid reaction time than the liquid-fueled ICBM's developed earlier brought about a contract, in 1958, for development of an all-solid ICBM, the *XSM-80 Minuteman*. With a maximum range of 5500 nautical miles, *Minuteman* will have greater flexibility in that it can be used for lesser ranges by dropping off one or more of its three stages. It will be a highly sophisticated weapon, incorporating the best developmental features from earlier ICBM experience.

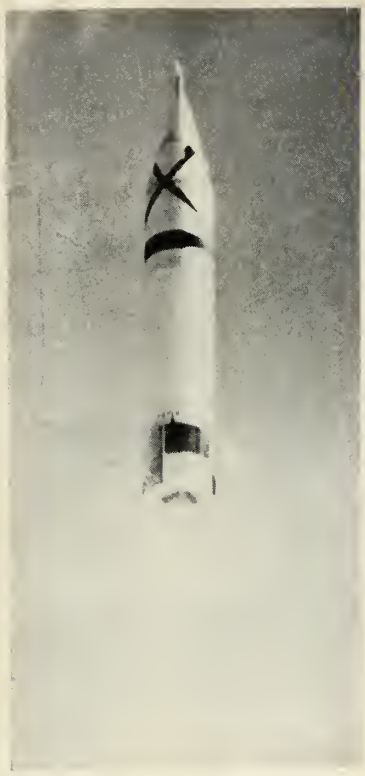
Designed for operational use about 1963, *Minuteman* will be a "hard-based" missile, stored in underground bomb-proof silos ready for instantaneous action. First of the second generation long-range ballistic missiles, *Minuteman* will be smaller, lighter, less complex and considerably less expensive than its first generation counterparts. The program is under the management of ARDC's Ballistic Missile Division. In October, 1958, Boeing was named principal contractor for assembly and test.

WAGTAIL

An air-to-ground missile, *Wagtail* is designed for greater penetration effect through low-altitude launch. Concept calls for use of forward-firing rockets after launch and before ignition of primary power plant. This will permit very low velocities while guidance system adjusts to target. The sophisticated guidance system will then permit the weapon to climb over obstacles, like hills and trees, and attack at low level. Minneapolis-Honeywell is prime contractor for the *Wagtail* system.

WHITE LANCE

Another air-to-ground weapon, designed for use with fighter bombers of Tactical Air Command, *White Lance* is an advanced version of the Navy's *Bullpup*. Martin is prime contractor. Initial deliveries to Air Force scheduled for near future, will include missiles almost identical to *Bullpup*. Later version will have increased range and be equipped with a greatly improved guidance system.



WORKHORSE *Jupiter* rises from Cape.



TWO-PART missile is field-assembled.

JUPITER *U.S. ARMY Surface-to-Surface*

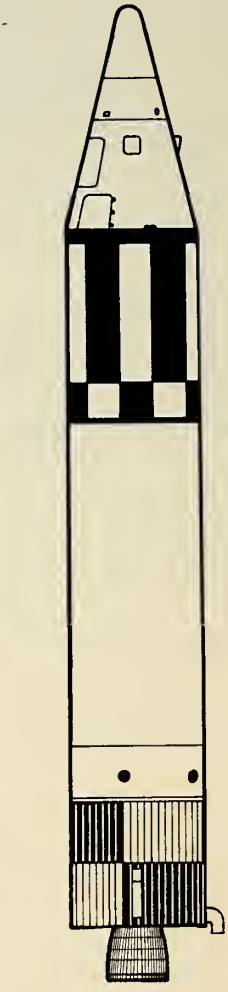
Developed by the Army Ballistic Missile Agency, the *SM-78 Jupiter* was the first American intermediate range ballistic missile to be launched successfully. In a Department of Defense decision on missile roles and missions, the *Jupiter* was turned over to the Air Force for operational employment, with training of USAF crews to be handled by ABMA.

The Air Force's 864th Jupiter squadron recently completed training at Redstone Arsenal, Huntsville, Ala. A second squadron, the 865th, is now in training there. The *Jupiter* system is scheduled to go to Italy this year.

Jupiter was designed to deliver a nuclear payload over a range of 1500 nautical miles. It is composed of two parts which are assembled in the field immediately prior to launchings. They are the "thrust unit," containing the rocket engine and fuel tanks, and the "warhead unit," which can contain either nuclear or conventional warheads and fuzing systems. Guidance is by the Delta Minimum self-contained all-inertial system of ABMA.

The *Jupiter* program was started in mid-1955 and first contract for engineering and production work was awarded Chrysler Corp. in June, 1956. *Jupiter* test vehicles have figured prominently in space research experiments including first recovery of a full-scale, heat-protected IRBM nose cone in May, 1958, and launching of a nose cone containing special instrumentation and a live monkey in addition to the warhead on Dec. 13, 1958.

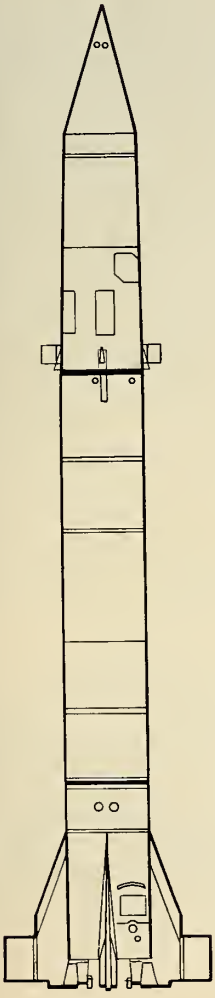
First Chrysler-built, operational-type *Jupiter* was successfully launched on Jan. 22, 1959.



SPECIFICATIONS

DESIGNATION:	SM-78
PRIME CONTRACTOR:	Chrysler
STATUS:	Operational
RANGE:	1500 nautical miles
VELOCITY:	10,000 mph
FRAME	
Manufacturer:	Chrysler
Length (overall), ft.:	60
Diameter (body), ft.:	8.75
Weight (gross), lbs.:	110,000
Material (major):	Aluminum
GUIDANCE	
Manufacturer:	Ford Instrument Co.
Type:	Inert
POWERPLANT	
Manufacturer:	Rocketdy
Propellants:	Liquid oxygen and kerose
Type & Number:	Regenerative cooled (
Thrust, lbs.:	150,0
WARHEAD	
Type:	Nucl
Nose Cone:	Goodyear Aircr
GROUND SUPPORT MAJOR CONTRACTORS	
Ground Support (General):	Ha Aircr
Transporters:	Frueh

REDSTONE *U.S. ARMY Surface-to-Surface*



Developed by the Army Ballistic Missile Agency, the *Redstone* is a high-accuracy missile used to extend and supplement the range and fire power of artillery cannon. It is a mobile system which can be fired from portable launching pads. A well-trained unit can move into a previously surveyed position, fuel the missile, set the guidance and fire in about two hours.

Range of the weapon is 200 miles. Power is supplied by a 75,000-pound-thrust Rocketdyne liquid-propellant engine. Graphite vanes located in the exhaust of the rocket supply thrust control; and external fins provide aerodynamic stability. *Redstone* is cylindrical in shape with a conical nose and cruciform tail surfaces.

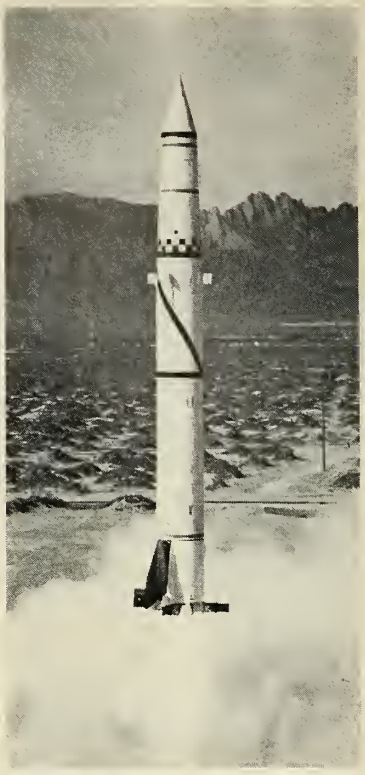
The missile's inertial guidance system is entirely self-contained. Prior to launch, the desired flight program is fed into a program device, which plays back the information to the various elements of the control system that guide the missile in flight.

The *Redstone* has nuclear capability, but it can also be armed with conventional explosives. The weapon is designed so that it may be transported by air, rail or truck, including the complete launching system. It is composed of three component parts which can be assembled in the field prior to launching: the powerplant unit, the fuel tank unit and the warhead and control unit. The missile is launched in the vertical position from a platform five feet high.

Redstone has been operational since early last year. Two Army Missile Groups *(Redstone)* are overseas.

SPECIFICATIONS

DESIGNATION:	SSM-A-14
PRIME CONTRACTOR:	Chrysler
STATUS:	Operational
RANGE:	200 mi.
FRAME	
Manufacturer:	Reynolds Metal Co., Chrysler
Length (overall), ft.:	63
Diameter (body), ft.:	5.8
Span, ft.:	12
Weight (gross), lbs.:	61,000
Material (major):	Aluminum
GUIDANCE	
Manufacturer:	Ford Instrument Co.
Type:	Inertial
POWERPLANT	
Manufacturer:	Rocketdyne
Propellants:	Liquid oxygen and alcohol
Type & Number:	Regenerative cooled (1)
Thrust, lbs.:	75,000
WARHEAD	
Type:	Nuclear capability (warhead separates)
GROUND SUPPORT MAJOR CONTRACTORS	
Fueling:	Air Products

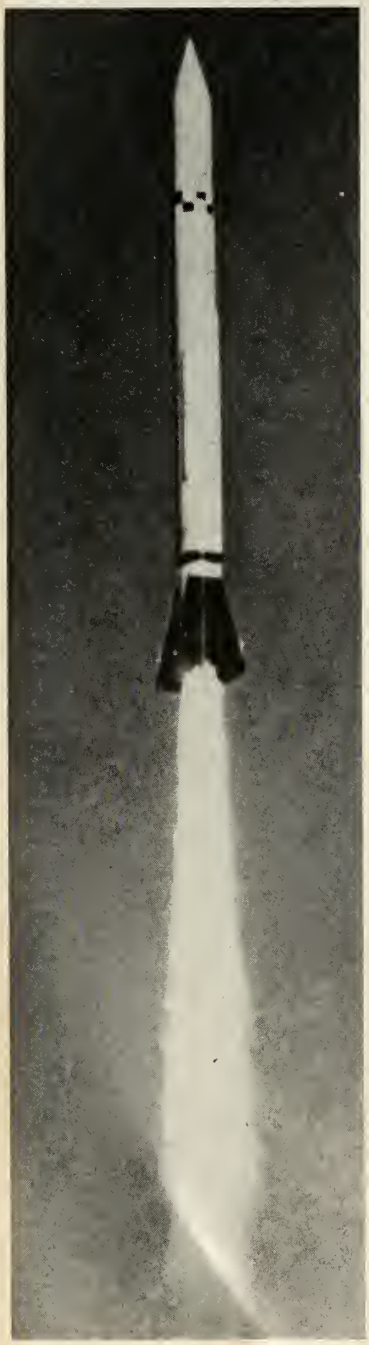


RELIABLE *Redstone* **is highly mobile.**



FIVE-FOOT platform is high enough.

CORPORAL *U.S. ARMY Surface-to-Surface*



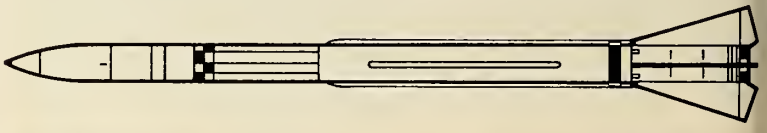
SOARING up from White Sands range.

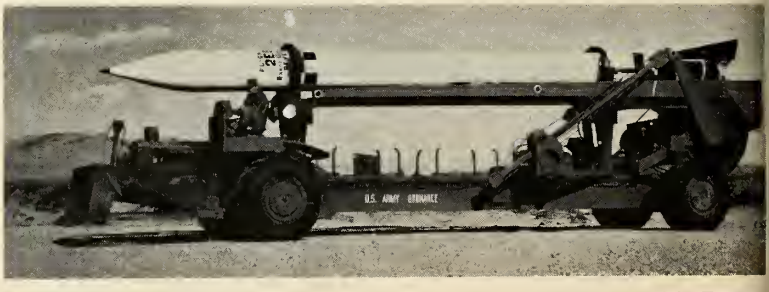
A 30-inch diameter Army artillery missile, *Corporal* was the Army's first ballistic-type weapon. It is in operational service and battalions have been deployed to Europe. A 75-mile-range missile, it is scheduled for replacement by the more advanced *Sergeant*.

The Corporal program has two prime contractors. Firestone Tire and Rubber Co.'s guided missile division has responsibility for production of the missile and for ground handling and launch equipment. Gilfillan Brothers, Inc., handles radar and other ground guidance equipment. Gilfillan also serves as subcontractor to Firestone for some of the guidance components in the missile.

Corporal is guided by a preset and command system. Basic firing data is computed for the guidance equipment and entered as "dial settings" before the missile is launched. After firing, minor corrections are made to the trajectory to insure accurate impact.

In service use, a *Corporal* battalion has 250 men. Each battalion has two batteries, a firing battery and a headquarters service battery. There are two operational launchers in each battalion. The *Corporal* carries either a conventional or nuclear warhead in the eight-foot nose section. Below lies the guidance stowage section, followed in sequence by a cluster of cells to carry compressed air to pressurize the propellant tanks, the propellant valve system, the rocket engine and the guidance vanes and rudders. The missile assembly measures 46 feet.





TACTICAL transporter-erector for *Corporal*. Battalions have been deployed in Europe.

SPECIFICATIONS

DESIGNATION:	XM4E1
PRIME CONTRACTOR:	Gilfillan, Firestone
STATUS:	Operational
RANGE:	75 miles
FRAME	
Manufacturer:	Firestone
Length (overall), ft.:	46
Diameter (body), ft.:	2.5
Weight (gross), lbs.:	11,000
Material (major):	Steel
GUIDANCE	
Manufacturer:	Gilfillan, Clary Multiplier Co.
Type:	Preset & command
POWERPLANT	
Manufacturer:	Ryan
Propellants:	Nitric acid and aniline
Type & Number:	Liquid propellant (1)
WARHEAD	
Type:	High explosive or nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Firestone
Fueling:	Firestone, GFE
Radar & ground control:	Gilfillan, Motorola
Handling & service:	Firestone
Transport Vehicles:	GFE

SERGEANT *U.S. ARMY Surface-to-Surface*

Sergeant is a solid-fueled ballistic-type battlefield missile designed to replace the six-year old *Corporal*. It incorporates many improvements over its predecessor in mobility, reliability and accuracy, although range is approximately the same.

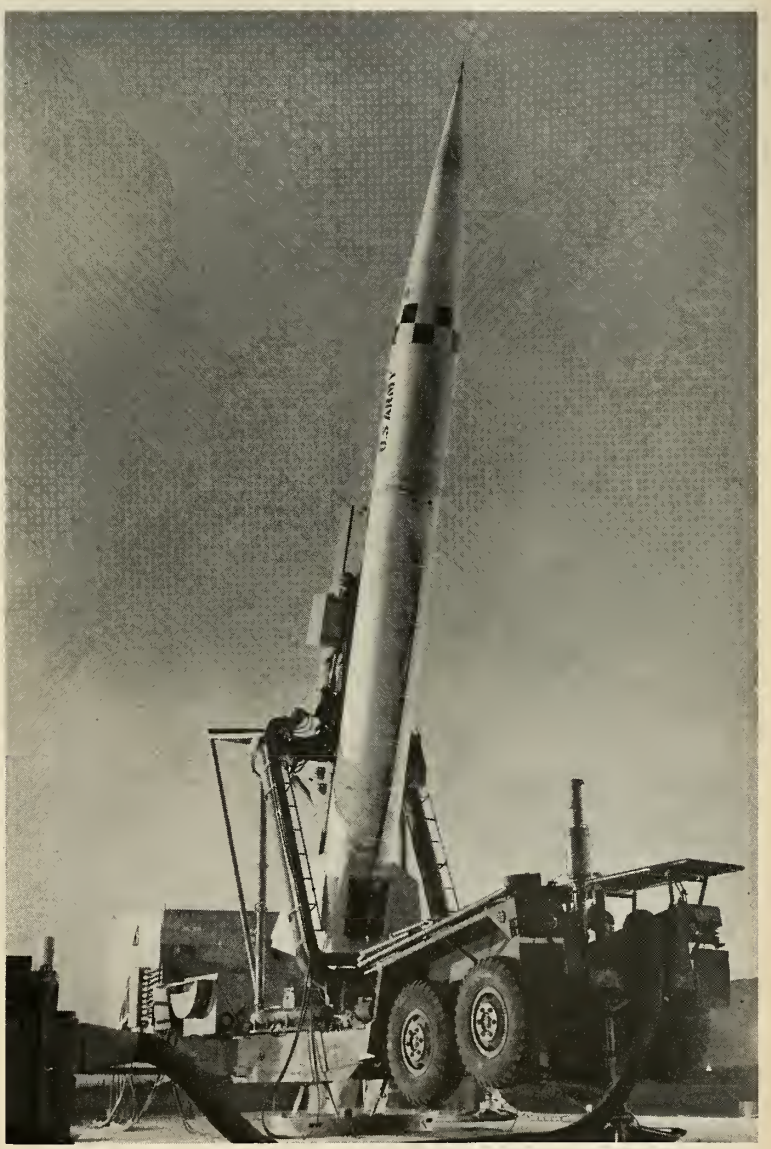
Like *Corporal*, the *Sergeant* can carry either a nuclear or conventional warhead, is air transportable and can be rapidly emplaced and fired under all conditions of weather and terrain by a comparatively small crew. The use of solid propellants and inertial guidance have minimized system maintenance requirements and simplified ground handling procedures and equipment. The missile is launched in a near-verticle position from an erector-launcher.

Development of the *Sergeant* to its current state of refinement is the result of a joint effort between Jet Propulsion Laboratory and Sperry Utah Engineering Laboratory. Production of the weapon system, including erector-launcher, servicing, handling and maintenance equipment, is the responsibility of Sperry Rand Corporation. Sperry received the prime contract for production of the missile system in 1956.

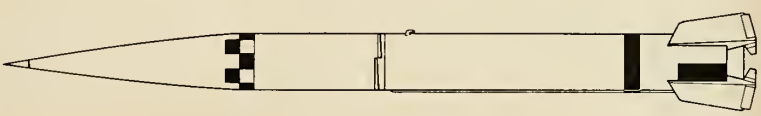
The *Sergeant* is currently entering first hardware production at Sperry's Salt Lake City manufacturing facilities.

SPECIFICATIONS

DESIGNATION:	FAGMS-S
PRIME CONTRACTOR:	JPL/Sperry Rand
STATUS:	Development production
RANGE:	75+ miles
FRAME	
Manufacturer:	Sperry
Length (overall), ft.:	34
Diameter (body), ft.:	2.6
Span, ft.:	5.9
Material (major):	Aluminum and Steel
GUIDANCE	
Manufacturer:	Sperry
POWERPLANT	
Case manufacturer:	Sperry
Propellant loading manufacturer:	Thiokol
Propellant type:	Solid
Thrust, lbs.:	50,000
WARHEAD	
Type:	Nuclear capability
GROUND SUPPORT MAJOR CONTRACTORS	
Launching station:	Sperry
Check out equipment:	Sperry
Handling and transport:	Sperry



LAUNCHED in near-vertical position, *Sergeant*, like *Corporal*, is easily handled.



HONEST JOHN *U.S. ARMY Surface-to-Surface*

Originally developed by Army Ordnance, *Honest John* is an artillery rocket designed to provide close fire support for ground operations. It is mounted on and launched from a highly mobile self-propelled launcher.

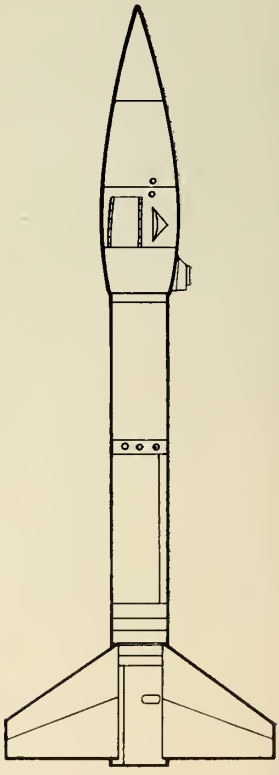
Honest John, originally designated *M-30* but now known as *M-31A1C*, is a free-flight rocket having no electronic controls. It features extreme mobility and simplicity, and it can be fired by a crew of six. It can carry a variety of warheads, including conventional high-explosives, nuclear or chemical loads. Its range is equivalent to that of medium-to-long range artillery.

Major parts of the *Honest John* rocket—the head compartment, fins, pedestal and power plant—are assembled at the factory or arsenal. Final assembly takes place near the firing site, and the completed rocket is then moved forward to the battle zone on its self-propelled launcher.

Honest John has been under development since 1950 when Army Ordnance first outlined to Douglas Aircraft Co. the basic idea for a large calibre artillery rocket. First tests, conducted at White Sands in 1951, dictated a series of improvements. Further tests with modified rockets led to large-scale contracts.



SIX-MAN crew can handle and fire *Honest John*, shown on its self-propelled launcher.



SPECIFICATIONS

DESIGNATION:	M-31A1C
PRIME CONTRACTOR:	Douglas, Emerson Electric
STATUS:	Operational
RANGE:	16.5 miles
VELOCITY:	750 mph
FRAME	
Manufacturer:	Douglas, Emerson
Length (overall), ft.:	27
Diameter (body), ft.:	2.5
Span, ft.:	8
Weight (gross), lbs.:	5800
Material (major):	Steel
GUIDANCE	
Type:	Unguided
POWERPLANT	
Manufacturer:	Hercules
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Rock Island Arsenal
Transport Vehicles:	OTAC

LITTLE JOHN *U.S. ARMY Surface-to-Surface*

Designed and developed by the Army's Redstone Arsenal as a supplement to *Honest John*, the *XM-47 Little John* is also a free-flight rocket without electronic controls, featuring a high degree of accuracy, simplicity of design and ease of operation. Its range is comparable to that of medium and heavy artillery.

Little John is about half as long as *Honest John*, has a body diameter of only 12½ inches compared with 30 for *Honest John*, and weighs only 800 pounds, less than a sixth as much as its companion weapon. Lightweight launchers and ground equipment are adaptable for an extremely high degree of mobility on the ground. They can also be airlifted by either fixed-wing aircraft or helicopters.

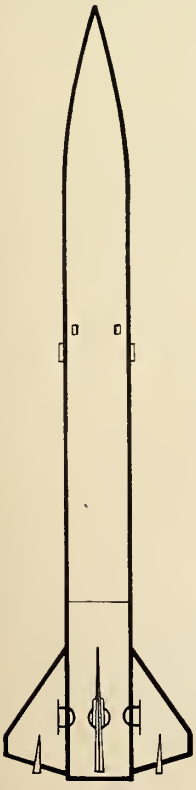
Although not yet officially designated operational, *Little John* rockets were turned over this year to the 101st Airborne Division, Fort Campbell, Ky., for training and development of combat techniques.

Little John was developed under a "crash" program that started at Redstone Arsenal in February, 1956. It was first test fired in June of that year.

Propellant for the solid-fueled rocket is produced by Allegheny Ballistics Laboratory, with Consolidated Western Steel supplying motor parts. Frame is built by Emerson Electric and the Army's Rock Island Arsenal provides the small, compact launchers.

SPECIFICATIONS

DESIGNATION:	XM-47
PRIME CONTRACTOR:	Emerson Electric
STATUS:	Development production
RANGE:	10 miles
VELOCITY:	Supersonic
FRAME	
Manufacturer:	Emerson Electric
Length (overall), ft.:	14.5
Diameter (body), in.:	12.5
Span, ft.:	2.5
Weight (gross), lbs.:	800
Material (major):	Steel and aluminum
GUIDANCE	
Type:	Unguided
POWERPLANT	
Manufacturer:	Allegheny Ballistics Lab.
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	High explosive or nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Rock Island Arsenal





TAKING FLIGHT from White Sands range.



NOT YET officially operational, *Little John* has been turned over to training troops.

LACROSSE *U.S. ARMY Surface-to-Surface*

Developed out of the experiences of the Pacific campaigns of World War II, where it was difficult to get artillery hits on targets like caves and bunker entrances, *Lacrosse* is designed to replace heavy artillery in strikes against strong points delaying advance of ground troops.

A highly accurate weapon, *Lacrosse* has its own missile automatic checker which automatically tests all phases of its operation just before firing. The *Lacrosse* system consists of the missile, a launcher mounted on a standard two-and-one-half-ton truck, and the guidance system, which is controlled by a forward guidance station acting in a capacity similar to a field artillery observation post. Like *Honest John* and *Little John, Lacrosse* features extreme mobility.

Lacrosse weighs slightly more than a ton and can carry a wide variety of conventional or atomic warheads, depending upon the tactical situation. The missile body has three major assemblies: nose section, center and tail. Fo swept wings and four movable tail fi control pitch, yaw and roll.

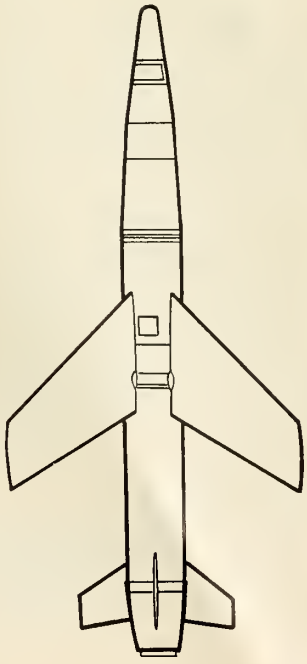
The first two units employing *L crosse* were activated in June, 195 They are the 5th Missile Battalio 41st Artillery, and the 5th Missile Ba talion, 42nd Artillery, both located Fort Sill, Okla. Each has approximate 170 officers and enlisted men. The mi sile was developed by Cornell Aeronau tical Laboratory and put in productic by The Martin Co. at its Orlando plan



ACCURATE *Lacrosse* **replaces artillery.**

SPECIFICATIONS

DESIGNATION:	SSM-A-12
PRIME CONTRACTOR:	Cornell Aero Lab., Martin
STATUS:	Production
RANGE:	20 miles
VELOCITY:	Mach 2
FRAME	
Manufacturer:	Martin
Length (overall), ft.:	19.2
Diameter (body), ft.:	1.7
Span, wing, ft.:	9
Span, fins, ft.:	4.7
Weight (gross), lbs.:	2300
GUIDANCE	
Manufacturer:	Federal Telephone Lab
POWERPLANT	
Manufacturer:	Thiok
Propellants:	Sol
Type & Number:	Cast (
WARHEAD	
Type:	Nuclear capabili
GROUND SUPPORT MAJOR CONTRACTORS	
Radar & Ground Control:	Federal Tel communication, Farrand Optic





NOW IN hands of artillerymen, *Lacrosse* **has lightweight launcher, automatic checker.**

NIKE-AJAX

U.S. ARMY Surface-to-Air

Nike-Ajax, the first American surface-to-air operational missile, has now been phased out of production and will gradually be replaced by *Nike-Hercules* units, although it is still operational in a number of metropolitan sites. Still capable of combating known types of bomber aircraft, it has been in service since 1953. About 10,000 *Nike-Ajax's* were built and about 3000 have been fired in the Army's various test and training programs during the past six years.



HORIZONTALLY positioned on launcher.



SPECIFICATIONS

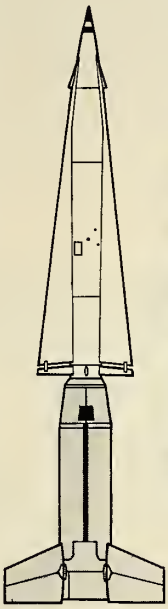
DESIGNATION:	SAM-A-7
PRIME CONTRACTOR:	Western Electric
STATUS:	Operational
RANGE:	25 miles
VELOCITY:	Mach 2.5
FRAME	
Stages:	2
Manufacturer:	Douglas, Borg-Warner (booster)
Length (overall), ft.:	31
Diameter (body), ft.:	1
Span, ft.:	4
Weight (gross), lbs.:	2300
Material (major):	Aluminum, magnesium and steel
GUIDANCE	
Manufacturer:	Western Electric
Type:	Command
POWERPLANTS	
First Stage (Booster)	
Manufacturer:	Goodyear
Propellants:	Solid
Type & Number:	Cast uncooled (1)
Second Stage	
Manufacturer:	GFE
Propellants:	Nitric acid and JP
Type & Number:	Liquid, cooled (1)
Thrust, lbs.:	2600
WARHEAD	
Type:	High explosive

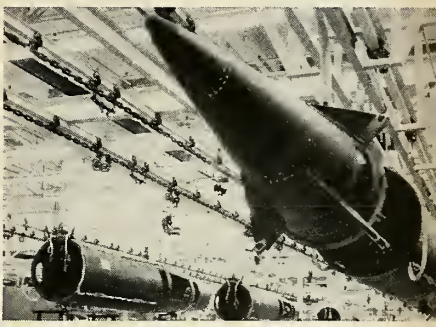
NIKE-HERCULES

U.S. ARMY Surface-to-Air

An advanced member of the *Nike* family, *Nike-Hercules* offers greater range, speed and destructive power than its predecessor, *Nike-Ajax*. *Hercules* is scheduled to be sited at Strategic Air Command bases and to replace *Nike-Ajax* installations around metropolitan areas. About 50 batteries have been converted to *Hercules* weapons.

Hercules has both nuclear and conventional warhead capability and has been operational in certain sites since October, 1958.





FINAL assembly line for the *Hercules*.

SPECIFICATIONS

DESIGNATION:	SAM-A-25
PRIME CONTRACTOR:	Western Electric
STATUS:	Operational
RANGE:	80 miles
VELOCITY:	Mach 3+
FRAME	
Stages:	2
Manufacturer:	Douglas, Goodyear, Borg Warner
Length (overall), ft.:	39
Diameter (body), ft.:	2.5
Span, ft.:	7.5
Material (major):	Aluminum, magnesium and steel
GUIDANCE	
Manufacturer:	Western Electric
Type:	Command
POWERPLANTS	
First Stage (Booster)	
Manufacturer:	Radford Arsenal
Propellants:	Solid
Type & Number:	Cast uncooled (4)
Second Stage	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast, uncooled (1)
WARHEAD	
Type:	Nuclear

HAWK *U.S. ARMY Surface-to-Air*

One of the Army's newest air defense weapons, the *Hawk* is designed to be used primarily against low-flying enemy aircraft. It is a mobile system, to be used by both Army and Marine Corps troops in the field. Fired from a small two-wheel launcher, *Hawk* has a ceiling capability ranging from less than 100 feet to more than 38,000 feet. Unusual radar instrumentation provides effectiveness in the "blind zone" of conventional radars. The weapon system also has a high rate of fire, since three missiles can be fired from a single launcher.

Hawk is powered by a solid-propellant system developed by Thiokol and in production at Aerojet-Sacramento.

First *Hawk* emplacements will be located in New York and Washington to complement *Nike* defenses. A *Hawk* battery consists of 36 missiles, with three missiles to each of 12 launchers. The launcher emplacements are covered by balloon-like domes to protect the missile from the weather. The missile can be fired through the dome.

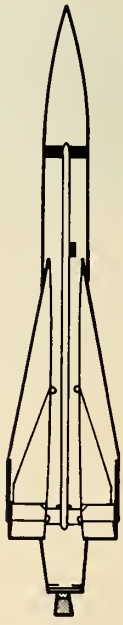
The *Hawk* system features simple, rugged equipment, easy to maintain. It is air transportable by helicopter or medium-sized fixed-wing aircraft. *Hawk* is scheduled to be operational in 1960.



THREE *Hawks* can be fired from one uni



VERSATILE ARMY *Hawk* sits poised for launching at the White Sands Proving Grounds.



SPECIFICATIONS

DESIGNATION: XM3
PRIME CONTRACTOR: Raytheon
STATUS: Development production
VELOCITY: Supersonic
RANGE: 20 miles

FRAME
- Stages: 2
- Manufacturer: Northrop, Raytheon
- Length (overall), ft.: 16.8
- Diameter (body), ft.: 1.2
- Span, ft.: 4
- Weight (gross), lbs.: 1275
- Material (major): Steel

GUIDANCE
- Manufacturer: Raytheon
- Type: Radar homing

POWERPLANTS

First Stage
- Manufacturer: Aerojet, Thiokol
- Propellants: Solid
- Type & Number: Cast (1)

Second Stage
- Manufacturer: Aerojet, Thiokol
- Propellants: Solic
- Type & Number: Cast (1)

WARHEAD
- Type: High explosive by Picatinny Arsena

GROUND SUPPORT MAJOR CONTRACTORS
- Launcher: Northrop, Food Machinery
- Radar & Ground Control: Raytheon
- Handling & Service: Raytheon, Northrop Food Machinery
- Transport Vehicles: Northrop Food Machinery

U.S. ARMY MISSILES OF THE FUTURE

PERSHING

A selective range, surface-to-surface two-stage ballistic missile, *Pershing* is designed as eventual replacement for *Redstone*. Both stages will be solid-propelled, permitting ease of handling in the field. With a new transporter-erector-launcher, *Pershing* will have the mobility of the smaller missiles in the Army battlefield family. It will deliver a nuclear warhead up to 700 miles. *Pershing* will be smaller than *Redstone*—about 50 feet overall compared with *Redstone's* 63 feet—and considerably lighter than its predecessor.

Martin-Orlando has the prime system responsibility. Fuzing and arming subcontractor for the nuclear warhead is Bulova Watch Co. Bendix Eclipse-Pioneer is developing the inertial guidance stable platform and associated equipment. Thiokol will provide the solid-propellant rockets and Thompson Products Accessories Division is developing the new transporter-erector-launcher.

NIKE-ZEUS

An advanced air defense weapon, *Nike-Zeus* is being developed to provide a defense against all forms of air threat, with special emphasis on defense against ballistic missiles. A solid-propelled weapon, it will have a nuclear warhead and a command guidance system. *Zeus* will be about the same length as *Nike-Hercules*, but considerably heavier. A high thrust powerplant of 450,000 pounds thrust will boost it to Mach 7 speed. Range will be about 200 miles.

Prime contractor is Western Electric, with Douglas building the frame. Thiokol will build the large booster and Grand Central the sustainer rocket.

SS-10, SS-11

Already in production, the *SS-10* and *SS-11* are anti-tank guided missiles. They are wire-guided and employ solid propellants. They can be launched from a fixed emplacement, from a ground vehicle, a helicopter or an airplane. *SS-11* is an advanced version of *SS-10*, having twice the range and higher speed. Both weapons are built by Nord Aviation in France and are being procured in service and evaluation quantities.

SHILLELAGH

A lightweight missile system being developed for close-in support of ground troops, *Shillelagh* is designed to provide "greatly increased firepower," probably nuclear, against armor, troops and fortifications. In one application it will be vehicle-mounted. Expected to be operational in the mid-1960's, its prime contractor is Aeronutronics Division of Ford Motor Co. (The system is also known as *Pentomic*.)

REDEYE

A shoulder-fired, bazooka-type air defense missile, *Redeye* is designed to provide individual troops with defense against low-level air attack in forward areas. Marine Corps is also interested in the development program. Guidance will be infrared homing. Prime contractor is Convair-Pomona.

DAVY CROCKETT

Another weapon for the pentomic Army, *Davy Crockett* is a light, nuclear-tipped weapon designed to be fired by one or two men in the field. It is being developed as a family. Prime contractor is Martin.

LOBBER

Not a weapon but a cargo ballistic missile, *Lobber* is a nine-foot solid-propellant ballistic missile designed to carry a 50-pound payload over a 50-mile range. Fired from a portable launcher, it was first tested last December. Basic idea is to move priority equipment such as medical supplies in the battlefield area. *Lobber* is first step in a program to study feasibility of moving much larger priority payloads, ultimately including men. Convair has been awarded a *Lobber* development contract by the Army.

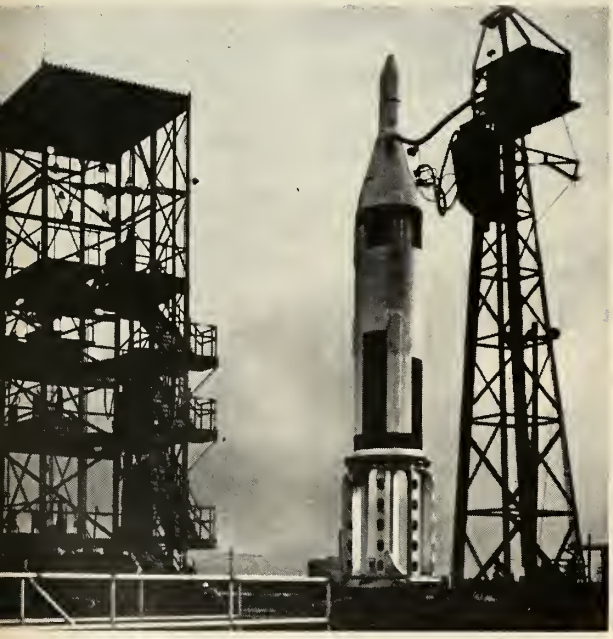
POLARIS *U.S. NAVY Surface-to-Surface*

One of the most important missiles in the American arsenal, *Polaris* adds a new dimension to naval warfare in the atomic age. Launched from mobile, underwater bases it has range equivalent to land-based intermediate range ballistic missiles. The Navy calls it an FBM (Fleet Ballistic Missile).

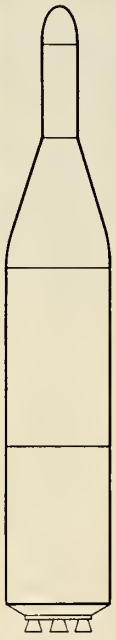
Of advanced design, *Polaris* is considerably smaller and lighter than its land-based counterparts. A single FBM submarine, specifically designed for the *Polaris* system, can carry 16 missiles. Missiles are carried aboard the sub in individual containers. At launch time, inert gases propel the missile above the water. Its rocket booster then takes over to provide initial boost. At altitude, a second-stage rocket cuts in to put the weapon on its ballistic trajectory toward target. Guidance is inertial, and both rocket stages are solid.

Tied in with the *Polaris* system is the Ship Inertial Navigation System (SINS) developed by Sperry, which provides at any given time the latitude, longitude, local vertical and precision azimuth.

Although designed primarily for use with the new FBM subs, *Polaris* can be launched from surface ships equipped with SINS or from land installations. Under present shipbuilding programs, nine *Polaris* FBM subs have been authorized; six of them are under construction. The *Polaris* system is scheduled for operational use late in 1960.



NAVY'S *POLARIS* should be ready for operational use next year.





BLAST OFF—Test vehicle leaves Cape.

SPECIFICATIONS

PRIME CONTRACTOR: Lockheed Sunnyvale

STATUS: Development

RANGE: 1500 nautical miles

VELOCITY: 6000 mph (average)

FRAME

Stages:	2
Manufacturer:	Lockheed
Length (overall), ft.:	46.5
Diameter (body), ft.:	9.3
Weight (gross), lbs.:	28,000
Material (major):	Steel

GUIDANCE

Manufacturer:	GE/MIT, Sperry Gyro
Type:	Inertial

POWERPLANTS

First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	(1) Cast, uncooled, 4 nozzles
Thrust, lb.:	80-100,000
Second Stage	
Manufacturer:	Aerojet, Thiokol
Propellants:	Solid
Type & Number:	(1) Cast, uncooled, 3 nozzles, jetavators

WARHEAD

Type: Nuclear

GROUND SUPPORT MAJOR CONTRACTORS

Launcher:	Westinghouse, Sperry Gyro
Fueling:	Aerojet
Radar & ground control:	G.E.
Handling & service:	Westinghouse
SINS	Sperry

REGULUS *U.S. NAVY Surface-to-Surface*

Regulus I, the first operational attack missile to join the fleet, resembles a swept-wing jet fighter. Under development since 1948, it achieved operational status in 1954. Currently, four conventional submarines and four cruisers have *Regulus* capability. The missile was phased out of production in 1958, but is expected to remain on operational duty for some time. A total of 514 of the missiles were built by Chance Vought.

The 900th launch of the recoverable missile was accomplished in April. 1959, from the cruiser USS Toledo.

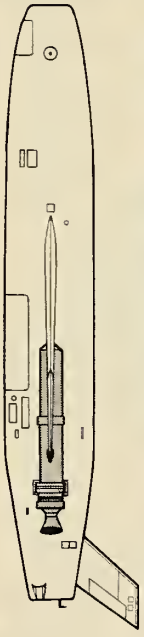
Also in 1959, *Regulus* participated in Post Office Department experiments in carrying "missile mail." One *"Reg"* carried mail on a training operation out of Point Mugu, Calif., in May. In June, a mail launch was effected from a submarine far at sea to the naval base at Mayport, Fla.

Regulus I is launched from a short rail launcher, where it rests on four slipper fittings. Launching boost is from two rockets which accelerate it to flying speed in about two seconds, when its turbojet sustainer takes over.

Regulus II, an inertially guided successor to *Regulus I,* with considerably greater speed and range, was cancelled by the Navy in December, 1958, after the missile had completed 90% of its development program. It had made 48 test launches, including launches from both a submarine and a surface ship.



REGULUS—with umbilical cord attached.





WHEELED CART is used to move *Regulus* on carrier deck.

SPECIFICATIONS

DESIGNATION:	SSM-N-8
PRIME CONTRACTOR:	Chance Vought
STATUS:	Operational
RANGE:	500 miles
VELOCITY:	Mach 0.9
FRAME	
Manufacturer:	Chance Vought
Length (overall), ft.:	34
Diameter (body), ft.:	4.5
Span, ft.:	21
Weight (gross), lbs.:	14,000
Material (major):	Aluminum
GUIDANCE	
Manufacturer:	Sperry
Type:	Command
POWERPLANTS	
First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	Solid
Type and Number:	JATO (2)
Thrust, lbs.:	66,000 @ 33,000
Second Stage	
Manufacturer:	Allison
Propellants:	JP
Type & Number:	Turbojet (1)
Thrust, lbs.:	4600
WARHEAD	
Type:	High explosive or nuclear

WEAPON ABLE

U.S. NAVY Surface-to-Surface

A 500-pound, 12.75-inch antisubmarine rocket, *Weapon Able* is installed on destroyers and frigates. A special fire control system aims the weapon, which carries a conventional explosive charge, at enemy subs; it is unguided in flight. The rocket sinks rapidly and covers a larger ocean area than old-type depth charges. It is in operational service.

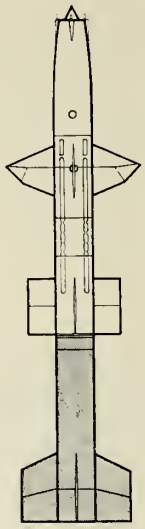
TALOS *U.S. NAVY Surface-to-Air*

Designed originally as an air defense missile to protect the surface fleet from attacking enemy aircraft, *Talos* has indicated in testing that it can also be used as a bombardment weapon against ships or shore targets, or as a long range anti-submarine weapon when equipped with a nuclear warhead.

Talos recently became operational as the principal armament of the guided missile ship USS Galveston. It was first fired at sea from the Galveston on Feb. 25, 1959. Under the present shipbuilding program, seven cruisers, one of which will be nuclear-powered, will have *Talos* capability.

The missile is accelerated to high speed by a solid-propellant rocket. The booster is jettisoned upon attainment of cruising speed, and a 40,000 pound-thrust ramjet provides cruise power. The weapon carries a conventional high explosive charge with proximity fuzing. Employing beam rider guidance, it can reach targets at a range of 65 miles and altitudes above 75,000 feet.

Talos stemmed from the Navy's *Bumblebee* program and was originally developed by the Applied Physics Laboratory of Johns Hopkins University. The system was turned over to Bendix for production. A land-based Army version of *Talos* has been cancelled.





USS Galveston, first ship to be equipped with *Talos*, shows off its lethal weapon.

SPECIFICATIONS

DESIGNATION:	SAM-N-6
PRIME CONTRACTOR:	Bendix
STATUS:	Operational
RANGE:	65 miles
VELOCITY:	Mach 2.5
FRAME	
Manufacturer:	McDonnell
Length (overall), ft.:	20 (booster 10 ft.)
Diameter (body), ft.:	2.5
Span, ft.:	9.48
Weight (gross), lbs.:	7000
Material (major):	Steel
GUIDANCE	
Manufacturer:	Farnsworth Electronics, Sperry
Type:	Beam rider
POWERPLANTS	
First Stage (Booster)	
Manufacturer:	Bendix
Propellants:	Solid
Type & Number:	Cast (1)
Second Stage	
Manufacturer:	McDonnell
Propellants:	JP
Type & Number:	18" ramjet (1)
Thrust, lbs.:	40,000
WARHEAD	
Type:	High explosive or nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	GE, RCA, American Machine & Foundry, North Ordnance
Radar & ground control:	RCA
Handling & serv.:	GE, Northern Ordnance

TERRIER *U.S. NAVY Surface-to-Air*

Another offshoot of the Navy's *Bumblebee* program, *Terrier* was designed to intercept enemy aircraft at ranges and altitudes beyond the capability of conventional anti-aircraft guns.

Terrier has been operational for five years and it is currently installed on the guided missile cruisers USS Boston and USS Canberra, and on the guided missile destroyer USS Gyatt. Under present shipbuilding programs, 27 additional ships will have *Terrier* capability. These will include: two Forrestal-class carriers, three guided missile cruisers, 1 nuclear-powered guided missile cruiser, 19 guided missile frigates, one nuclear-powered guided missile frigate, and one nuclear-powered aircraft carrier.

Terrier is also suitable for beachhead operations by the Marine Corps. The First Medium Anti-aircraft Missile Battalion, which is stationed at the U.S. Marine Corps Base, Twenty-nine Palms, Calif., is equipped with the missiles.

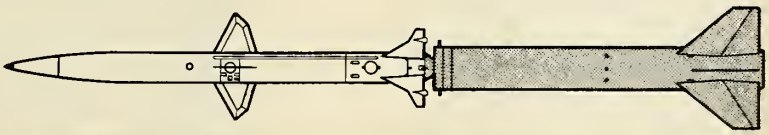
Booster-launched, the weapon travels to the target by beam-radar guidance.

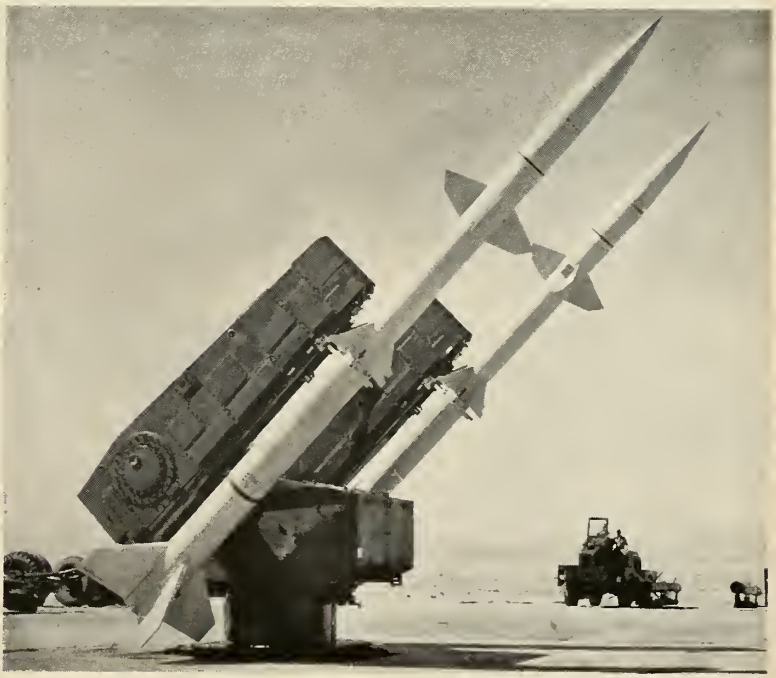
On shipboard installation each *Terrier* launcher is served by its own magazine and missile overhauling and servicing room. The missiles and their boosters are stored vertically in a ready service ring, one for each arm of the two-missile launcher. The missile is selected, positioned, loaded and placed on its launching rail in a matter of seconds.

Terrier was developed by the Applied Physics Laboratory of Johns Hopkins University, at Silver Spring, Md. Production is handled by Convair/Pomona, Calif., a division of General Dynamics Corporation.

SPECIFICATIONS

DESIGNATION:	SAM-N-7
PRIME CONTRACTOR:	Convair
STATUS:	Operational
RANGE:	10 miles
VELOCITY:	Mach 2.5
FRAME	
Stages:	2
Manufacturer:	Convair
Length (overall), ft.:	15 ft., 27 with booster
Diameter (body), ft.:	1
Span, ft.:	3.5
Weight (gross), lbs.:	2500
GUIDANCE	
Manufacturer:	Reeves/FTL, Sperry
Type:	Beam rider
POWERPLANTS	
First Stage (Booster)	
Manufacturer:	Allegheny Ballistics, The Hicks Co.
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
Second Stage	
Manufacturer:	Allegheny Ballistics
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Northern Ord.
Radar & ground Control:	Sperry Gyro, Western Elec., Reeves Instr.
Handling & service:	Baker-Raulang, Wash. Tech. Associates
Transport vehicles:	Baker-Raulang





TWIN carriers in reloading position frame two supersonic surface-to-air *Terriers.*

ADVANCED TERRIER

Under development is an *Advanced Terrier* incorporating improved guidance and with substantial improvements in coverage. A larger weapon than the basic *Terrier*, it is expected to have about double the range. Convair is prime contractor. The new missile will eventually replace *Terrier*.

SIDEWINDER *U.S. NAVY Air-to-Air*

Sidewinder holds the distinction of being the first guided missile to destroy an aircraft under combat conditions. This occurred in September, 1958, when the weapon was used by planes of the Chinese Republic against Chinese Communist aircraft.

Sidewinder is a rugged, inexpensive missile with fewer than two dozen moving parts. Personnel require no specialized technical training to handle and assemble it.

The missile has a passive infrared guidance system which permits it to home on the tailpipe of the target aircraft. The seeker occupies the first four inches of the missile, followed by the guidance section. Servo motors are located between the forward fins. Warhead is high explosive.

Developed by the Naval Ordnance Test Station (NOTS), China Lake, Calif., *Sidewinder* became operational in July, 1956, and is now the guided missile most widely used by Navy squadrons with the Sixth Fleet in the Mediterranean and the Seventh Fleet in the Western Pacific. *Sidewinder* will also be used by the USAF and several allied nations.

SIDEWINDER 1-C

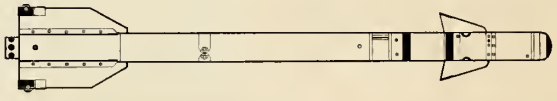
Under development at Naval Ordnance Test Station, China Lake, Calif., is a second-generation version of *Sidewinder*, known as *Sidewinder 1-C*, which will have higher speed and greater range capability. Philco Corp. is prime contractor with NOTS.

SPECIFICATIONS

DESIGNATION:	USAF GAR-8 (USN) AAM-N-7
PRIME CONTRACTOR:	Philco, GE
STATUS:	Operational
RANGE:	6-7 miles
VELOCITY:	Mach 2.5
FRAME	
Manufacturer:	Hunter-Douglas, Norris Thermador
Length (overall), ft.:	9.3
Diameter (body), ft.:	.42
Span, ft.:	2
Weight (gross), lbs.:	155
Material (major):	Aluminum
GUIDANCE	
Manufacturer:	Philco, GE
Type:	Infrared homing
POWERPLANT	
Manufacturer:	Naval Powder Plant
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Check-Out Equipment:	Philco



SAILORS load combat-proven *Sidewinders* on a Navy F9F jet.









SEQUENCE shows *Sidewinder* firing against an F6F drone. The missile's passive infrared guidance lets it home on tailpipe.

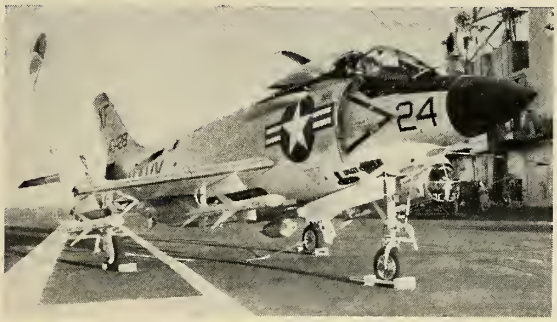
SPARROW III *U.S. NAVY Air-to-Air*

A fleet air defense weapon attaining a speed of 1000 miles per hour immediately after launching and a top speed of more than 1500 miles per hour, *Sparrow III* became operational in August, 1958. It replaced *Sparrow I*, phased out of production.

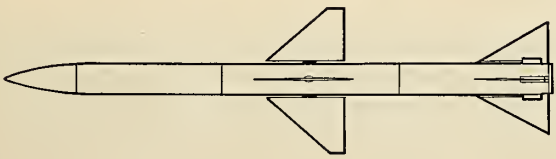
First deployment was with McDonnell F3H-2 squadrons in the Western Pacific. A new version with higher capability will be launched from the supersonic all-weather fighter, the F4H-1. The *Sparrow III* gave the fleet two features not available in earlier missiles of this type: all-weather capability and the ability to attack high-performance enemy aircraft from any direction, including head-on.

Guidance is by radar homing, which becomes active in the first seconds of flight by launching aircraft. Guidance signals deflect the wings of the missile and direct a collision course to the target, even under evasive action.

The now-obsolete *Sparrow I*, which became operational in the spring of 1956, was produced by Sperry-Farragut Co. *Sparrow II*, now cancelled, was an experimental weapon not intended for fleet use. Douglas Aircraft Corp. was prime contractor on *Sparrow II*.



MISSILE on F3H-2 interceptor on flight deck of Midway.



SPECIFICATIONS

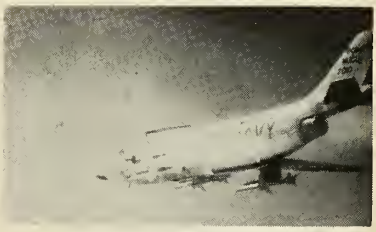
DESIGNATION:	AAM-N-6
PRIME CONTRACTOR:	Raytheon
STATUS:	Operational
RANGE:	5-8 miles
VELOCITY:	Mach 2.5-3
FRAME	
Manufacturer:	Raytheon
Length (overall), ft.:	12
Diameter (body), ft.:	.75
Span, ft.:	3.25
Weight (gross), lbs.:	380
Material (major):	Aluminum and magnesium
GUIDANCE	
Manufacturer:	Raytheon
Type:	Radar homing
POWERPLANT	
Manufacturer:	Aerojet General
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Handling & Service:	Elgin National Watch Co.

ACTION series shows *Sparrow III* being launched from F3H-2, which can carry four.







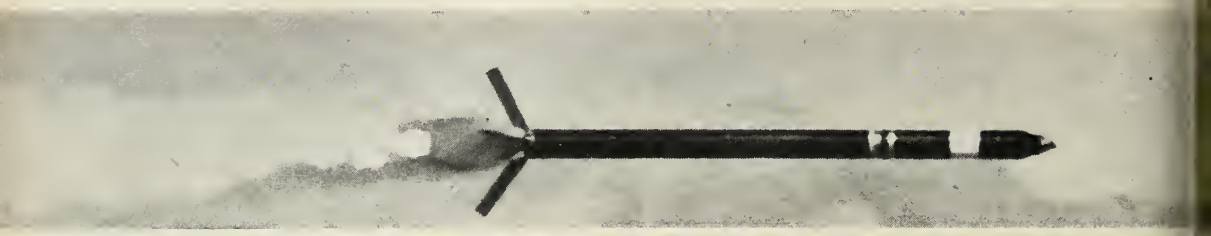




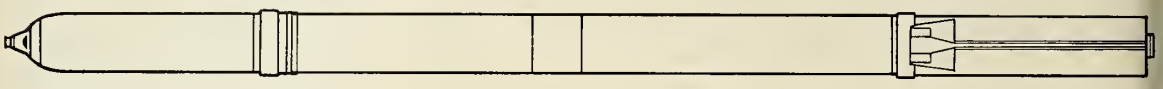




ZUNI *U.S. NAVY Air-to-Surface*



IN FLIGHT, ***Zuni*** **clearly shows its blast-operated fins, which fold away and allow the rockets to be carried compactly.**



The Navy's *Zuni* was designed chiefly as a rocket for use by fighter and attack aircraft against ground targets. However, one of the four interchangeable warheads for the weapon permits it to be used against aircraft targets. The other three warheads are (1) general purpose, (2) antitank and antipersonnel, and (3) flare. *Zuni* has blast-operated folding fins, a feature that allows rockets to be carried compactly in expendable launchers each with four rounds. The rocket and its launchers were developed by the Naval Ordnance Test Station, China Lake, Calif., for the Bureau of Ordnance.

Zuni has been approved for operational use, but has not yet made its debut.

Zuni is effective against vehicle convoys, tanks, troop concentrations, gun emplacements, trains, and small ships. In night attack, one *Zuni* can illuminate two square miles of surface area with its flare head, while a second burst can deliver high-explosive warheads to destroy the target in the same pass by the attacking aircraft. Its high velocity and short time-to-target assures it a high-kill potential in air-to-air attacks as well.

Zuni, because it is an unguided weapon, has several advantages: immunity to countermeasures, all-weather capability, high reliability, and simplicity. Because of these advantages and because it does not require any field maintenance or checkout, it is especially well suited to sustained carrier operations in which aircraft complete a mission, land, refuel, rearm, and take off again.

SPECIFICATIONS

PRIME CONTRACTOR:	NOTS
STATUS:	Production
RANGE:	5 miles
VELOCITY:	Mach 3
FRAME	
Manufacturer:	Hunter-Douglas
Length (overall), ft.:	9.17
Diameter (body), ft.:	0.42
Weight (gross), lbs.:	107
Material (major):	Aluminum
GUIDANCE	
Type:	Unguided
POWERPLANT	
Propellants:	Solid
Type & Number:	Extruded (1)—1 nozzle
WARHEADS	
Type & Number:	High explosive—4 interchangeable
FUZES	
Type & Number:	Proximity, point-detonating, base (3)



NAVY plane shown carrying four expendable launchers, each containing four ***Zunis.***

BULLPUP *U.S. NAVY Air-to-Surface*

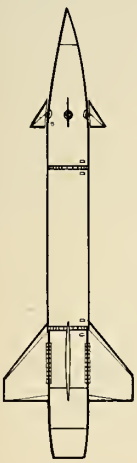
Designed for air launching outside ne effective range of enemy fire, *Bull-up* provides light attack aircraft with reater capability against tactical sur-ace targets, such as tanks, airfield in-tallations, truck convoys, oil tanks and ailroads.

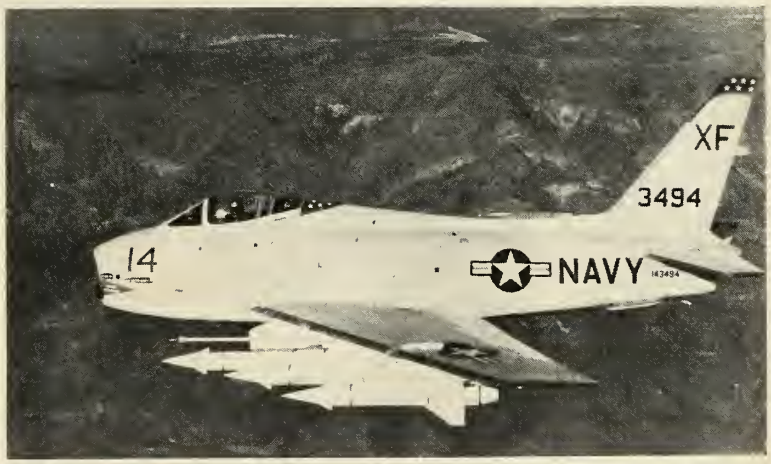
Relatively inexpensive, highly accu-ate and simple in design, *Bullpup* be-ame operational aboard the USS Lex-ington on April 25, 1959.

The weapon is guided by radio signal guidance under direct pilot control. Changes in direction are caused by pilot commands on a hand switch in the cockpit. These changes are transmitted to the missile where they are translated to movement of the control vanes.

The missile is divided into three major parts: the nose, containing the guidance control system; the center section, carrying a 250-pound warhead; and the tail, carrying propulsion and tracking flares. Power is supplied by a single solid rocket. The whole assembly weighs less than 600 pounds.

Bullpup is launched by several planes—the FJ-4B Fury, A4D-2 Skyhawk and F-100.

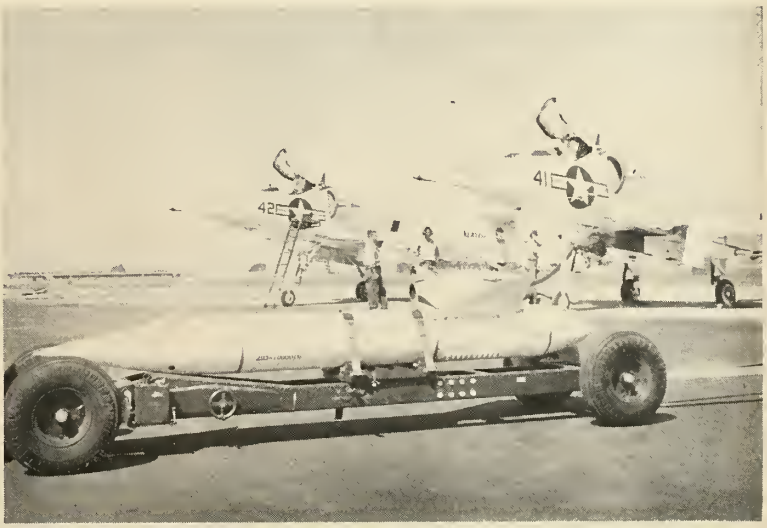




FIVE *Bullpups* **can be attached to wings of FJ "Fury" for assault on ground targets.**

SPECIFICATIONS

ESIGNATION:	ASM-N-7
RIME CONTRACTOR:	Martin
TATUS:	Operational
ANGE:	4 miles
ELOCITY:	Mach 1+
RAME	
Manufacturer:	Martin
Length (overall), ft.:	11
Diameter (body), ft.:	1
Span, ft.:	2.7 (approx.)
Weight (gross), lbs.:	571
Material (major):	Aluminum
UIDANCE	
Manufacturer:	Martin
Type:	Visual reference radio command
OWERPLANT	
Manufacturer:	Allegheny Ballistics
Propellants:	Solid
Type & Number:	Cast, uncooled (1)
ARHEAD	
Type:	High explosive



TECHNICIANS prepare A4D Skyhawk for attachment of assembled *Bullpups.*

U.S. NAVY MISSILES OF THE FUTURI

ASROC

A sophisticated anti-submarine rocket, *ASROC* is designed for launching from surface ships to seek subs at longer ranges than were possible with cancelled *RAT* (up to 10 miles through air plus limited underwater range). An acoustic homing device provides underwater guidance. Minneapolis-Honeywell has been awarded a research and development contract from Navy BuOrd.

ASTOR

A sub-launched weapon for use against enemy subs, *ASTOR* (Anti-Submarine Torpedo Ordnance Rocket) will carry a nuclear warhead. In development by Westinghouse Ordnance, it is electrically-propelled and wire-guided as it takes off from the launching submarine.

CORVUS

Designated *XASM-N-8, Corvus* is an air-to-surface missile specially designed for carrier-based aircraft, but also adaptable to shore based Navy and Marine planes. Its guidance system will home on enemy radar. Temco has development contract; Reaction Motors Div. of the Thiokol Corp. will supply the solid rocket; Texas Instruments and W. L. Maxson are working on electronic components.

EAGLE

A new trend in air-to-air missiles, *Eagle* is designed for use with relatively slow launching aircraft, with high performance built into the missile instead of the launching plane. This "standoff" weapon will have long air-to-air range—about 100 miles—and can be nuclear-fitted. The contractor is Bendix Aviation; so far, it has reached only the early stage of its long-range development.

GIMLET

A highly accurate unguided air-launched rocket. Its existence has been confirmed by Department of Defense, its contractor has not been identified. Status: now in development.

SUBROC

Goodyear Aircraft has a $65,000,000 contract for research and development work on *Subroc*, an anti-sub missile which can be launched from above or below the surface. *Subroc* system can detect enemy sub at long range (25-50 miles), compute its course and fire the missile. *Subroc* is expected to be defensive weapon for *Polaris* subs. Working with Goodyear are Librascope, Inc. and Kearfott Co., all under the technical direction of the Naval Ordnance Laboratory, at White Oak, Md.

TARTAR

A surface-to-air missile designed for use aboard destroyers, *Tartar* is a junior version of *Terrier* but it has about the same range. It employs beam rider guidance and is powered by a single solid rocket of about 15,000 pounds thrust. In advanced development, it is scheduled for early fleet use aboard three guided missile cruisers and 18 destroyers. Range is about 10 miles, speed above Mach 2 and warhead conventional. Prime contractor for the *Tartar* system is Convair/Pomona, a division of General Dynamics Corp.

GREAT BRITAIN

BLUE STREAK

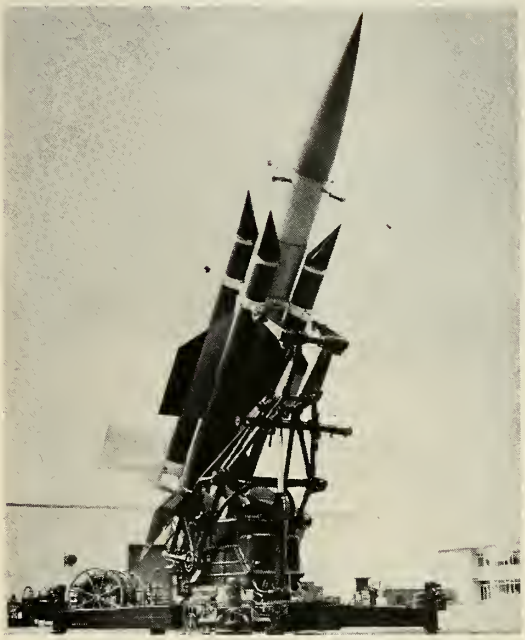
Britain's only long-range missile project, *Blue Streak* is an intermediate range ballistic missile designed to carry a thermonuclear warhead over distances up to 2000 miles. Ten feet in diameter, *Blue Streak* is more than 60 feet long, roughly the size of the American *Thor*. It is intended to be a "hard-based" missile, launched from underground bombproof silos. Prime contractor and coordinating authority is de Havilland Propellers Ltd., with Rolls Royce, de Havilland Aircraft and Sperry Gyroscope Ltd. as associated contractors.

THUNDERBIRD

A surface-to-air missile for use by both the Royal Army and the Royal Air Force, *Thunderbird* is similar in performance and operational use to the American *Nike-Hercules*. Designed for mobility and ease of handling, it is fired from a compact wheeled launcher. The solid-fuel *Thunderbird* is 21 feet long and has a wing span of 5 feet, 3 inches; the center section has a diameter of 21 inches. English Electric is prime contractor. Missile is in production.

BLOODHOUND

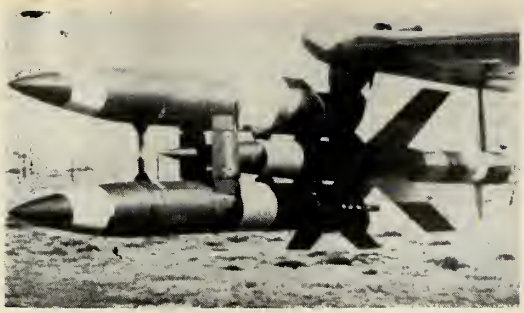
Another British surface-to-air weapon, *Bloodhound* is boosted by a solid-propellant rocket to a velocity of 1500 feet per second and sustained on the rest of its flight by two Bristol 16-inch Thor ramjets delivering 15,000 pounds of thrust. *Bloodhound* is 15 feet long and 16 inches in diameter. Guidance is by semi-active homing. Cooperating contractors are Bristol Aeroplane, which manufactures frame and engines, and Ferranti Ltd., which supplies the guidance system. *Bloodhound* is in production for the Royal Air Force.



SOLID-FUELED *Thunderbird* **elevated on mobile launcher.**



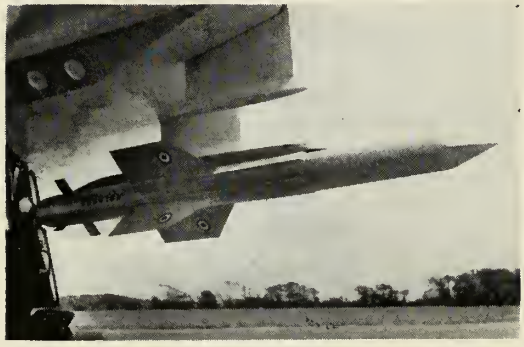
RAF's *Bloodhound* **on guard, North Coates, Lincolnshire.**



DEVELOPED early, *Fireflash* is now a standard weapon.

FIREFLASH

Britain's first operational air-to-air missile, the Fairey *Fireflash* went into development shortly after World War II and was first tested in 1953. *Fireflash* has no sustainer rocket; it is launched by two solid-propellant boosters wrapped around the missile. Body is tubular with cruciform wings. Guidance is by Marconi beam rider. *Fireflash* is carried as armament on the Supermarine Swift MK. 7, the Hawker Hunter and the Australian-built Avon-Sabre. It is now used as a training weapon for the Fighter Command.



INFRARED-guided *Firestreak* attached to a Sea Vixen.

FIRESTREAK

In development for the past six years, *Firestreak* is a more advanced air-to-air missile than *Fireflash*. *Firestreak* is a slim, tubular weapon 7 feet long with cruciform wings and fins. Power is supplied by a single solid-propellant rocket. Range is about eight miles. An infrared detection system which homes on enemy engine exhaust provides guidance. *Firestreak* is carried on under-wing mounts on the Gloster Javelin, English Electric P1 and de Havilland Sea Vixen. Prime contractor is de Havilland Propeller. The missile is in service with the Royal Air Force and in production for both the RAF and the Royal Navy.



FIRING a *Seaslug* from triple launcher of destroyer.

SEASLUG

A fleet defense weapon for the Royal Navy, *Seaslug* is a surface-to-air weapon carried aboard guided missile destroyers of the Hampshire Class. It is fired from triple deck launchers which automatically compensate for ship roll. Guidance is by semi-active homing, integrated with the destroyer's radar. *Seaslug* is powered by a solid-fuel sustainer rocket and boosted initially by four dry rockets mounted concentrically around the missile. The boosters are jettisoned after burnout. Prime contractor is Armstrong Whitworth; General Electric Co. Ltd. has guidance responsibility and Sperry the control system.



HEAVIEST tanks are vulnerable to solid-fueled *Vigilant*.

VIGILANT

An Army short-range battlefield missile, *Vigilant* has a pistol-like firing mechanism which guides it toward its target. Primarily an anti-tank weapon, it is carried in a portable launching cannister which weighs only 45 pounds and can be handled by one man. Solid-fueled, the missile is 53 inches long and has a wing span of less than one foot. Prime contractor is Vickers Armstrong Ltd.

FRANCE

SS-10, SS-11

A versatile missile which can be launched from jeeps, tanks, aircraft or helicopters, *SS-10* and *-11* are short-range battlefield weapons designed primarily for anti-tank use. They are wire-guided and solid-propelled. The missiles have been ordered by nine countries, including U.S. *SS-11* is longer-ranging version. Contractor is Nord Aviation.



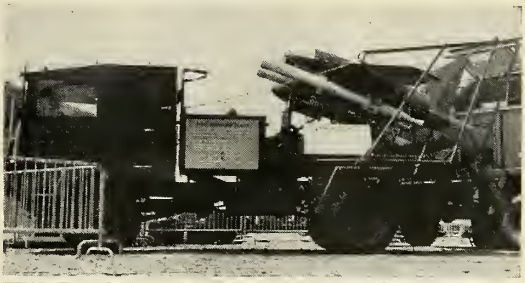
FRENCH Alouette helicopter with four deadly *SS-11's*.

ENTAC

Built by DEFA, *Entac* is similar in use and nearly identical in range and velocity. Also wire-guided and solid-fueled. In production.

SE 4200

A product of Sud Aviation, *SE 4200* is a short-range winged missile. It is launched from a truck-mounted ramp by solid boosters which drop off. Range is about 60 miles. High-explosive charge is carried beneath the missile in a pod.



TWO French Army battalions are armed with the *SE-4200*.

PARCA

In production, the DEFA (Army Arsenal) *Parca* is a surface-to-air weapon with a maximum speed of close to Mach 2 and a range of 14 miles. It is a beam rider and its warhead is detonated by proximity fuze. Power is supplied by a liquid rocket plus four solid boosters. Missile weighs slightly more than one ton.



TAKE-OFF of surface-to-air *Parca*, now in production.

SE 4300

A surface-to-air weapon similar in principle to *Nike*, Sud Aviation's *SE 4300* is used as a training vehicle by the French Army. Subsonic, it has a range of 12 miles. Liquid-fueled, it weighs one ton.

MARUCA

Subsonic, *Maruca* is a short-range anti-aircraft missile for use on ships of the French Navy. Fifteen feet long, it has a 5 foot, 3 inch span. Liquid-propelled, it has a range of about 10 miles. It is built by Ruelle Naval Arsenal.



LIQUID-fueled *Maruca* guards fleet against air attack.



WITH same job as *Maruca, Masurca* is bigger and faster.



SEMI-TRAILER carries the solid-boosted MATRA *R. 422.*

MASURCA

Another product of the Ruelle Naval Arsenal, *Masurca* is a larger anti-aircraft weapon. Supersonic, it has a 15-mile range. It is 18 feet 8 inches long and has a span of 3 feet 3 inches. Solid-propelled, it weighs slightly more than one ton with boosters.

MASALCA

The Latocoere *Masalca* is a small interceptor missile for use on small ships of the French Navy. It is designed to stop enemy aircraft at ranges up to 60 miles.

TRIDENT

A pilotless aircraft type of surface-to-air weapon, *Trident* is similar in principle to the American *Bomarc*. Liquid-propelled, it is built by Sud Aviation.

TYPE 422

Capable of speeds over Mach 2, the MATRA *R. 422* is a two-stage surface-to-air missile fired from a mobile launcher-transporter. It has a solid booster and a solid sustainer in the second stage. Built and tested in limited numbers, it employs a command guidance system. An advanced "B" version has a range of 30 miles.

TYPE 510, 511

These are MATRA-built air-to-air weapons to be used by various fighters of the French L'Armee de l'Air. *M. 510* is 10 feet long, weighs 350 pounds and has a speed capability of close to Mach 2. It is in production. *M. 511*, externally similar, features an improved guidance system.

TYPE 5103

Built by Nord, the *5103* is an air-to-air missile using beam-rider guidance. Powered by a solid-fuel booster and a solid sustainer, it is in production.

AA.20

A MATRA-built air-to-air weapon, the *AA.20* is used on Mystere A and B fighters. In production, the liquid-propelled missile has a speed of Mach 1.5 and a range of one mile.

R.051

Also built by MATRA, the *R.051* is a solid-fueled air-to-air weapon, about 10 feet long and weighing 350 pounds. It is used on Mirage and Voutour fighters. Speed is Mach 1.5. In production.

BB-10

A guided-bomb type of weapon, *BB-10* features cruciform fins, an annular shroud wing and canard surfaces. It is radio-controlled.

ITALY

AIRONE

Built by Polverfizi Giovanni Stacchini, *Airone* is a short-range surface-to-surface weapon. Solid propelled and unguided, it has a range of about 6 miles.

C-7

Centro Studi Propulsione a Reazione builds the *C-7*, an air-to-air missile. A solid-fuel engine provides power and the missile is guided to its target by an infrared homing system.

ORIONE SAR

A Stacchini product, *Orione Sar* is a limited-range surface-to-air weapon. Winged, with a 15-foot span, it is about 6 feet long.

ROBOTTI

Robotti is the name for a family of battlefield rockets under development by Motofides. The basic rocket is unguided, supersonic, about 16 feet long and 4 feet in diameter.

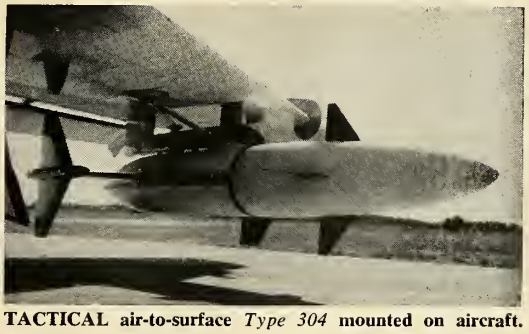
SWEDEN

TYPE 304

About 12 feet long with winged tail and small forward control fins, the Bofors *Type 304* is a tactical air-to-surface missile. The SAAB-32 Lansen all-weather attack plane carries two of these missiles on underwing mounts.

TYPE 315

This is a surface-to-surface weapon, deck-launched from destroyers. About 14 feet long with booster, it has a cruciform tail and small control fins in the nose section.

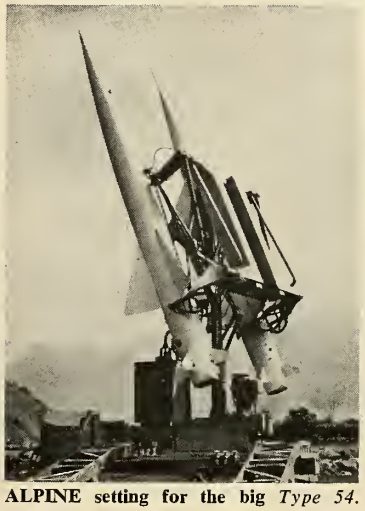


TACTICAL air-to-surface *Type 304* mounted on aircraft.

SWITZERLAND

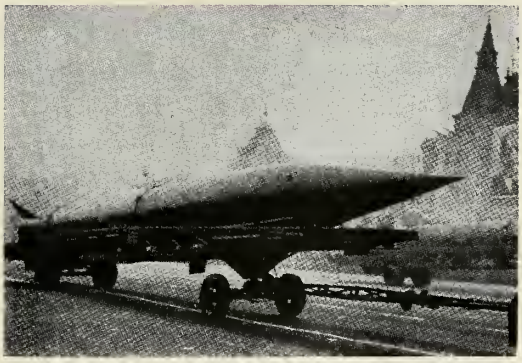
TYPE 54

A surface-to-air anti-aircraft weapon, *Type 54* is built by Oerlikon. Twenty feet long, it has a 16-inch diameter and weighs about 800 pounds. A 2000-pound-thrust liquid rocket provides power. Guidance is by beam-riding; warhead has proximity fuze. Advanced versions known as *Types 56* and *57* are in development; *Type 54* is in production.

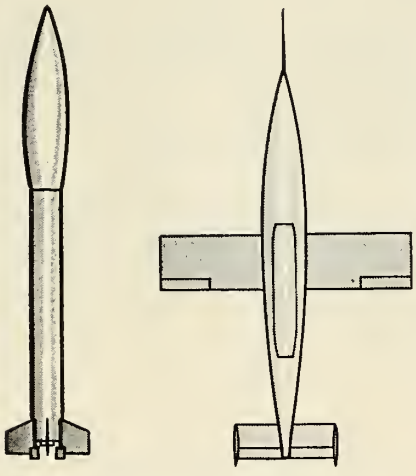


ALPINE setting for the big *Type 54*.

SOVIET UNION



NUCLEAR warhead-packing *T-1*, copied from German *V-2*.



M-100A J-2



UNGUIDED *T-5B* artillery rocket shown in Moscow parade.

M-100A

Although little is known of Soviet air-to-air missiles, this type made its first appearance in Korea as an unguided rocket. Later version is believed to have infrared guidance. About 8 feet long, it has a range of about 5 miles. It is solid-propelled. Speed is Mach 2-plus.

J-2

Basically a target drone, *J-2* is a pilotless aircraft type of vehicle also adaptable as a surface-to-surface missile or as an anti-submarine weapon. Subsonic, its range is in the 500-mile category. It is launched by a pair of solid boosters and sustained by an axial-flow turbojet. It is radio-guided.

J-3

An advanced version of *J-2*, the *J-3* is also a pilotless aircraft type, but with swept wings rather than the straight wings on its predecessor. It has four boosters for launch, and in addition to the turbojet sustainer it has a 15,000-pound-thrust ramjet engine which gives it supersonic capability. Its range is 450 miles and it is radio/radar-guided. *J-3* is 38 feet long and has a span of 23½ feet. It carries a one-ton warhead.

M-2

M-2 is a two-stage surface-to-air weapon developed from the German *Rheintochter*. In service, it is launched from mobile units. The 25-foot missile has a speed in excess of 1500 miles per hour. Guided by radar and infrared, it employes solid propellants in both stages.

COMET

This is a family of surface-to-surface missiles which originally started as a research vehicle. *Comet 1* is a short range (100 miles) single-stage weapon in operational service, reportedly also used as a sub-launched missile. It is powered by a single solid-fuel engine. *Comet 2* has a greatly improved powerplant and an inertial guidance system. Its range is in the 500-600 mile class. The 44-foot missile is in production.

ME (IGOR)

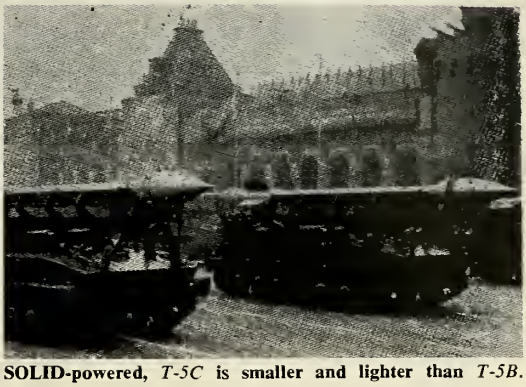
One of the earliest Soviet missiles, the *ME* is an anti-tank rocket of the bazooka type. It is two feet long and has a diameter of 3 1/3 inches. It is powered by a sulphur-based solid rocket with a three-second burning time. The weapon supposedly has a maximum range of two miles but its effective range against tanks is about 1000 yards.

T-1

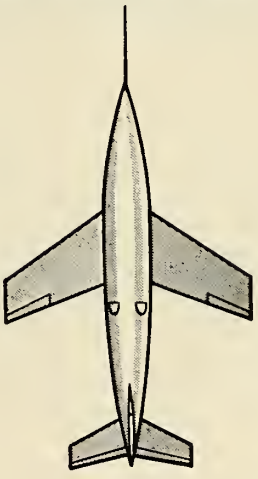
A Soviet copy of the German *V-2*, *T-1* is a surface-to-surface missile in the medium-range bracket. Frequently seen in Red Square parades, *T-1* has been operational for some time. It is equipped with a mobile, self-propelled launcher. About 50 feet long, *T-1* employs a liquid-fuel rocket engine. It is guided by a radio-inertial system. Grossing about 20 tons, it is equipped with a nuclear warhead.

T-2

The mainstay of the Soviet missile arsenal, the *T-2* has been deployed to a number of bases in Soviet Europe and reportedly has also been concentrated along the southern flank of the satellite countries to cover American air bases in North Africa. Although it stemmed from the German *V-2*, *T-1* is a greatly advanced version, with a range of more than 1500 nautical miles. A two-stage weapon, it grosses about 60 tons and overall length is more than 100 feet. It has a liquid-propellant (oxygen/alcohol) powerplant in each stage, and guidance is supplied by a radio-inertial system. Warhead is nuclear.



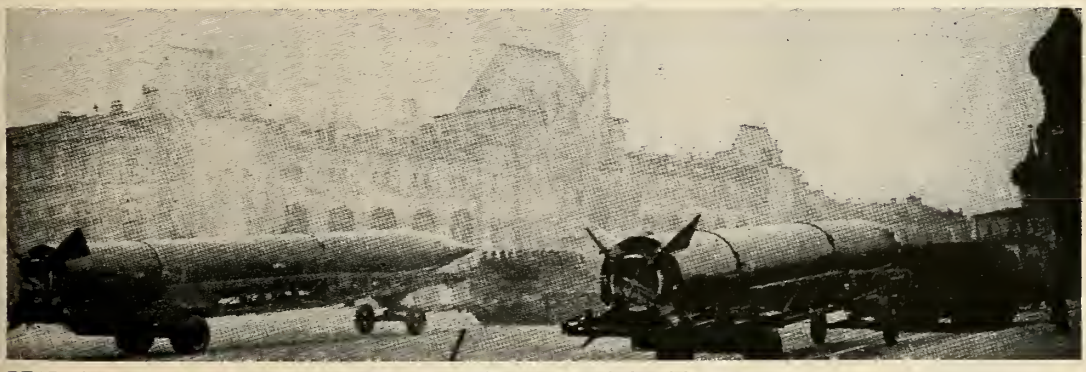
SOLID-powered, *T-5C* is smaller and lighter than *T-5B*.



J-3



M-2



REAR view of the highly mobile, operational *T-1*, guided by a radio-inertial system.



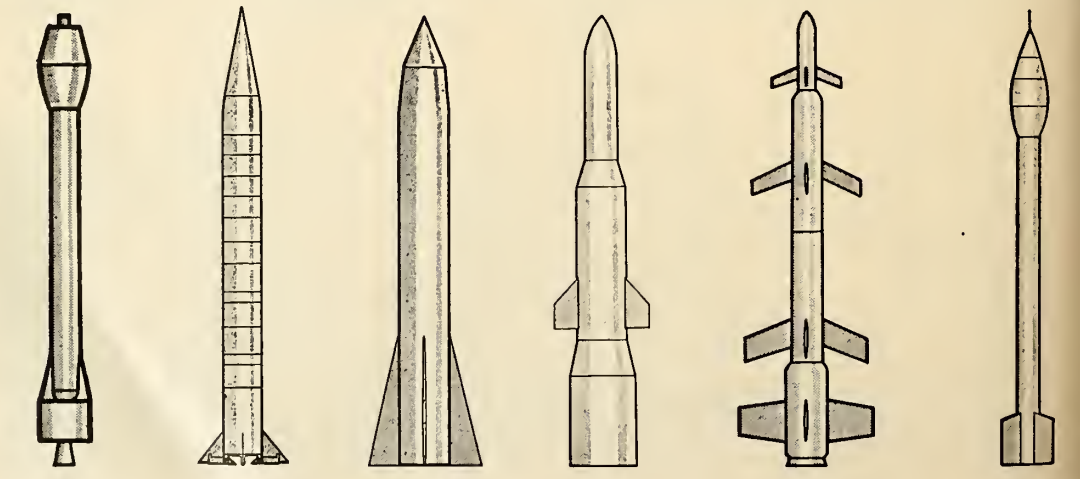
TWO-STAGE surface-to-air *M-2* travels at better than 1500 mph and is guided by both radar and infrared.

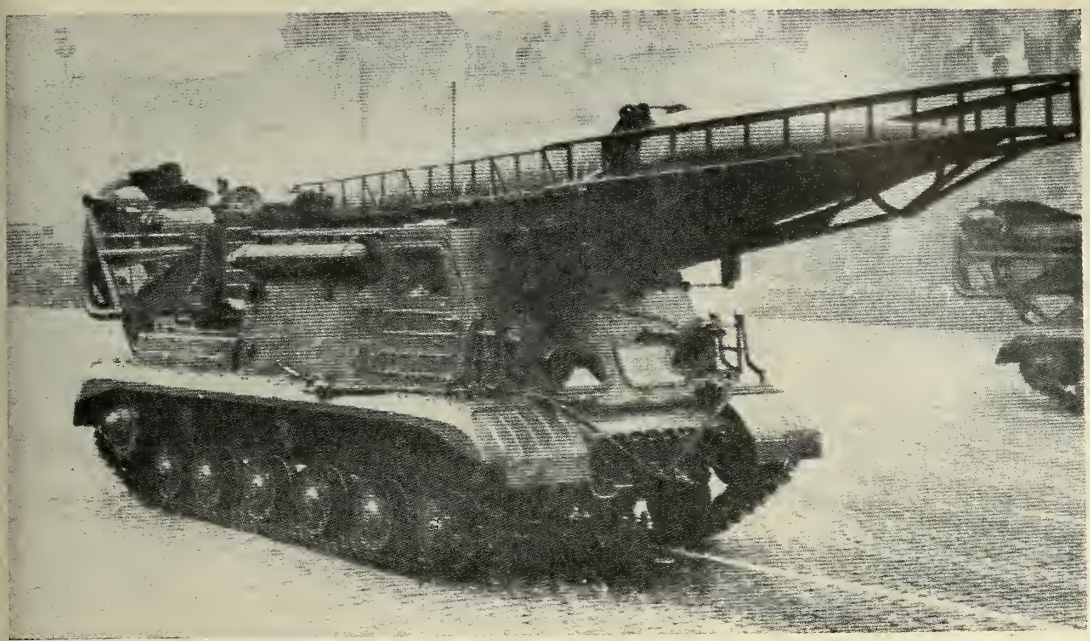
T-3

The much-discussed Soviet intercontinental ballistic missile, *T-3*, according to qualified authorities, is scheduled for operational service in 1959. Like the American *Atlas* and *Titan*, it is designed to carry a thermonuclear warhead more than 5000 miles. It is a two-stage missile employing high-thrust liquid-fuel engines in both stages; estimates of the amount of thrust vary widely. The missile has an overall length of 100-125 feet and it grosses about 85 tons. Guidance is radio-inertial. An advanced version of this weapon is known as *T-3A*. This version, in development production status, has an estimated range of more than 6000 miles and a velocity of 16,000 miles per hour. Like *T-3*, it is a two-stage liquid-fuel missile with a higher thrust engine in the first stage.

T-4

Capable of delivering a one-ton warhead over a distance of 1000 miles, *T-4* falls in the medium-range ballistic missile category. It is 50-55 feet long and has a diameter of 6½ feet. Grossing 35 tons, it is a two-stage weapon, both stages liquid-fueled. Warhead is nuclear.





OPERATIONAL *T-7A* **is comparable to U.S. Army's** *Corporal* **and has a range of 70 miles and solid-fuel powerplant.**

T-4A

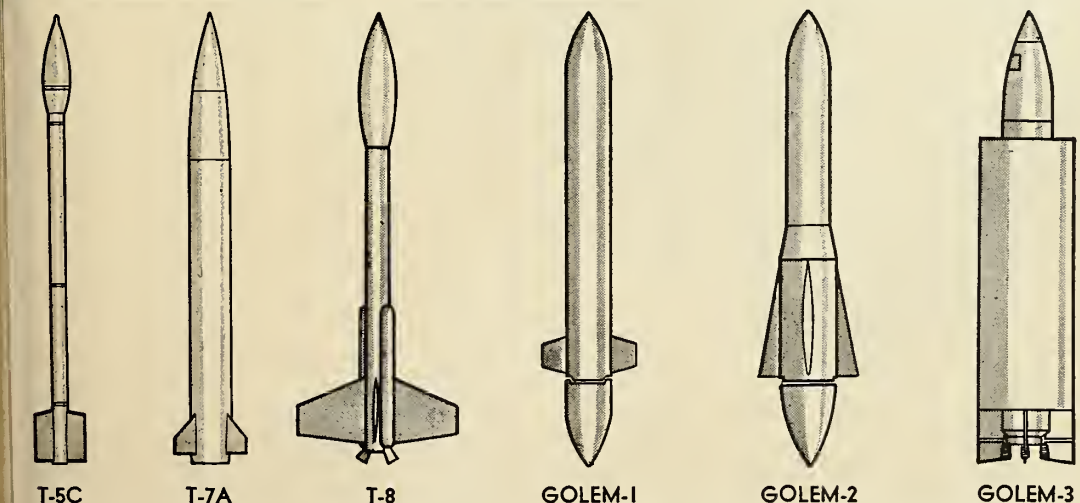
This is the Soviet counterpart of the American *Dyna-Soar* boost glide bomber, stemming from German *Saenger-Bredt* antipodal bomber in design status at the end of World War II. Although reliable sources have reported that the U.S.S.R. is working actively on this project, its status is unknown.

T-5

A short-range artillery rocket, *T-5* is one of the earlier Soviet missiles. Grossing about 2½ tons, it is 32 feet long and 3 feet in diameter. A *T-5* field battery has six launchers each. The rocket is unguided.

T-5B, T-5C

Also artillery rockets, *T-5B* and *T-5C* are later versions of the basic *T-5*. Both have been seen frequently in Moscow parades and both are in operational service. They are carried on self-propelled tank-like launchers. *T-5B* is 30 feet long and has a range of 25 miles. *T-5C* is a smaller weapon, 25 feet long and about a foot and a half in diameter. It has a solid-propellant powerplant. Both weapons are unguided.



T-6

Another surface-to-air weapon, *T-6* is a two-stage missile with a service ceiling of about 60,000 feet. The weapon grosses two tons and has a speed in excess of 1500 miles per hour. Its first stage has four solid boosters and there are two more solid rockets in the sustainer power plant for the second stage. It is radar-guided and carries a high explosive warhead with proximity fuze.

T-7A

The *T-7A* is an adaptation of a research rocket to military use as a short-range surface-to-surface missile. In service, it is about 25 feet long and about 2½ feet in diameter. Where the original version was liquid-propelled, the operational weapon has a solid-fuel powerplant. Comparable to the American *Corporal*, it has a range of 70 miles.

T-8

An anti-aircraft weapon, *T-8* is the Soviet counterpart of the American *Nike-Ajax*. In service for several years, it has a range of 15 miles and carries a high explosive-proximity fuzed warhead. Speed is Mach 2-plus. The missile is boosted by two solid-propellant rockets; a larger liquid rocket of 4600 pounds thrust powers the second stage. Fired from mobile launchers, it is used by field batteries in non-permanent positions.

GOLEM-1

Another missile adapted from German World War II work, *Golem* is an underwater-to-surface weapon launched from a chamber which is towed by a submarine. In production, it has a range of about 400 miles. It has a liquid-fuel engine which burns oxygen and alcohol and it employs a radio inertial guidance system. Grossing 16½ tons, it is 54 feet long.

GOLEM-2

A longer-ranging underwater-to-surface missile, *Golem-2* is reportedly a naval version of the *T-2* IRBM. A two-stage weapon like *T-2*, it has liquid-fuel engines. Launching is from the towed underwater chamber, as in *Golem-1*. *Golem-2* is 57 feet long, 7 feet in diameter and has a range of about 1200 miles. It is still in developmental status.

GOLEM-3

An anti-aircraft weapon designed for launch from a submarine or surface vessel, *Golem-3* has a range of about 8 miles and reportedly has underwater launch capability. It is 17 feet long and 2 feet in diameter. Power is supplied by a 15,000-pound-thrust solid-fuel engine. The missile weighs 2.2 tons and is guided to its target by an infrared system.



MODEL of *Sputnik III* satellite dramatizes peaceful use of launching capability. Inset shows "ion trap."

Have sidearms, will travel

When SAC slings a pair of GAM-77 Hound Dog air-ta-graund missiles under the wings af the new B-52G bamber, it has what amaunts to a brand-new manned weapan system.

Far the Hound Dog's jet engine drives it at supersanic speed ta a target hundreds af miles away. Its self-cantained inertial autonavigatar, set befare launch by the B-52's crew, can't be jammed, can't be decayed.

The GAM-77 Haund Dag pragram gat underway in August, 1957. The missile is already in its flight test phase. Thanks to accelerated develapment, it will be deplayed by 1960.

SAC's and ARDC's "blue-suit" integratian programs further speed the Hound Dog's aperatianal status. As every other test missile comes aff the praductian line, half the crew assigned ta it is fram the Air Farce.

The Missile Divisian af Narth American Aviatian is weapan system contractor for the GAM-77 Haund Dag.

MISSILE DIVISION

NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA



Saturn's Test Tower To Be Ready by Sept. 1

HUNTSVILLE—Construction work was completed last week on the modification of the 145-foot rocket engine static test tower at Redstone Arsenal to accommodate the 1½-million-pound-thrust *Saturn* booster.

The Department of Defense says it expects the tower will be ready for use when support facilities are finished Sept. 1. The *Saturn* test vehicle will be delivered to the Army Ballistic Missile Agency's Test Laboratory in November. The first static testing is due in December.

ABMA is developing the *Saturn* booster, a clustering of eight H-1 liquid propellant motors—for the Advanced Research Projects Agency, Department of Defense, for heavy space applications. The booster will stand 75 feet tall and have a diameter of 22 feet.

Steel pilings were driven down to bedrock, in some cases as far as 60 feet, to provide structural support for the test tower. The $850,000 job has been in progress since January. In addition to a new structural steel test position the work consists of an enlarged blast deflector pit, a steel buttress for additional horizontal strength, and two 101-foot steel girders that help support a super-structure housing a crane hoist atop the concrete tower.

Earlier, ARPA announced selection of a modified **Aerojet** first *Titan* stage and a new **Pratt-Whitney** and **Convair** *Centaur* rocket as the second and third stages of the *Saturn* project, which is to provide a reliable system for lifting multi-ton loads into high orbit and deep space by 1962 or 1963.

The three-stage *Saturn* will weigh at liftoff about 580 tons of which about 500 tons will be propellants, and will stand about 200 feet tall.

The modified *Titan* second stage will be somewhat longer than its regular 54 feet and will be 10 feet in diameter. It will provide a 360,000-pound thrust. The third-stage *Centaur* will use two rocket engines with combined thrust of 30,000 pounds and be 10 feet in diameter.

The vehicle will have an all-inertial guidance system to automatically compensate for loss of thrust if one of the booster engines should fail.

The third-stage *Centaur* is being developed by Pratt & Whitney, and Convair.

CLASSIFIED

For approved storage and transportation of high explosives and propellants in Los Angeles area contact:
W. A. Murphy, Inc.
436 North Arden Drive
El Monte, California
CUmberland 3-8048

Circle No. 97 on Subscriber Service Card.

people



TRUAX

Capt. Robert C. Truax, USN, (Ret.), former national president of the American Rocket Society, has joined Aerojet-General Corp. as director of Advanced Development at its Liquid Rocket Plant in Sacramento. Truax, 42, who has spent almost his entire professional career in the development of rockets, guided missiles and satellites, received the Robert H. Goddard medal in 1951 for his outstanding work in rocket development and last year was awarded the Navy's Legion of Merit decoration for his contribution to the *Polaris* program. (See M/R profile, November, 1957, p. 114.)



WAWRA

Aerojet also has named **Cecil W. Wawra** of Paris director of European Operations. He will coordinate the company's activities in Western Europe, concentrating on projects in which A-G is associated with European companies in national or NATO defense programs. From 1951 to 1956, Wawra represented the General Tire and Rubber Co., parent-company of Aerojet, at Rome, and since 1956 has represented both General Tire and Aerojet-General in Paris.



MILLER

Dr. Curt E. Miller, a specialist in aero and space medicine, has joined the Aeronautics Division of Wiancko Engineering Co., where he will conduct research on animal instrumentation and the effects of inertial forces and other space environmental factors associated with getting man into space.

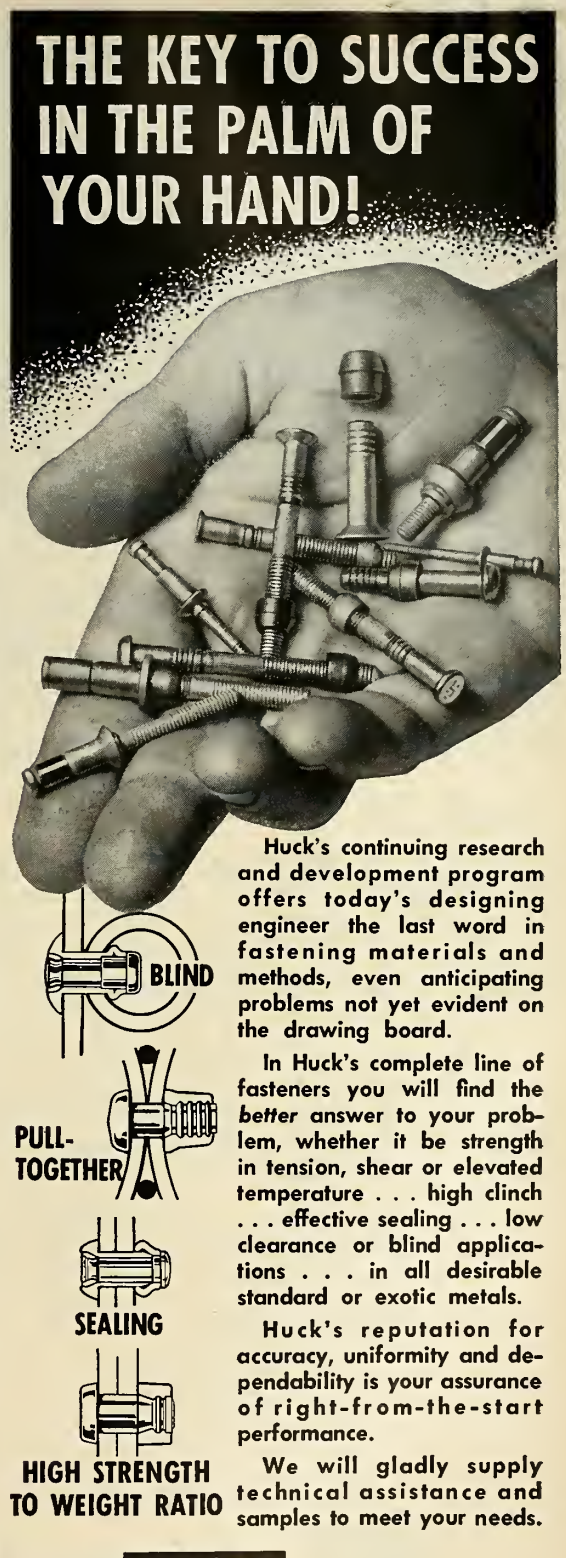
Matthew H. Portz became the National Aeronautics and Space Administration's Western Public Information Officer on July 13. Located at the NASA Western Coordination Office, 150 Pico Boulevard, Santa Monica, Calif., he will be responsible for information activities in Southern California and neighboring states. Portz is transferring to the new post from the NASA Lewis Research Center, Cleveland, where he has been Information Officer since August, 1956. His successor at Lewis is **Harry J. McDevitt Jr.,** formerly of the General Electric Co. News Bureau.



LUNGER

Election of **Wilbur E. Lunger** as staff vice president of manufacturing, and **H. Ben Young** as staff vice president of engineering and research of ACF Industries, Inc., has been announced. Both of the new corporate vice presidents were officers in ACF operating divisions—Lunger as vice president of manufacturing with American Car and Foundry division in New York City, and Young as director of engineering and research at W-K-M division, Houston.

Henry P. Steier, former M/R electronics editor, has been named corporate director of Public Relations for Lear, Inc. Immediately prior to joining Lear, Steier was special assistant for Technical Information to E. R. Quesada, Federal Aviation Agency administrator. He was with American Aviation Publications, Inc., publishers of M/R, from 1955 to 1958 after holding increasingly responsible positions in the electronics engineering field. Steier was a major contributor to the design and development of the first high-production cathode ray tubes for commercial television and holds patents in the field of electron optics and secondary emission techniques.



Huck's continuing research and development program offers today's designing engineer the last word in fastening materials and methods, even anticipating problems not yet evident on the drawing board.

In Huck's complete line of fasteners you will find the *better* answer to your problem, whether it be strength in tension, shear or elevated temperature . . . high clinch . . . effective sealing . . . low clearance or blind applications . . . in all desirable standard or exotic metals.

Huck's reputation for accuracy, uniformity and dependability is your assurance of right-from-the-start performance.

We will gladly supply technical assistance and samples to meet your needs.

HUCK *MANUFACTURING COMPANY*

2480 Bellevue Ave. Detroit 7, Mich. Phone — WA 1-6207

Circle No. 96 on Subscriber Service Card.



A "TIME-TABLE" FOR SPACE CONQUEST

BY **1963** – INSTRUMENTED PLANETARY SOFT LANDING

BY **1968** – SPACE STATION FOR STAGING TO MOON AND PLANETS

BY **1970-75** – MOON BASE

These predictions were made by Alexander Kartveli, Vice-President for Research & Development at Republic Aviation, and one of the most optimistic of the 56 leading space experts of the world who were consulted by the U.S. House of Representatives Committee on Astronautics & Space Exploration for its report: "The Next 10 Years in Space, 1959-1969."

JOIN REPUBLIC IN AN **INTEGRATED ATTACK** ON PROBLEM AREAS OF **SPACE EXPLORATION**

It's the fervent conviction of engineers and scientists at Republic Aviation that the courageous "Space Time-Table" above is entirely feasible – given a tradition-free, integrated approach to the problems. Such an approach is evident at Republic Aviation. Here, groups of specialists from many disciplines are working in close collaboration to solve problems across the entire spectrum of space technologies, which limit today's interplanetary and upper atmosphere flight capabilities.

Expanded by $35,000,000 last year, Republic's integrated Research and Development program has already produced signal advances in space guidance concepts; in new propulsion systems (plasma, nuclear); in radiation physics; in new materials and processing techniques; in unique hypersonic configurations; and in prototype development of hardware (as an example: hydraulic systems that operate reliably up to 1000°F).

Professional men—who can meet new challenges with enthusiasm and dedication – are urged to look into openings with our R&D groups, working in an atmosphere of exhilarating intellectual adventure.

Electronics
Inertial Guidance & Navigation
Digital Computer Development
Systems Engineering
Information Theory
Telemetry-SSB Technique
Doppler Radar • Countermeasures
Radome & Antenna Design
Microwave Circuitry & Components
Receiver & Transmitter Design
Airborne Navigational Systems
Jamming & Anti-Jamming
Miniaturization — Transistorization
Ranging Systems
Propagation Studies
Ground Support Equipment

Thermo, Aerodynamics
Theoretical Gasdynamics
Hyper-Velocity Studies
Astronautics Precision Trajectories
Airplane/Missile Performance
Air Load and Aeroelasticity
Stability and Controls
Flutter & Vibration
Vehicle Dynamics & System Designs
High Altitude Atmosphere Physics
Re-entry Heat Transfer
Hydromagnetics
Ground Support Equipment

Plasma Propulsion
Plasma Physics
Gaseous Electronics
Hypersonics and Shock Phenomena
Hydromagnetics
Physical Chemistry
Combustion and Detonation
Instrumentation
High Power Pulse Electronics

Nuclear Propulsion and Radiation Phenomena
Nuclear Weapons Effects
Radiation Environment in Space
Nuclear Power & Propulsion Applications
Nuclear Radiation Laboratories

Send resume in complete confidence to: Mr. George R. Hickman, Engineering Employment Manager, Dept. 4G-4

REPUBLIC AVIATION

Farmingdale, Long Island, New York

reviews

ZIRCONIA: ITS CRYSTALLOGRAPHIC POLYMORPHY AND HIGH TEMPERATURE POTENTIALS, B. C. Weber and M. A. Schwartz, Aeronautical Research Laboratory, WADC, 26 pp, available from OTS, U.S. Department of Commerce, Washington 25, D.C.

Zirconia (ZrO_2), with its melting point of 4850°F, is one of the most promising materials for high-temperature applications, according to this report. In addition to being among the most stable of the refractory oxides, it has very high strength, good corrosion resistance, hardness, high thermal shock resistance, and high thermal conductivity—qualities important in rocket, ramjet, and missile applications. The report clarifies some of the controversial data presented in literature concerning this refractory metal, reviews the chemistry of zirconia, and presents some of its future potentialities.

Also described are advancements in metal-modified oxides. According to the report, the usefulness of zirconia is now dependent on controlling its crystallographic transformation.

CTR-292 FIBER GLASS AND GLASS LAMINATES, 1930-58, available from OTS, U.S. Department of Commerce, Washington 25, D.C.

A catalog of technical reports which lists all reports of research in the fields of fiber glass and glass laminates has been published by the Office of Technical Services, U.S. Department of Commerce.

Many of the reports listed are the result of research conducted for the Army, Navy, Air Force, and other agencies of the U.S. Government. Others are German documents captured by the Allies during World War II.

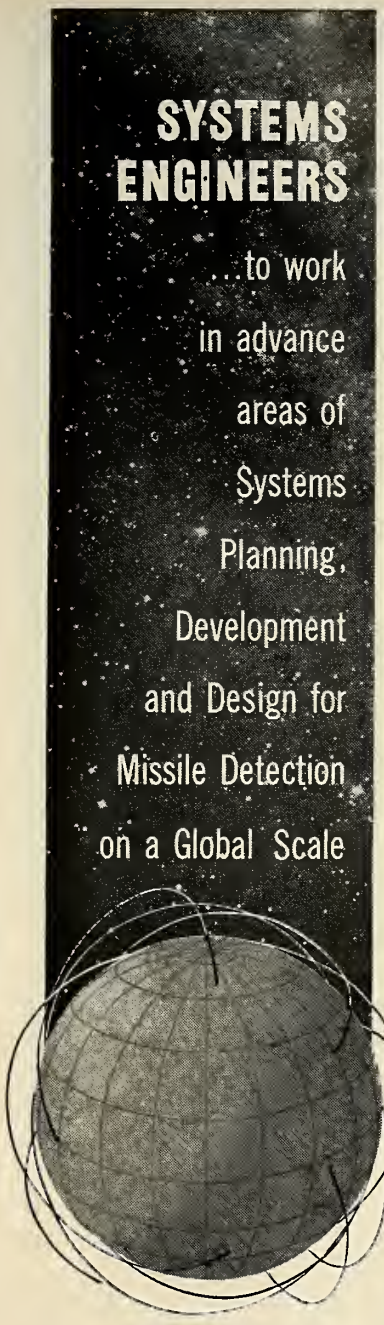
SOVIET RESEARCH IN LUBRICANTS AND LUBRICATION: Dec. 1958, 27 pp, available from OTS, U.S. Department of Commerce, Washington 25, D.C.

Russia and her satellites were not ahead of the United States in the field of lubricants and lubrication at the beginning of 1958, but were trying to gain headway by studying the work of others, Soviet literature indicates.

According to a survey of published Russian literature by a U.S. Government agency, "It appears that Soviet scientists are not ahead in any process, products, or applications." The study included material on lubrication, lubricants and additives, and formulation of lubricating compositions.

The review of abstracts of Russian technical reports appearing from 1950 to the end of 1957 showed that Red researchers were apparently concentrating on areas fairly well known and defined by U.S. scientists.

This may mean, the survey concludes, that while the Soviets realized the po-



These positions are with the Missile Detection Systems Section of General Electric and require high technical and creative capacities. All assignments offer fruitful opportunities to make state-of-the-art advances with an organization that encourages and rewards the individual contributor. The ability to function both through individual action and team leadership is highly valued. Current openings are in these areas:

ADVANCED RADAR SYSTEMS PLANNING

Work in this area calls for engineers able to visualize and define future defense and space problems and conceive advanced radar systems to solve them.

RADAR SYSTEMS ANALYSIS & DEVELOPMENT

An advanced degree and/or strong background in systems analysis and design is essential for such assignments as:

...analyze and define requirements for advance detection systems and determine broader parameters for such systems; establish their feasibility.

...analyze long range missile detection systems and specify optimum configuration on the basis of utility, performance, cost and delivery.

SPECIALISTS IN ELECTROMAGNETIC PROPAGATION

PhD or MS is required in this area. Scientists will carry out analysis of propagation phenomena, as related to long range missile detection. Plan detailed investigations and illustrate practicability of results. Ability to assume responsibility essential.

OPPORTUNITIES IN D & D OF RECONNAISSANCE RECEIVER DESIGN & SYSTEMS EQUIPMENT

Assignments require specialized background in one or more of these areas: VHF and UHF frequency spectra (P & L bands) • ECM • Microwave; wave guide components, Duplexers, switches, hybrids; VHF and UHF transmitters.

ALSO POSITIONS IN COMPUTER APPLICATIONS

(Knowledge of large business or special purpose computers needed) and COMPUTER PROGRAMMING (experience with IBM 704 & 709 needed.)

Write in confidence to: Mr. James P. Kinsella, Div. 73-WU

Missile Detection Systems Section

HEAVY MILITARY ELECTRONICS DEPT.

GENERAL ELECTRIC

Court Street, Syracuse, New York

rapidly expanding

major missile and

space project facility

in New England

creates key positions with

"growing room" for

electronic engineers

Billion-dollar United Aircraft Corporation has long been a pace-setter in aerodynamics, themodynamics, propulsion, air frames, airborne equipment, etc. Now, establishment of a new division has placed the Corporation squarely in the *integrated electronic systems* field.

THE MEN WE SEEK have had experience in electronic sub-systems and are now prepared for Weapons Systems Management wherein they must view the entire concept of integrated systems. We solicit skills in

- Communications Systems
- Computer Systems
- Inertial Guidance Systems
- Fusing and Arming
- Ground Support
- Guidance Systems
- Radar Systems
- Feedback Controls
- Autopilots

BENEFITS: Connecticut countryside living — ultra sophisticated projects dealing with advanced flight systems, missile systems, orbital and lunar studies — "first aboard," wide-open opportunities to start high, move higher — the finest corporate-owned research facilities anywhere — company supported advance degree programs — and the revealing fact that we acknowledge how vital is electronics to this weapon systems field.

If you are serious about your career, then you owe it to yourself to write immediately to Mr. John North at:

missiles & space systems

A Division of

UNITED AIRCRAFT CORPORATION

431 MAIN STREET • EAST HARTFORD, CONN.

tential importance of the field, they were not especially proficient in it.

A large amount of research, the report observes, was being expended on hydrocarbon chemistry, an effort which could lead to new petroleum processes and products.

ON THE PROBLEM OF RE-ENTRY INTO THE EARTH'S ATMOSPHERE, A. C. Robinson and A. J. Besonis; WADC, U.S. Air Force. 68 pp. $1.75. Available from OTS, U.S. Department of Commerce, Washington 25, D.C.

Problems concerned with safely recovering a manned satellite after it has orbited the earth or gone around the moon are presented in this Air Force report from the standpoint of deceleration, heating, and accuracy of impact.

The study indicates further that simple, non-lifting re-entry will be feasible from satellite orbits. It appeared possible to achieve impact accuracy sufficient for ground installation, suitably alerted, to find the vehicle. The lunar re-entry, however, presents a severe total heat problem, and accuracy requirements are such that some lift or other control will probably be required.

Deceleration and peak heating rates were found to be no larger than those encountered in ballistic missile re-entries, but the total heat input was much larger because the heating lasts longer.

ORBITAL STORAGE OF CRYOGENIC FLUIDS, D. R. Cramer, WADC, U.S. Air Force. 13 pp. Available from OTS, U.S. Department of Commerce, Washington, D.C.

This Air Force report indicates that simple, multi-layer reflective-type shielding provides the answer to the problem of storing low-boiling point propellants during long space flights.

A study was made to determine if research on combined regenerative and radiative heat transfer techniques was necessary for the development of storage containers. It was found that for most containers of probable capacities, yearly liquid hydrogen losses can be maintained below an acceptable 5% if sufficient reflective layers are used.

Research specifically in the heat transfer area is not required for the development of such containers, the report concludes.

WELDING AND BRAZING OF MOLYBDENUM, N. E. Weare and R. E. Monroe, Defense Metals Information Center, Battelle Memorial Institute for Office of Director of Defense Research and Engineering, Department of Defense. 47 pp, $1.25. Available from OTS, U.S. Department of Commerce, Washington 25, D.C.

The report identifies the best methods, as drawn from the published literature, for welding molybdenum to itself.

It also provides guidelines for producing the most useful molybdenum joints. Metallurgical considerations involved in joining the metal are discussed, as well as cleaning and testing techniques.

Joining processes examined include fusion, resistance, and solid-state welding, and brazing.

Advertiser's Index

AC Electronics Div., General Motors Corp. 13
Agency—D. P. Brother & Co.

Aerojet-General Corp., Sub., General Tire & Rubber Co. 28
Agency—D'Arcy Advertising Co.

Aeronutronic Systems, Inc., Sub., Ford Motor Co. 40, 41
Agency—Honig-Cooper & Miner

Aeroquip Corporation 9
Agency—Fred M. Randall Co.

Aircraft Armaments, Inc. 99
Agency—George C. Ruehl, Jr.

AiResearch Mfg. Co., Div., The Garrett Corp. 73
Agency—J. Walter Thompson Co.

Allied Chemical & Dye Corp., General Chemical Div. 125
Agency—Kastor, Hilton, Chesley, Clifford & Atherton, Inc.

Allied Chemical & Dye Corp., Nitrogen Div. 112
Agency—G. M. Basford Co.

Allison Div., General Motors Corp. .. 24
Agency—Kudner Agency, Inc.

American Potash & Chemical Corp... 35
Agency—The McCarty Co.

Annin Company, The 19
Agency—The McCarty Co.

Armco Steel Corp. 39
Agency—N. W. Ayer & Son, Inc.

Avco Corp., Crosley Div. 3
Agency—Benton & Bowles, Inc.

Baldwin-Lima-Hamilton, Loewy-Hydropress Div. 115
Agency—Gray & Rogers

Bausch & Lomb Optical Co. 80
Agency—Wolff Associates, Inc.

Behlman Engineering Co. 120
Agency—Jack Packard Adv.

Bendix Aviation Corp., Bendix Friez Div. 124
Agency—Odgen Advertising Co., The

Bendix Aviation Corporation
Bendix Products Div. 25
Bendix Systems Div. 6
Hamilton Div. 130
Scintilla Div. 121
Utica Div. 97
Agency—MacManus, John & Adams, Inc.

Boeing Airplane Co. 67
Agency—Fletcher Richards, Calkins & Holden, Inc.

Bristol Company, The 127
Agency—James Thomas Chirurg Co.

Brunswick-Balke-Collender Co. 10
Agency—McCann-Erickson, Inc.

Brush Instruments, Div., Clevite Corp. 134
Agency—Duffy, McClure & Wilder, Inc.

H. W. Butterworth & Sons Co. 11
Agency—William Jenkins Adv., Inc.

Callery Chemical Co. 96
Agency—Ketchum, McLeod & Grove, Inc.

Cameron Iron Works, Inc. 16
Agency—Boone & Cummings

Chance Vought Aircraft, Inc. 78, 79
Agency—Tracy-Locke Co., Inc.

Cole Electric Co. 23
Agency—Taggart & Young, Inc.

Conax Corp. 15
Agency—Harvy Advertising Agency

Continental Aviation & Engrg. Corp., Sub., Continental Motors Corp. ... 4
Agency—The Hopkins Agency

Consolidated Electrodynamics Corp. 22, 116
Agency—Hixson & Jorgensen, Inc.

Convair, Div.-General Dynamics Corp. 17
Agency—Barnes Chase Co.

Crane Company 126
Agency—The Buchen Company

Data-Control Systems, Inc. 129
Agency—H. J. Benati & Associates

Delavan Mfg. Co. 100
Agency—W. D. Lyon Co.

Dit-Mco, Inc. 89
Agency—Jones & Hanger, Inc.

Douglas Aircraft Co., Inc. 18, 104
Agency—J. Walter Thompson Co.

Dow Corning Corp. 8
Agency—Church & Guisewite Adv., Inc.

DuKane Corp. 101
Agency—The John Marshall Ziv Co.

Dyna-Therm Chemical Corp. 12
Agency—Taggart & Young, Inc.

Eastern Industries, Inc. 94
Agency—Remsen Adv. Agency, Inc.

Electro Instruments, Inc. 30
Agency—Clyde D. Graham, Adv.

Excelco Developments 110
Agency—Melvin F. Hall Adv. Agency, Inc.

Fansteel Metallurgical Corp. 133
Agency—Symonds, MacKenzie & Co.

Flexonics Corp., Aeronautical Div. ... 27
Agency—O'Grady-Andersen-Gray, Inc.

Forbes & Wagner, Inc. 105
Agency—Melvin F. Hall Adv. Agency, Inc.

General Magnetics 118
Agency—George Homer Martin Associates

Genisco, Inc. 129
Agency—Clyde D. Graham, Adv.

Grand Central Rocket Co. 77
Agency—Jakobsen Adv. Agency

Grinnell Company 26
Agency—Noyes & Co., Inc.

Hallicrafters Co. 108
Agency—Henry B. Kreer & Co., Inc.

Hoffman Laboratories, Div., Hoffman Electronics Corp. 185
Agency—Honig-Cooper, Harrington & Miner

Huck Mfg. Co. 179
Agency—F. B. Hubert Adv.

Indiana Gear Works 103
Agency—Bozell & Jacobs, Inc.

International Telephone & Telegraph Corp. 34
Agency—J. M. Mathes, Inc.

Janitrol Aircraft Div., Surface Combustion Corp. 82
Agency—Odiorne Industrial Adv., Inc.

Jet Propulsion Laboratory, Calif. Institute of Technology 37
Agency—Stebbins & Cochran

Kelsey—Hayes Co. 70
Agency—Zimmer, Keller & Calvert, Inc.

Kern Instruments, Inc. 118
Agency—Richmond Adv. Service, Inc.

Kollmorgen Optical Corp. 124
Agency—Wilson, Haight, Welch & Grover, Inc.

Lavelle Aircraft Corp. 14
Agency—The Roland G. E. Ullman Organization

La Vezzi Machine Works 99
Agency—R. W. Sayre Co.

Leach Corp., Relay Div. & Inet Div... 2
Agency—Hixson & Jorgensen, Inc.

Lockheed Aircraft Corp. 74, 75
Agency—Foote, Cone & Belding

Lockheed Aircraft Corp., Missile System Div. 123
Agency—Hal Stebbins, Inc.

Loewy-Hydropress Div., Baldwin-Lima-Hamilton 115
Agency—Gray & Rogers

Magnavox Co., The, Government & Industrial Div. 88
Agency—Rothbardt & Haas Adv., Inc.

Martin Company, The 86, 87
Agency—VanSant, Dugdale & Co.

Marman Div., Aeroquip Corp. 33
Agency—Fred M. Randall Co.

Metallizing Co. of Los Angeles 129
Agency—Ross Adv. Agency

Metallurgical, Inc. 72
Agency—Fischbein Adv. Agency

Metals Disintegrating Co. 135
Agency—Williams & London Adv.

Minneapolis-Honeywell Regulator Co., Honeywell Div. 178
Agency—Commerce Advertising

Motorola, Inc., Military Electronics Div. 91, 92, 93
Agency—Compton Advertising, Inc.

National Engineering Service 95
Agency—Al Paul Lefton Co., Inc.

Neway Equipment Co. 117
Agency—Creative Ad Art

Newbrook Machine Corp. 111
Agency—Melvin F. Hall Adv. Agency

New Departure Div., General Motors Corp. 81
Agency—D. P. Brother & Co.

North American Aviation, Inc.
Missile Development Div. 177
Rocketdyne Div. 20
Agency—Batten, Barton, Durstine & Osborn, Inc.

Northrop Corp. 65
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Nutt-Shel Company 186
Agency—Welsh-Hollander Adv.

Olympic Plastics Co., Inc. 120
Agency—The Rouse Co.

Pan American World Airways, Inc., .. 113
Agency—Willard E. Botts Adv., Inc.

Philco Government & Industrial Div., Western Dev. Labs. 69
Agency—Maxwell Associates, Inc.

Radio Corporation of America 84, 114
Agency—Al Paul Lefton Co., Inc.

Raybestos-Manhattan, Inc. 102
Agency—Gray & Rogers

Raytheon Mfg. Co. 36
Agency—Donahue & Coe, Inc.

Reeves Instrument Corp. 7
Agency—Edward W. Robotham & Co.

Charles Ross & Son Co., Inc. 123
Agency—Asher, Godfrey & Franklin, Inc.

Ryan Aeronautical Co. 136
Agency—Batten, Barton, Durstine & Osborn, Inc.

Sanborn Company 98
Agency—Culver Advertising, Inc.

Scaife Company 31
Agency—E. A. Korchnoy, Ltd.

Screw Products Corp. of America ... 131
Agency—Phillips/Robbins, Inc.

Space Technology Laboratories, Inc. .. 106
Agency—Gaynor & Ducas, Inc.

Sperry Rand Corp., Sperry Gyroscope Div. 42
Agency—Equity Adv. Agency, Inc.

Stratoflex, Inc. 132
Agency—Magnussen

System Development Corp. 119
Agency—Stromberger, LaVene, McKenzie

United Aircraft Corp., Hamilton-Standard Div. 85
Agency—Chambers Wiswell Shattuck Clifford & McMillan, Inc.

United Aircraft Corp., Norden Div. .. 62
Agency—Lennen & Newell, Inc.

United Aircraft Products, Inc. 122
Agency—Weber, Geiger & Kalat, Inc.

Westinghouse Electric Corp., Defense Products Group 59, 60, 61
Agency—Ketchum, MacLeod & Grove, Inc.

Westvaco-Chlor-Alkali Div., Food Machinery & Chemical Corp. 109
Agency—James J. McMahon, Inc.

Wyman-Gordon Co. 38
Agency—The Davis Press, Inc.

EMPLOYMENT SECTION

General Electric Co. 181
Agency—Deutsch & Shea, Inc.

Missiles & Space Systems Div., United Aircraft Corp. 182
Agency—Chambers, Wiswell, Shattuck, Clifford, McMillan, Inc.

Republic Aviation Corp. 180
Agency—Deutsch & Shea, Inc.

From Little Acorns...

Recently, one of NASA's procurement chiefs showed me a photostat of the first U. S. Government airplane contract, dated Jan. 27, 1908. It called for construction by Wilbur and Orville Wright of a heavier-than-air machine sufficiently "demountable" to be carried on "an ordinary Army wagon." The contract price was $25,000. Scribbled in the margin of the document in faded ink was the prophetic phrase: "from little acorns . . ."

As space technology moves out of the acorn stage, the success of the United States program will continue to be in direct ratio to the quality of teamwork between government and industry. NASA's predecessor, the National Advisory Committee for Aeronautics, achieved a high degree of teamwork with the aircraft industry. When NASA was formed, it was determined that its space mission should not interfere with the type of service NACA used to provide.

Therefore, NASA was divided into two separate technical branches: the Office of Aeronautical and Space Research and the Office of Space Flight Development. Although the former will naturally be involved in research for NASA's own operational needs in space flight, it will also continue to provide research advice and assistance to the industry. However, most leaders of the aircraft/missile industry realize that NASA's principal mission for some time to come is research and development. They are also aware that an R&D organization seldom, if ever, deals in large production contracts.

Civilian-oriented science programs do not require busy assembly lines producing quantities of rockets and space vehicle components. With the possible exception of some workhorse vehicles, such as the relatively inexpensive *Scout*, the new large rockets designed for civilian purposes will be produced in limited quantity.

Thus, NASA will not be stockpiling vehicles and parts as the military programs must. The situation differs only slightly in the case of scientific payloads. Even in a series of experimental projects, such as the *Pioneer* space probes, the payload packages vary with each shot, according to the data to be collected. One type of vehicle will be used to launch several types of payloads. Both rockets and payloads, however, call for a very high degree of reliable design and assembly.

We have determined, for example, that further reliance upon *Juno II's* and *Thor-Ables* is uneconomical for space science purposes because they have limited load-carrying capacities and lack versatility. Neither vehicle has upper-stage guidance, so the payload must be spin-stabilized, thus restricting both its mass distribution and gross weight. Hence NASA's Fiscal Year 1960 *Juno II* and *Thor-Able* launching schedules have been curtailed and more funds and effort are being devoted to development of *Thor-Deltas* (which have coasting guidance) and to the larger *Vegas* and *Centaurs*. Future NASA vehicles — *Thor-Deltas*, *Vegas*, and *Centaurs*—can lift heavier payloads far more cheaply and efficiently than the *Juno II's* and *Thor-Ables*.

What, then, is the incentive for a company to develop a rocket or a scientific payload for NASA, only to have it become obsolete very quickly, with no production contracts to look forward to?

The answer lies in what rocket-industry leaders themselves have said repeatedly. They consider their work for NASA vital to the future of their companies because this agency is in the forefront of space research. These industry officials know that the positions and continued growth of their companies depend on the vigor of their research divisions. They also point out that despite the relatively small size of the NASA budget request for Fiscal Year 1960 ($485,300,000), NASA's priority is second only to that of national defense. Moreover, as NASA develops, its budget, too, will inevitably grow in the years ahead.

In final analysis, however, the greatest stimulus of all is the challenge to industry's technological capabilities.

Alex V. Topchiyev, a prominent member of the Soviet Academy of Sciences, once told a news conference that *Lunik* was ". . . a natural result of the free development of science and technology under socialism where boundless scope is given to human talent and genius."

If this situation can prevail in the USSR, then imagine what can be accomplished in a free society.

NASA is confident that our industry-government team will prove to the world's uncommitted peoples what we have always known; namely, that in the space realm, as in other fields of endeavor, democracy provides far and away the best climate for talent and genius.

DR. T. KEITH GLENNAN
Administrator, NASA



T. (for Thomas) Keith Glennan has been Administrator of NASA since it was created in 1958. An electrical engineering graduate of Yale, he served through World War II as director of the Navy's Underwater Sound Lab at New London. He then was associated with Ansco until becoming president of Case Institute in 1947. During 1950-52, Glennan served as a member of the AEC. He holds several honorary Doctor's degrees and is a Fellow of the American Academy of Arts and Sciences.

SUBSCRIBER SERVICE
missiles and rockets

For additional information about any product or service advertised mentioned in the editorial pages of this issue of Missiles and ockets:

Use the attached prepaid reply cards. Circle numbers shown on e reply card that correspond with numbers appearing beneath items scribed. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at ttom of the card.

Your requests for information will be forwarded promptly to the mpanies concerned.

NEW PRODUCT BRIEFS

E EQUIPMENT. It may soon be possible to locate and permanently record roduction speeds lack of bond in ad honey-comb sandwich—both flat c curved shapes. The new Thermoaic method is now receiving final aation in the engineering-research cies of Magnaflux Corporation, higo, where several aircraft plants co-operating in tests. The method oices an exact pattern of every point od bond between the core material cskin, and of over-heavy braze as el The dark brown pattern remains anent, fixed on the skin's surface t removed by a solvent, thus perig photography for records, and ital examination of the section or n both vendor and customer plants sired. Installations will include full atic control, conveyorized spray es and controlled heat application.

No. 229 on Subscriber Service Card.

ES SHELLS. Thor Ceramics, Inc. anes a new range of epoxide resin el for encapsulating all types of comnts. Available holes and leads facilitassembling operations on winding rn The low water absorption characrics of thermosetting epoxide resin ot t the enclosed components from at and atmosphere. Sealing is acmished with liquid epoxy resin at ing the material of shell. The shells avi high tensile strength and operate a maximum temperature of 150°. eir excellent electrical qualities ova dielectric constant of 3.70 at 60 rcl with a low loss factor of 0.009. ari ions in shapes from tubular to ct gular may be ordered. Diameters ng from 1/8" to one inch and heights on 1/4" up. Identifying colors may also dered.

No. 230 on Subscriber Service Card.

EF ELING VALVE. A refueling valve #4-1755-000) is now available from ere Supply Mfg. Co. which is readily ada ble to unusual flow rates and to inc exotic and high energy fuels and he fluids. Normally the valve is built h dle a flow rate of 200 g.p.m. with erating pressure of 50 psi. Operin temperatures range from —65° – 60°F., fuel and ambiet.

No. 231 on Subscriber Service Card.

FUNCTIONAL MICROSOURCE. SIE (Southwestern Industrial Electronics Co.), a division of Dresser Industries, Inc., announces the introduction of its latest series of K-1 Microsource. The new K-1 Microsource is designed for use with any standard oscillator within its frequency range to produce small, known, controlled test signals. In addition, an internal battery and associated polarity-reversing switch are now incorporated to allow testing high-gain dc amplifiers. An added feature is the spring-loaded, momentary-on position in the dc "on-off" switch to allow generation of positive or negative test pulses. The new K-1 consists basically of a potentiometer, a rectifier type voltmeter and a shielded step attenuator. Voltages are set on the meter by the potentiometer, and multiples of the voltage selected by the step attenuator. Output is read directly on the front panel meter, and is continuously variable from zero to 10 volts, with a db scale also provided. The K-1 continues to feature the human-engineered appearance and functional ease of use pioneered by SIE in its Advanced Design Instrument line.

Circle No. 232 on Subscriber Service Cord.

CONTACTOR. A new secondary contactor which can be used with any dc welding power source to interrupt high amperage welding current has been announced by Air Reduction Sales Company. The unit is specifically designed as auxiliary equipment for Aircomatic (Airco's gas-shielded metal-arc process) and Heliweld (Airco's tungsten-inert-gas process) applications where the power source employed does not have a primary contactor. Rated at 600 amperes, the unit operates on 115 volts, single phase, 50 or 60 cycle current, and will effectively interrupt welding currents up to capacity at 100% duty cycle.

Circle No. 233 on Subscriber Service Card.

PLIER. Mathias Klein & Sons, has introduced a new oblique cutting plier designed with high leverage to do many of the jobs too tough for a conventional oblique cutter to handle. "Handform" handles assure greater ease and comfort in cutting. Catalog No. 228-8. Length—8 inches.

Circle No. 234 on Subscriber Service Card.

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD
First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

POSTAGE WILL BE PAID BY ADDRESSEE

MISSILES and ROCKETS
17 EAST 48th STREET
NEW YORK 17, N.Y.

SUBSCRIBER SERVICE DEPT.

NAME.....
TITLE/POSITION.....
COMPANY.....
Product Mfg./Service Offered.....
ADDRESS.....
CITY.....ZONE.....STATE.....
Card cannot be processed unless all information is given. Please limit requests to ten items.

MISSILES AND ROCKETS
JULY 20, 1959
Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers: _____

MISSILE LITERATURE

CHECKOUT TECHNIQUES. Ling Aviation Inc. has published a booklet reviewing automatic systems checkout as related to techniques instaad of equipment to permit broadest coverage of approaches applicabla to design of automatic systems checkout equipment.
Circle No. 209 on Subscribor Service Cord.

SEMICONDUCTORS. Ohio Semiconductors, a new company producing compound semiconductor devices and materials, offers full descriptive literature on the MS-41 Magnetoresistor, HS-51 Halltron, Hr-31 Halltron, MC-1 Magnetic Circuit and TA-11 "Thermo-Cell" Thermoelectric Junction. Each piece gives basic specifications, examples of applications and charts showing performance characteristics.
Circle No. 210 on Subscribor Service Card.

CATALOG. Electronic Speciality Co. announces the publication of a new 40-page catalog, No. AV-100, describing the complete facilities and products of the Avionics Division of the Company. Products covered by this publication include static time dalays, standard time delays, missile fuzes and programmers, flashers, voltage and frequency sensors, meter relays, power supplies and inverters, automatic check-out equipment and specialty devices. Included also are descriptions of the application of these products in complete systems developed by the Electronic Specialty Co. Typical systems included are Miss-Distance Indicator, Terrain Clearance System, Zero Delay Radar Augmenter, Proximity Fuze, Command Guidance Receiver, Word Warning, Coded Flasher, Autopilot, Aircraft Electrical Supply Sensor and Controller, and Flight Control System analyzer.
Circle No. 211 on Subscribor Service Cord.

DIODE CATALOG. A four-page catalog on silicon glass diodes is now available from Silicon Transistor Corp., manufacturer of silicon diodes and power transistors. The two-color spec sheet lists some of tha firm's high reliability general purpose and fast switching diodes and includes curves, charts and other pertinent data.
Circle No. 212 on Subscriber Service Card.

BROCHURE. Capabilities for tha isolation and reproduction of a wide variety of environmental characteristics are described in a new brochure entitled Environmental Facilities, publishad by the Missile and Space Vehicle Department of the General Electric Company. Reproducible environments discussed in tha brochure include conditions of vibration, with varying temperatures and eltitudes; humidity; tension and compression; shock; acoustics; acceleration; and pressure. Also described are chambers designed to simulate natural conditions of rain, sunshine, sand, salt spray, and fungus culture.
Circle No. 213 on Subscribor Service Cord.

GYROS. The new four-page, two-c brochures—one on floatad frae g and one on rate gyros—ara now a abla from Daystrom Pacific. Explod view, airbrush drawings show typ gyro designs. Major dasign features application advantages are pointad Complete specifications are providad two series of free gyros, FC35, FC45, and for ona series of rate g R-51.
Circle No. 214 on Subscribor Service

FASTENERS. A technical file folde cluding a new MS conversion table fasteners has just been released by Century Fastener Corporation. folder attempts to answer all quest pertaining to pracision, accuracy dependabla service for screws, b stop-nuts and special screw req ments.
Circle No. 215 on Subscribor Service

POWER SUPPLIES. The Electronic search Associates, Inc., announces availability of a four-page catalog w describes their Magitran line of state regulated power supplies. T supplies combine the features of r netic and transistor regulators, and many novel features not presently a able in conventional designs. The log sheet provides information several new intermediate current u as well as new specification data high current models. The catalog s provides full descriptive mat graphs, specifications, physical data related information.
Circle No. 216 on Subscribor Service

COMPUTERS. A 6-page illustr bulletin describing the new G-15 di computer with particular emphasis the magazine-loaded photo tape ra is offered by the Bendix Computer Also included are descriptions of PC and INTERCOM 1000 programming tems; accessory punched card, magr tape and paper tape equipment; eral special purpose devices and specifications. Copies will be mailed request.
Circle No. 217 on Subscribor Service

MAGNESIUM HYDRIDE. Immed availability of a new technical bul on magnesium hydride is announced The Dow Chemical Company. The page manual includes a general cussion of the metal hydrides with tions covering properties, reactions, and handling precautions for ma sium hydride. The unusual combina of properties in magnesium hyd suggests a wide range of uses such Captive hydrogen for foaming; a hydrogen for drying operations source of highly reactive magnesiu source of readily released hydroge reducing agent; energy for propel or explosives; a polymerization cat
Circle No. 218 on Subscribor Service

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD
First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

MISSILES and ROCKETS
17 EAST 48th STREET
NEW YORK 17, N.Y.

SUBSCRIBER SERVICE DEPT.

POSTAGE WILL BE PAID BY ADDRESSEE

NAME
TITLE/POSITION
COMPANY
Product Mfg./Service Offered
ADDRESS
CITY ZONE STATE

Card cannot be processed unless all information is given. Please limit requests to ten items.

MISSILES AND ROCKETS
JULY 20, 1959
Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

● ● Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

● Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

● ● New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers: _____



"The next voice you hear..."

Tomorrow—or the day after tomorrow—we'll hear ›ices from the remote reaches of space. They will travel ver electronic highways that span interplanetary dis-nces in a matter of seconds.

Hoffman has been a leader in modern communica-›ns since electronics moved from the primitive stage simple entertainment radio to become a major tool science, industry, and defense. And probing into the ecrets of space affords the scientists and engineers at offman exciting new areas for exploration.

To meet these challenges, Hoffman is broadening its capabilities to develop new techniques in space communications, such as:

METEOR BURST COMMUNICATIONS • FORWARD SCATTER TRANSMISSION • FREQUENCY SYNTHESIZERS • SELVOX • VLF COMMUNICATIONS SYSTEMS • SPECIAL PURPOSE TRANSMITTERS AND RECEIVERS • DATA LINK SYSTEMS

Communications problems in the conquest of space are being met *now* at Hoffman, where creative minds are helping to build the electronic future of America.

Hoffman Electronics CORPORATION ®

HOFFMAN LABORATORIES DIVISION / 3740 South Grand Avenue, Los Angeles 7, California

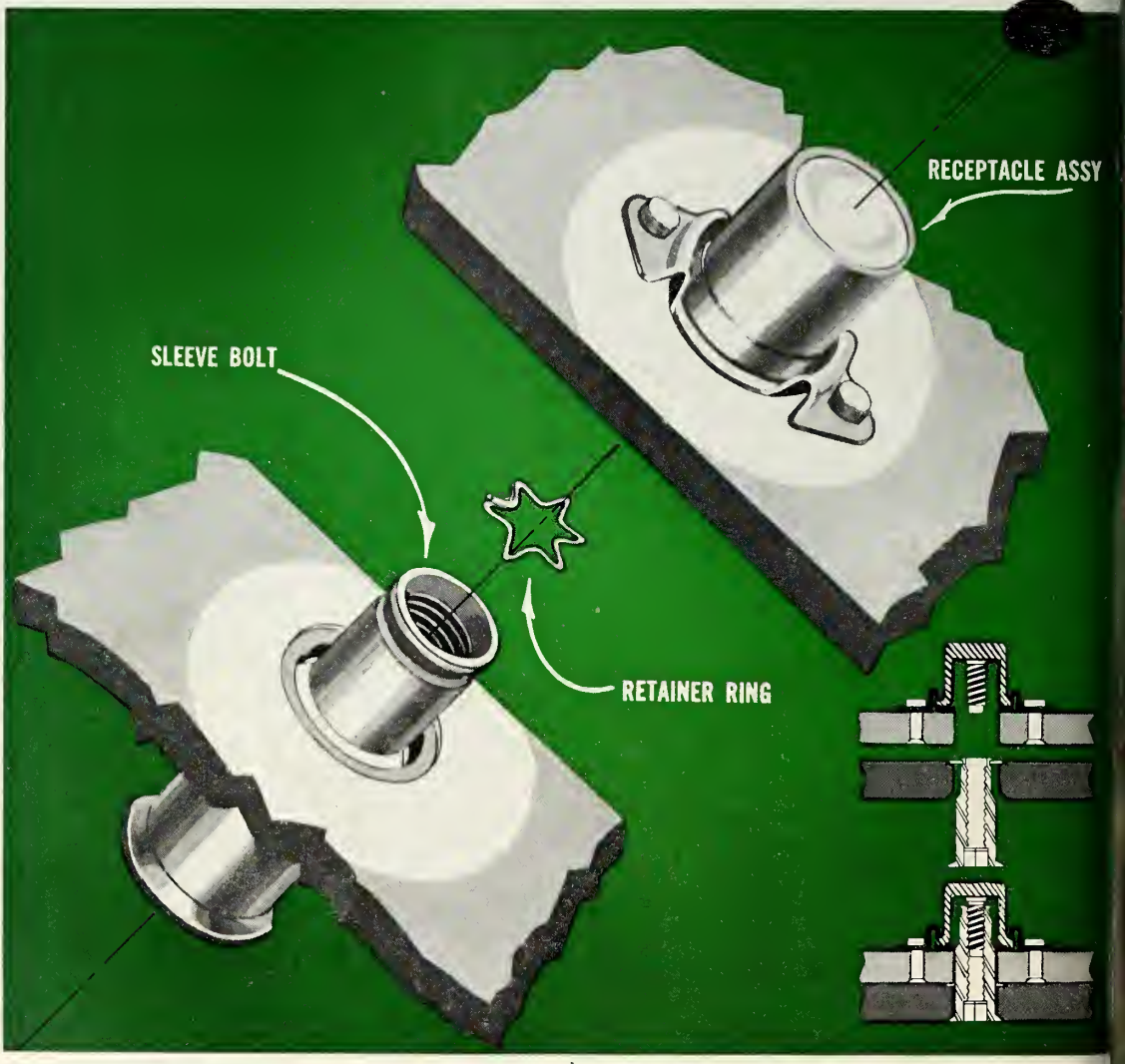
Missile Support Equipment • Radar • Communications • Electronic Countermeasures • Navigation
Solar Power Supplies • Electro-Mechanical Equipment • Weapons Systems • Field Services

Significant developments at Hoffman have created positions for scientists and engineers of high calibre. Please address inquiries to Vice President, Engineering.

Circle No. 38 on Subscriber Service Card.

EVER INSTALL AN ACCESS PANEL WITH HOLES MISALIGNED as much as .040 in.?

Nutt-Shel's structural panel fastener closes gaps between panel and structure up to .125 in. *even when holes are misaligned as much as .040 in.*



In just a few turns the self locking, self jacking sleeve bolt is installed or removed. No special tools or instructions required. Construction is foolproof. Only four parts; nothing to adjust.

This high strength fastener, 4500 lbs. tensile and 13,000 lbs. double shear, has a deep hex recess for faster power driving and high preload. The fail-safe shear groove in sleeve bolt prevents over torquing.

Only one common hole size for panel and substructure Sleeve bolt is retained near flush, for easy removal of highly curved panels. Receptacle and sleeve bolt are readily replaceable. Self draining receptacle prevents moisture accumulation.

STYLES

Standard and self sealing types. Two-lug and corner-floating receptacle styles. Made in alloy steel for temperatures to 550° F. and in corrosion resistant steel for 700° F. service.

Nutt-Shel
An SPS Company

2701 SO. HARBOR BOULEVARD
SANTA ANA, CALIFORNIA

Circle No. 39 on Subscriber Service Card.

JULY 27, 1959

JUL 1959
HOUSTON PUBLIC
LIBRARY
Houston, Texas



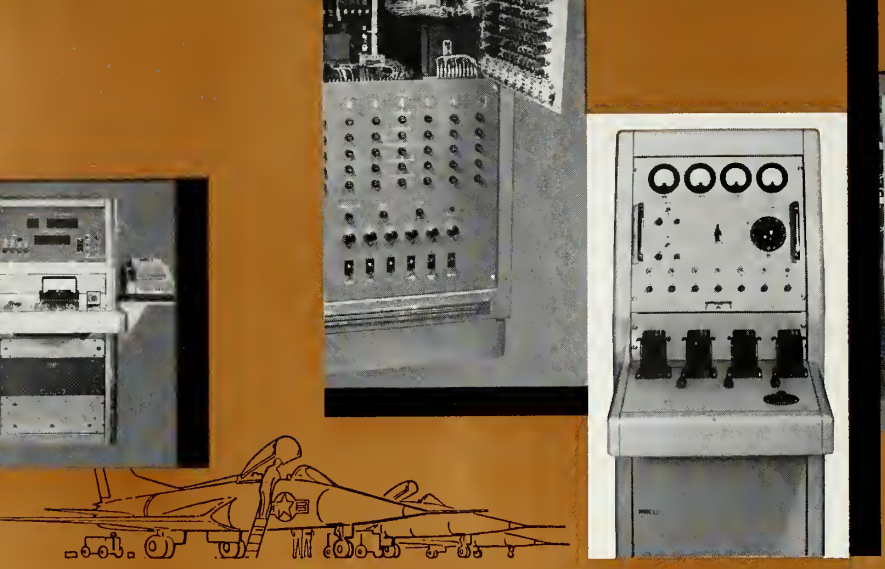
ATLAS BALCONY SCENE

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

AF *Thor* Base on 15-min. Alert . . 11
upport Vehicle Requirements . . 17
he Outlook for Solids 31

AN AMERICAN AVIATION PUBLICATION



TEST EQUIPMENT CAPABILITY...from SMI

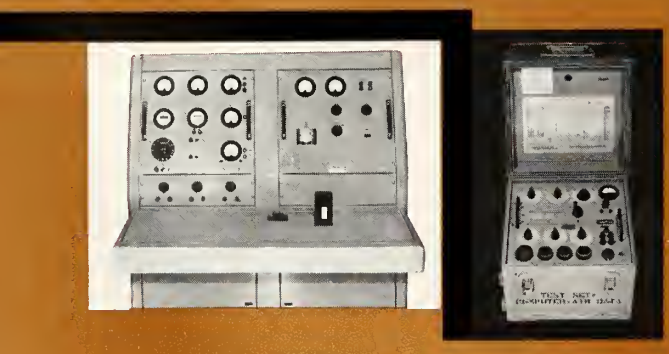
On flight lines and at missile launching sites...in production plants and depot maintenance centers...wherever speed and precision are vital, SMI test equipment capability meets the need with new levels of utility, repeatability...resolution...accuracy.

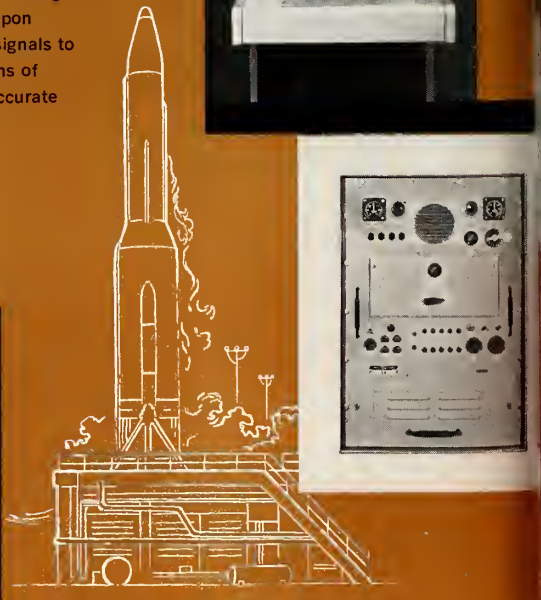
The SMI line of test equipment ranges from small, portable units that test single functions to console models that test complex airborne and missile electro-mechanical and electronic systems. Included in the line are pressure generation devices capable of generating static, differential and total pressures to simulate conditions from 1000 feet below sea level to 80,000 feet at speeds to Mach 5.

For example, SMI's TS 539 Air Data Computer Test Set is used for checking out elements of the Hughes Aircraft Company MA-1 aircraft and weapon control system. The TS 539 provides both electrical and pneumatic signals to the computer under test, achieving extremely high accuracy by means of electronically controlled force balance sensors. Mach readings are accurate to .7 millimachs and altitude readings within 15 feet at a speed of 1.4 Mach and an altitude of 30,000 feet.

Write today for further information on the TS 539 Air Data Computer Test Set and for details on SMI capability in test equipment.

Engineers: Investigate the opportunities available now at SMI in the fields of aircraft and missile instrument-control systems development.





SERVOMECHANISMS SMI INC.

LOS ANGELES OPERATIONS: *12500 Aviation Boulevard, Hawthorne, Calif*

MECHATROL DIVISION: *Westbury, L.I., New York*

RESEARCH AND DEVELOPMENT CENTER: *Goleta, California*

The products of SMI *are available in Canada and throughout the world through Servomechanisms (Canada) Limited, Toronto 15, On*



WESTERN GEAR CAN SUPPLY THE SOLUTIONS

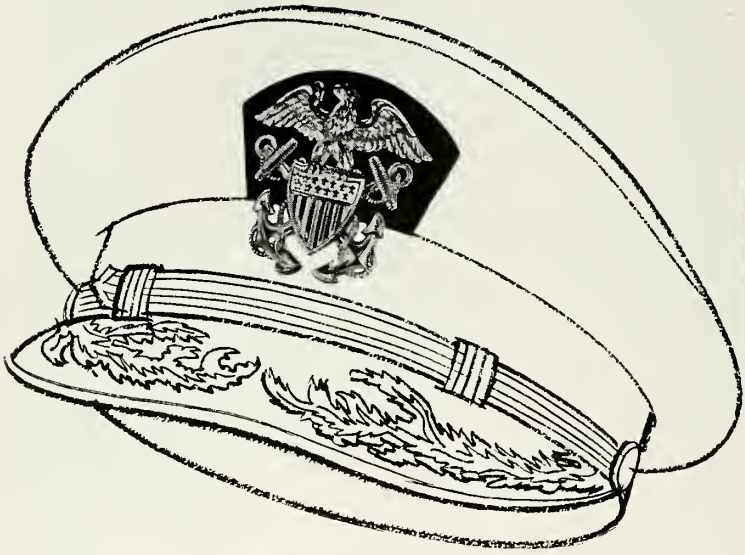
PRECISION PRODUCTS DIVISION

To insure the reliability of the missile, its positioning must be accurately and cautiously handled. No matter what mode of transportation, truck, rail, air or water, there are Western Gear precision drives and related equipment engaged in the touchy and delicate task of handling the mighty "birds." Moreover, Western Gear's extensive experience and facilities enable the company to effectively handle your system requirements.

For complete information on our capabilities and facilities, write on your letterhead for Bulletin 5900.

WESTERN GEAR CORPORATION
Precision Products Division, P.O. Box 192, Lynwood, California

5921



EAGLE

...an advanced system program for better professional personnel

As the symbol of our Navy's air-to-air advanced weapon system concept, the Eagle presents a new challenge to senior professional personnel in technical and management fields.

Bendix Aviation Corporation will develop the Eagle long-range missile system. The Bendix Systems Division of Ann Arbor, Michigan with laboratories also in Van Nuys, California holds the prime system management and engineering responsibility.

Specifically, Bendix Systems Division has opportunities for the following personnel in Michigan and California—project supervisors and engineers in:

- **missile guidance and control**
- **weights and aerodynamics**
- **airborne radar and computers**
- **countermeasures**
- **displays and human factors**
- **systems analysis**

Working with top men in these fields at Bendix Systems Division, you will find conditions ideal for personal achievement and pleasant living. If you are interested and qualified, please write Bendix Systems Division, Department K7-27, Ann Arbor, Michigan, or Van Nuys, California.

Bendix Systems Division
ANN ARBOR, MICHIGAN
VAN NUYS, CALIFORNIA

Bendix
AVIATION CORPORATION

Executive Editor .....CLARKE NEWL
Managing Editor ....DONALD E. PE

NEWS STAFF
News Editor .....REED BU
Defense and Legislative .....BETTY OSW
JAMES E
West Coast .....RICHARD VAN OS
Copy Editor .....ERICA K
Editorial Assistant .....DAVID NEWM

ASTRIONICS
Guidance and Control ....CHARLES D. LAF
Support Equipment .....HAL GETTI

ASTRONAUTICS ENGINEERING
Chemistry & Propulsion .....JAY HOL
Astrodynamics .....PAUL ME

MISSILE SUPPORT
Installations and Equipment
East Coast .....WILLIAM E. HOW
West Coast .....FRANK McGU

BUREAUS
Los Angeles .....FRED HUN
Paris .....JEAN-MARIE RIC
Geneva .....ANTHONY VANDY

CONTRIBUTORS
British Astronautics .....G. V. E. THOMPS
Propulsion .....MICHAEL LOREN
Industry .....JAMES J. HAGGERTY,
Soviet Affairs .....DR. ALBERT PA
Space Medicine .....DR. HUBERTUS STRUGH
Astrophysics .....DR. I. M. LEV
Research .....HEYWARD CANNEY,

ADVISORY BOARD
DR. WERNHER VON BRAUN . ROBERT P. HAVILA
DR. PETER CASTRUCCIO DR. ARTHUR KANTROWI
KRAFFT EHRICKE DR. EUGEN SAENG
R. F. GOMPERTZ ALEXANDER SA

PRODUCTION AND ART
Art Director .....WILLIAM MART
Assistant Art Director .....BACIL GUIL
Production Manager .....J. F. WAL
Ass't Production Manager .....ELSIE GR

BUSINESS STAFF
Publisher ..... E. D. MUHLFE
Advertising Sales Manager .....W. E. BROW
Eastern Advtg. Manager ..... P. B. KINN
Circulation Director .....L. L. BRETTN
Promotion Manager .....J. E. MULR
Advtg. Service Manager ..MRS. GLADYS BUSSE

ADVERTISING OFFICES
New York ..(17 East 48th St.) P. N. ANDERSC
A. B. SCHEFFL
Detroit ...(201 Stephenson Bldg.) K. J. WEL
Chicago .....(139 N. Clark St.) G. E. YONA
Los Angeles .(8929 Wilshire Blvd.) J. W. CLA
C. R. MARTZ, J
Miami .....(208 Almeria Avenue) R. D. HAG
Toronto (12 Richmond St. E.) ALLIN ASSOCIATI
London .....(28 Bruton St.) NORALL & HA
Paris .....11 Rue Condorc
Geneva .....10 Rue Grent

Missiles and Rockets Volume 5 Number 31

Published each Monday by American Aviatio Publications, Inc., 1001 Vermont Ave., N.W Washington 5, D.C. Wayne W. Parrish, *Pres dent;* Leonard A. Eiserer, *Executive Vice Pres dent & General Manager;* A. H. Stackpole, Fre S. Hunter, Eric Bramley, Robert R. Parris *Vice Presidents.*

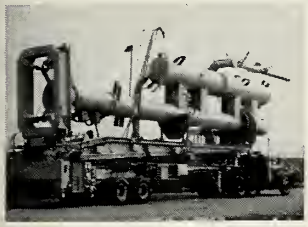
Printed at the Telegraph Press, Harrisburg, P Second class postage paid at Washington, D.C and at additional mailing offices. Copyrigh 1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, $8.00; 2 years, $12.00; 3 years, $14.00. Foreign—1 year, $10.00; 2 years, $18.00; 3 years, $26.00. Single copy rate—$.75. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr., M/R, 1001 Vermont Ave., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.

ABC NBP READERSHIP Features RESEARCH ABC



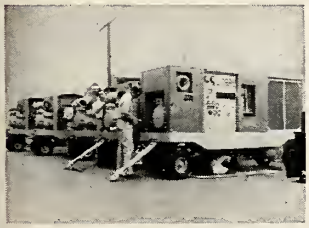
COVER: Multistoried gantry at Cape Canaveral surrounds huge Convair *Atlas* before blast-off. Technicians and engineers are shown pausing in their preparations and inspections.



VEHICLES used by Food Machinery and Chemical Corp. during *Navaho* program were instrumented for shock testing at varying speeds. See story on vehicle requirements, p. 17.



WORLD'S largest solid propellant mixer at Grand Central Rocket Co., Redlands, Calif., has batch capacity of 350 gallons. See survey of outlook for solids, p. 31.



AIR conditioners for Northrop *Snark* missiles are made by Hokanson Co. These are electrically driven, supplying 85 lbs./min., 45°F air. See report on cooling, p. 34.

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

JULY 27 HEADLINES

RAF *Thor* Base on 15-minute Alert
The Western World's first ballistic missile site has had 400 simulated countdowns; three more bases will be operational by next summer 11

SAC's 'Trigger' Network Is Being Doubled
The Air Force is adding greatly to its communications system surrounding Eurasia and plans eventually to use satellites 12

Missiles Fill A Gap in Connecticut
Inter-company cooperation highlights a still-growing activity that brings the Nutmeg State more than $500 million a year. Third in a series of regional surveys 14

Navy's Corvus Has First Successful Flight 43

GE's 'Tunnel Diode' May Outstrip Transistors 44

MISSILE SUPPORT

Support Vehicle Requirements Are Tricky
Experts stress early design to meet complicated needs; a wide variety of vehicle combinations are available 17

ASTRODYNAMICS

Pushing the Search for Space Vehicle Power
Government and industry strive to find sources of electrical power that will permit prolonged space missions 22

ASTRONAUTICS ENGINEERING

Hope Sustains Research into Monopropellants
Interest continues despite the strange fuels' many disadvantages; "near-miracle" is hoped for 28

Solids Manufacturers Look to Future With Confidence
With problems being overcome, the role of solid fuels—already important in military applications—is expected to grow greatly .. 31

ASTRIONICS

Electronics Cooling—Multimillion-dollar Stepchild
The demand for cooling units is growing. An M/R staff survey shows how the challenge is being met. First of two stories 34

Eyelets vs. Plated-thru Holes in Printed Circuitry
A report on a comprehensive test in which all located failures were in eyeletted phenolic boards 37

THE MISSILE WEEK

Washington Countdown 7
Industry Countdown 9
More About the Missile Week 43

DEPARTMENTS

Reviews 41
Soviet Affairs 41
Moscow Briefs 42
Propulsion Engineering ... 45
West Coast Industry 47
Contract Awards 48
When and Where 48
Editorial 50

USE LOTS OF TAPE?

"SCOTCH" BRAND Instrumentation Tapes cut operating costs

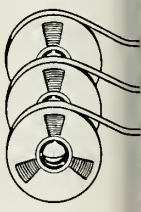


Let's develop our own small theory of relativit
For everything's relative, after all—even econom
Clearly, an economy effected now and *correcte*
later is no economy at all. In instrumentation tap
there's only one genuine economy—reliable pe
formance. And in performance, the last two wor
for any acute tape-user are "SCOTCH" BRAND.

First to last, "SCOTCH" BRAND Magnetic Tap
offer uniformity and reliability—born of the e
perienced 3M technology that created the first pra
tical magnetic tape and continues to advance tl
art of tape-making day by day.

But let's look at economy from another viewpoi
—in terms of some things around the periphery th
might not come so readily to mind—storage, us
waste, and time saved.

What other kind of record is so permanent it ma
last a lifetime, yet requires so little space for sto
age? Three reels of "SCOTCH" BRAND like those at the right "contain" 30 million characters. What other medium serves input, output and memory functions at such high speeds? Accepts both digital and analogue data?



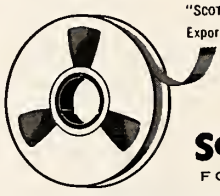
What other kind of record is not *consumed,* even when it is used? "SCOTCH" BRAND Magnetic Tape is run and rerun for analysis, eras
and used again, permits retaping with correction
editing and new data.

Last, but far from least—in these days when tim
is money, what other medium speeds up data acqu
sition, reduction and control programming in
way that keeps critical projects rushing forward
full tilt? Or cuts production lead time and huma
error to a point where a 1000% saving may b
realized?

At any cost, "SCOTCH" BRAND Magnetic Tap
would be a good buy. And in every applicatio
"SCOTCH" BRAND Tapes offer that greater econom
—reliability. "SCOTCH" BRAND High Resolutio
Tapes 158 and 159 let you pack more bits per incl
offer extra play reels. "SCOTCH" BRAND Sandwic
Tapes 188 and 189 end rub-off, build-up, cut hea
wear to an absolute minimum, show little wear i
50,000 computer passes. "SCOTCH" BRAND Hig
Output Tape 128 offers top output at low frequer
cies, even under ambient temperature extreme
"SCOTCH" BRAND Instrumentation Tapes 108 an
109 offer top performance at lowest cost.

Where there's no margin for error, there's n
tape like "SCOTCH" BRAND Magnetic Instrumenta
tion Tape. For details, write Magnetic Product
Div., 3M Company, Dept. MBW-79, St. Paul 6
Minn., or mail the reader inquiry card. © 1959 3M C

"SCOTCH" is a registered trademark of 3M Company, St. Paul 6, Minnesot
Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontari



REG. U.S. PAT. OFF.
SCOTCH BRAND MAGNETIC TAPI
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

Washington Countdown

IN THE PENTAGON

The budget squeeze for FY 1961 . . .
is already on for military and space planners. The Administration has passed the word that budgets are tentatively to be cut 10%. This would mean an across-the-board slash of more than $4 billion in the face of rising costs.

• • •

Problems with Convair's *Atlas* . . .
are believed to have been licked with the successful firing of a production model from Cape Canaveral July 21 and recovery for the first time of an *Atlas* nose-cone. But the first operational firing from Vandenberg AFB is still not expected before September. The Air Force wants to fire a few more of the big birds from Canaveral to make sure the cause of recent failures has been licked for good.

• • •

No new development . . .
resulting from production is believed to have caused the series of *Atlas* failures. Officials believe the cause was built into earlier models but failed to show up until recently.

• • •

A new hand is at the controls . . .
of the Pentagon's influentially-placed Ballistic Missile Committee. Deputy Defense Director Thomas Gates has taken over the committee's chairmanship. Ex-Missile Czar William Holaday formerly held the post.

• • •

Some code names . . .
for current ARPA projects to keep in mind:

. . . *Suzano*—A study program for a space platform to provide an advance base for space missions.

. . . *Principia*—An R&D program aimed at obtaining a solid propellant with a 10 to 20% greater specific impulse than any now known.

. . . *Pontus*—An R&D program aimed at obtaining a major improvement in structural and power conversion materials.

. . . *Tribe*—An R&D program aimed at obtaining a family of advanced military space vehicles.

. . . *Longsight*—Continuing studies of possible advanced projects including "unorthodox and creative" proposals.

ON CAPITOL HILL

The Hébert Subcommittee staff . . .
is still digging through a mountain of questionnaires from ex-military officers employed by defense contractors. Meantime, the subcommittee is expected to turn during the week of July 27 to looking into defense contractor associations.

• • •

First Air Force, then Navy . . .
is the order in which top military missile men are expected to testify at the House Space Committee inquiry into recent **Convair** *Atlas* and **Lockheed** *Polaris* failures. The hearings were called to find out whether the U.S. missile program is slipping.

AT NASA

Recent launching failures . . .
have hurt NASA's space research program. NASA did not plan for so many failures in its budget estimates. Now there is a lack of vehicles for some back-up shots.

• • •

NASA plans to bombard . . .
space with five satellites between now and the end of August. The space agency's accelerated launch schedule includes the last *Vanguard*, an *Explorer* balloon experiment, *Thor Ables III* & *IV*, and *Atlas Able IV*.

AROUND TOWN

Some of the reports . . .
that are being passed as the "latest" in the nation's capital:

. . . **Martin** *Matadors*—nuclear warhead-packing airbreathers—are being installed on Okinawa.

. . . It's possible that Russia may have a missile-launching nuclear submarine about the same time or not much later than the *Polaris* submarine will be operational.

. . . Russia has a good chance to have more than a dozen operational ICBM's in the hands of troops before *Atlas* is operational.

EXPANDING THE FRONTIERS

OF SPACE TECHNOLOGY...IN

QUALITY ASSURANCE

Quality assurance at Lockheed parallels in importance and augments the research and development, projects and manufacturing organizations. Quality assurance engineers establish audit points, determine functional test gear, write procedures and perform related tests.

These activities, supported by laboratories, data analysis, establishment of standards, and issuance of reports, all insure that Lockheed products meet or surpass contractural requirements. Economy and quality are maintained at every stage to produce the best products at the least cost. As systems manager for such major projects as the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; and Air Force Q-5 and X-7, quality assurance at Lockheed Missiles and Space Division has an important place in the nation's defense.

Engineers and Scientists—If you are experienced in quality assurance, reliability, or related work, you are invited to share in the future of a company that has an outstanding record of achievement and make an important individual contribution to your nation's progress in the race for space. Write: Research and Development Staff, Dept. G-4-29, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for Navy POLARIS FBM, DISCOVERER SATELLITE
Army KINGFISHER, Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLA. • ALAMOGORDO, N. M. • HAWAII

Industry Countdown

STRUCTURES

Major review of Air Force . . .

weapon system management is under way. Big question before Air Staff is whether AF has delegated too much authority to prime weapons system contractors. Officials are looking into criticism leveled at the failure to develop in advance major components and subsystems which delay delivery of weapon.

• • •

Stronger bid for missile . . .

business can be expected from **Ryan Aeronautical** with forthcoming corporate shift. Key change: Edward G. Uhl, who has resigned as vice president of **The Martin Co.,** probably will be joining Ryan shortly as senior vice president. His resignation has been kept quiet up until now. Uhl has been succeeded as Martin-Orlando general manager by G. T. Willey.

• • •

Unless major engineering . . .

problem is licked, hardened ICBM bases will be much more costly than anticipated. Each missile launching pad will require a horizontal underground tunnel 100 feet in length to furnish orientation line for inertial guidance checkout. Elevator systems alone as yet cannot provide the critical tolerances required for positioning the bird in exactly the same space position when lowered and raised. Base line is needed for perfect guidance checkout before firing.

• • •

More construction . . .

problems are posed in ICBM installations by requirement of each missile unit for fixed reference target to align the bird. Material must have equal coefficient of expansion. Reference target cannot settle, must be perfectly rigid and still withstand climatic changes.

• • •

Even wood is finding missile . . .

applications. Some dummy mockups of **Lockheed** *Polaris* are of redwood and are being used to check handling and launching "pop up" gear. One advantage—the dummies float.

• • •

Look for Navy to . . .

start stressing new tactical requirements for *Bullpup.* Missile will be operational with Atlantic fleet this month. Already operational with Pacific fleet squadrons, the air-to-surface weapon is being designed for a 5-year service life.

• • •

'Cold and slow' missile . . .

proposal of **Radiation Inc.** is attracting interest for its biological warfare possibilities. In sharp contrast to the fast and hot missiles being stressed today, this 10-foot "Sprayer" missile would use a slow-burning propellant—probably black powder—to travel at the speed of an old-time Piper Cub. From a low altitude it would spray wide areas of dense undergrowth inaccessible to aircraft and where helicopter operation would be too costly. Fuselage probably would be of cheap material like hard cardboard. Government medical services are looking into this one . . . Radiation also has proposal for moon base environmental simulator that would sustain crew of three for about a month.

PROPULSION

Hydrogen-oxygen rocket . . .

test stand at **Pratt & Whitney's** Florida facility is getting a good workout with full-scale 15,000 pound-thrust *Centaur* engine. Engine is being tested in horizontal facility before being moved to vertical site. Company reports good results—which might mean engine will be available before the vehicle which is expected in 1961.

• • •

One to watch . . .

U.S. Rubber Co. is now actively researching synthetic rubber and plastic-based solid fuels at a new laboratory in Naugatuck, Conn. The work is company-funded . . . Missile activity is picking up in Connecticut (see p. 14).

• • •

Gabriel Co. is building . . .

$1 million propellant plant at Mesa, Ariz., to load thrustors and other devices for its subsidiary, **Talco Engineering,** maker of ejection seats and cable cutters. New Rocket Power Division will be headed by Charles E. Bartley, founder of **Grand Central Rocket Co.**

ELECTRONICS

Courier delayed-relay . . .

communications satellite work is moving ahead. ARPA has let contracts totalling almost $9 million to **Philco** (communications package); **ITT** (ground-based communications) and **Radiation Inc.** (ground-based antennas).

• • •

Gyroless gyro development . . .

of **Martin-Orlando** should stand industry on its ears when it is announced. Most of the system is proprietary, but this much is revealed: Martin has fired a small tactical missile twice successfully—without gyroscopes. System is good for short distances. Works on principle of mass suspension with the missile itself providing necessary rotation.

NAVIGATION AND GUIDANCE FOR MISSILES ▶

The management team of Nortronics Division of Northrop Corporation has more specific astro-inertial guidance experience than any other company in the free world. Here in one tightly knit organization are the men who created the state-of-the-art for airborne inertial guidance. The key management-scientist-engineer team who pioneered the Snark inertial navigation system in 1947 is still actively advancing the frontiers of this art. The most recent example of this is a breakthrough in 24-hour celestial tracking systems.

The list of accomplishments achieved over the past 13 years, if listed here, would more than fill this page. None of these achievements would have been possible without a dynamic, aggressive management group dedicated to producing the best product for the lowest cost – on schedule.

Missile scientists and engineers recognize Nortronics as a leader in the field of navigation and guidance. Nortronics' leadership has been accomplished by advanced research and development programs and years of production experience. These programs have resulted in state-of-the-art advancements in navigation systems which were considered visionary a short time ago.

Nortronics has today the solutions to tomorrow's missile guidance problems, the management and facilities to produce the systems required. The company's complete understanding of the military and technical requirements of missile systems qualifies Nortronics as the leading producer of tomorrow's most challenging astronertial guidance systems.



NORTRONICS
A Division of **NORTHROP CORPORATION**

RAF *Thor* Base on 15-minute Alert

Western World's first ballistic missile site has had 400 simulated countdowns; double key arrangement gives Britain and U.S. joint nuclear control

by Clarke Newlon

FELTWELL BALLISTIC MISSILE BASE, ENGLAND—From a standing start, the Royal Air Force crews of this first operational ballistic missile base in the Free World today can fire its 15 nuclear-armed warheads at predetermined targets in just under 15 minutes.

More than 400 simulated countdowns of the **Douglas**-built *Thor* IRBM have brought the crews to this peak of efficiency, manned 24 hours a day, seven days a week as part of the deterrent force.

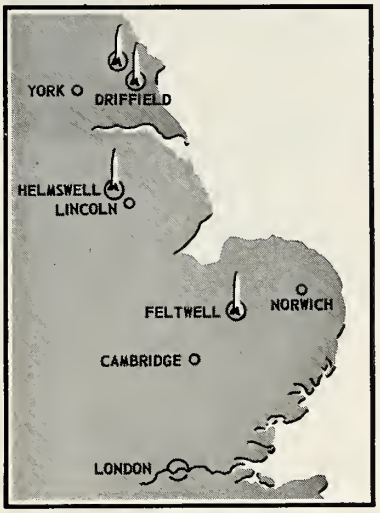
Feltwell became operational early in July. Farther to the north, along the east coast of Britain, Helmswell is expected to be operational in September, Driffield by December and a fourth unnamed base well before July, 1960, thus completing England's intermediate ballistic missile program.

Each base is of squadron strength—15 missiles. And each base consists of a main site and four satellite sites, each with three missiles. The maintenance and housekeeping facilities and personnel are at the main site. Feltwell has about 1000 RAF personnel who are responsible for command, operations, intelligence, communications, base support, safety and administration. Some 200 U.S. personnel, both military and civilian, have the responsibility for nuclear warhead storage, maintenance, technical supply and training. The main site and each satellite are separated by about 20 miles.

• **Vetoes and keys**—For the first time, officers of the RAF and USAF have a full explanation of both the "double veto" over the atomic bomb carried in aircraft from English bases and the similar "two key" arrangement for firing control of the *Thor*

The double veto as regards aircraft means that the British government must agree before nuclear bombs are actually carried in USAF aircraft from her bases; that also, Her Majesty's Government must concur before any nuclear bombs are dropped from planes which take off from her bases.

In the case of the double key for the *Thor* missiles, a comparable arrangement has been worked out. The commander at each site has one key. This must be turned to start the 15-minute countdown. The American officer at the site in charge of the atomic store has a second key. When the countdown has reached the point of minus three minutes, he must turn a second key before it can proceed further. And each U.S. site officer has a direct line to the Strategic Air Command Headquarters in Omaha which he can reach in 30 seconds.



BASE AT Feltwell is now operational. Three more will be added within a year.

Neither the double veto nor the double key precludes a delegation of authority by either side in a time of alert, when warnings were clear that an enemy was mobilizing for possible attack.

General Lauris Norstad, commander of SHAPE, incidentally, recently told newsmen that this double veto-double key arrangement which exists between Britain and France and which is being worked out with Italy, Turkey and Greece, is precisely the same agreement offered to France—and refused by Gen. De Gaulle.

• **The drill**—At Feltwell, the pilot *Thor* base, five crews of 16 men and two angry-looking guard dogs operate each site on an around-the-clock basis. The crews consist of one officer and six non-coms as launch crews; one U.S. officer with the second key, five police guards (and the two dogs); one fireman driver, one cook and one motor transport man.

Missiles for Feltwell are flown into nearby Lakenheath Airdrome, trucked over to the Receipt, Inspection and Maintenance (RIM) building at Feltwell where they are subjected to a complete checkout, and then sent to the sites. There the *Thors* are normally positioned horizontally under hangars on tracks. The three missiles are located 700 feet apart with the control van being roughly the fourth corner of the square. From this van, in a practice alert as they would in an actual firing, the countdown for all three missiles is controlled through five phases, as follows:

First: an automatic checkout of all equipment.

Second: retract cover hangar and raise missile.

Third: initial and slow propellant fueling.

Fourth: final and rapid fueling.

Fifth: missile disconnects from ground supply, own power takes over, engines ignite, missile fires.

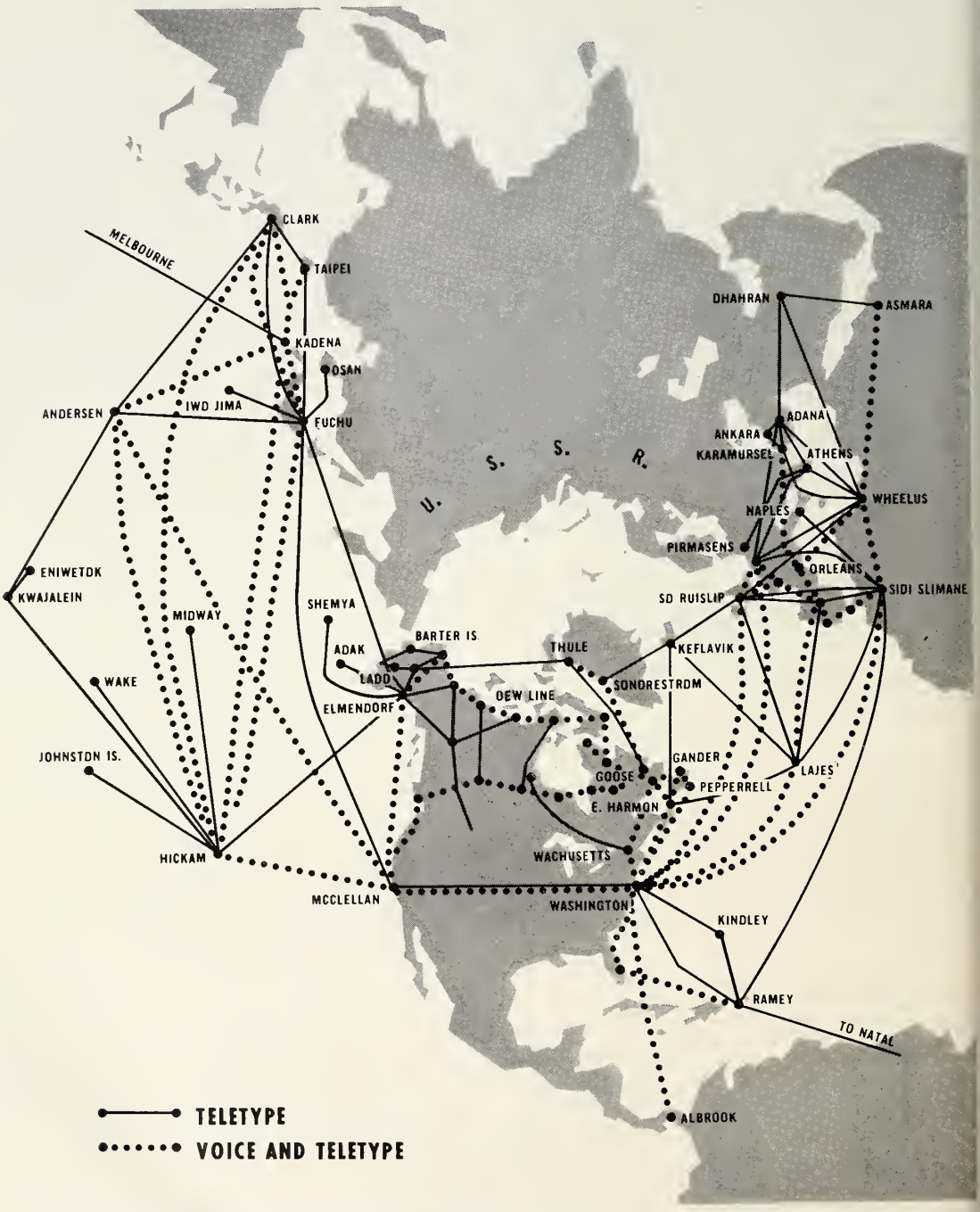
Throughout this operation there are points at which the countdown can be held for times ranging from minutes to several hours, thus cutting down the reaction time during an alert. Through tying in with the NATO warning system, the RAF feels it would have 40 minutes warning time for a bomber attack, probably about seven minutes for a missile attack. The *Thor* countdown can be stopped at firing time minus three minutes if required.

• **U.S. aid**—While the *Thor* bases are almost completely an RAF operation, the U.S. lends a big helping hand. In addition to the U.S. Air Force personnel aiding training and maintenance, Maj. Gen. William H. Blanchard, commander of SAC's Third Air Division in England, estimated that approximately 1000 installation and checkout technicians from **Douglas, A. C. Spark Plug, Rocketdyne, General Electric** and other American companies were working on or near the missile bases, most of them living in trailers.

Of the personnel trained and being trained for the four RAF missile squad-

(*continued on page* 39)

SAC's 'Trigger' Doubled f



MAP OF the Air Force's communications network graphically demonstrates how the system brackets the Soviet heartland.

missiles and rockets, July 27, 19

ssile Age

AF's vital communications network eventually will include satellites

by James Baar

WASHINGTON—A red phone sits in maha . . .

A baby-blue phone sits in Washgton . . .

The defense of the Free World ings on them. They are the key links the Air Force's 1.3-million mile mmunications network. Over these ould pass the word to unleash the ead power of SAC.

Today this means the U.S. bomber ets. Tomorrow the ICBM's.

The complications involved in buildg and maintaining such a communitions network are stupendous. And e complexity is growing greater as e ICBM enters the arsenals of the est and the East.

In order to meet the growing chalge, the Air Force is adding to its twork another 950,000 miles of comunication channels. Some of it will available in the very near future. l of it is scheduled to be operating thin two years.

Nor will this be the end.

The Air Force is looking for rapid velopment of communications satelles. These will help carry the increasig traffic load and insure still greater liability. They also will provide eans for reaching inaccessible areas such strategically vital zones as the ctic.

• **Heavy duties**—The Air Force mmunications system is designed to eet a number of specific difficult reirements. It must transmit such aphic information as maps and reconnaissance pictures. It must transmit pies of written material such as detled orders. It must transmit vast antities of data such as weather d flight information.

But most important of all to the curity of the Free World is that it nsmit verbal messages without fail the greatest possible speed. This is C's trigger.

To make this trigger work without l the Air Force communications net s been spread around the world from t United States like two great arms. e western terminus is Melbourne, stralia. The eastern, Dhahran, Saudi Arabia. Together they form a herculean "U" embracing the Soviet Eurasian heartland.

The entire multi-billion dollar system is designed to provide time. Time to get off the ground before you're hit. Time to determine that you're really under attack. Time to pull the trigger.

The missile is rapidly shrinking this time.

• **Command decision**—Today it would be a matter of hours. The DEW line across the top of North America would flash the warning of a bomber attack. NORAD and SAC would receive it simultaneously. An officer in the underground SAC command post at Omaha would raise the red phone. In less than a minute SAC planes around the earth would be ordered into the air.

As the SAC bombers moved toward their targets, the U.S. high command in Washington would have at least an hour and a half to decide whether World War III were on. But not much more. The bombers would be told to go in—or they would have to return.

Such a decision might well be made with only minutes to spare. Then the President, who alone has the authority to order the use of U.S. nuclear weapons, would give that order. An officer in the Pentagon command post would raise a baby-blue phone and speak the code word for "Go!"

Three years from now there will no longer be hours. There will be only minutes.

BMEWS, the **RCA** ballistic missile early warning system now under construction in Alaska and Greenland, would flash the warning to NORAD and SAC that hundreds of Soviet ICBM's had been launched.

There would then be 15 minutes before the ICBM's struck. All that formerly could be done in several hours would have to be done in this brief span. Plus a new task: Scores of U.S. ICBM crews along with the *Polaris* submarines then on station would be ordered to launch their missiles.

The Navy is developing an entirely new communications system designed to be capable for the first time of contacting submarines at great depth anywhere in the world's oceans. Huge towers are being built for the secret system at Cutler, Maine.

The exact method of tying the *Polaris* network into the rest of the nation's deterrent force is still to be determined at the highest military levels.

• **Meeting the challenge**—The unrelenting requirements for a communications net capable of triggering so vast a force in so short a time are staggering. There can be no delay. And its reliability must be nearly 100%. Ninety-nine percent is not good enough. Such a system would fail 14.4 minutes a day—virtually all the warning time BMEWS will be able to give.

The Air Force has been rapidly revamping its communications system because of this Missile Age challenge.

At present, 948,000 channel miles of the Air Force net are the old high frequency channels. These can be jammed and are highly sensitive to sun spots. And they have had to be duplicated many times in order to ensure the high reliability required.

However, the Air Force already has 325,000 channel miles of network based on the superior tropospheric scatter system. And the 950,000 more miles under construction are of the same type.

The troposcatter system is all but unjammable. It provides an extremely wide band of 132 channels. And it has 99.99% reliability.

The system operates by bouncing powerful signals off the troposphere from one relay station to another. The stations are up to 600 miles apart.

At the same time, many of the hundreds of thousands of channel miles of commercial lines and cables available to the Air Force on a full-time basis are being hardened and routed around target areas.

Finally, the Air Force has available in case of national emergency the use of Army and Navy facilities.

All of it is geared to one overriding goal: A guarantee that if some day someone has to reach for the red and the baby-blue phones the codeword for "Go!" will be heard around the earth.

Third of A Series

Missiles Fill Gap in Connecticut

Nutmeg State reaps better than $500 million a year from missile/space work employing about 100,000 and taking up slack caused by other defense cuts

by William E. Howard

HARTFORD—On July 2, 1957, three months before *Sputnik* galvanized the Free World, a team of eight Connecticut manufacturers approached the Springfield (Mass.) Ordnance District. Objective: a contract to develop and produce an entire missile system.

The mission failed. But the foresighted action nevertheless marked the beginning of a major new industry in the Nutmeg State—nearly every member of the team has since become heavily engaged in missile/space work.

Today, although the state still does not have a prime missile contractor, manufacture of highly specialized missile components and support equipment is a mushrooming business. Humming factories are turning out a big percentage of the bearings, springs, castings, gaskets and cams, as well as the more "exotic" items—like nose cones, mixing equipment for solid fuels and infrared guidance packages —that go into virtually every missile system in the nation's arsenal.

The total number of companies directly engaged in missile work was placed in 1958 by the Connecticut Development Commission at more than 220. These firms employ 83,000 on production lines and another 27,000 scientists and technicians. Some 358 research and development firms employ an additional 12,000—with much of their effort related to the new space technology.

Actually, the CDC figure may be considerably outdated. The Pratt & Whitney Division of United Aircraft, which is in the process of organizing to become a prime systems contractor, now has more than 1400 of its 6600 suppliers in the state. By year's end, P&W expects the Connecticut total to increase to 2000. Avco's Lycoming Division has more than 500 firms in the state which are suppliers or subcontractors. And the Electric Boat Division of General Dynamics, producer of *Polaris* fleet ballistic missile nuclear submarines, had another 123 at last count. Many of these suppliers sell to more than one of the bigger contractors—inside as well as outside the state.

Arriving at a dollar volume for the state's missile industry is virtually impossible, because of the multitude of small contracts and purchases conducted entirely within the industry. But basic contracts indicate that missile manufacturing is running at well over a $500 million annual rate.

• **Missile transition**—Industry experts note that Connecticut is in a period of transition brought on by the phase-in of missiles and a cutback in aircraft production and other military weapons long made here. The spurt in missile component manufacture appears to be offsetting this loss of other defense business.

The Connecticut Labor Department reports that aircraft and parts employment centered in Hartford, Bridgeport and New Haven was 60,000 in May—6000 less than the same month a year ago. However, total manufacturing employment is even with last year—at about 400,000 statewide.

Connecticut, along with other New England states, also has lost much of its textile industry in the migration to the South. As a result, despite the expanding national economy, the state is just about holding its own wh industry is on the increase elsewhe

Accordingly, state officials a lustily beating the drum to attr new industry.

Gov. Abraham Ribicoff journey to the West Coast a month ago a at a luncheon arranged by the Co necticut Development Commission San Francisco for a group of Nort ern California industrialists, he sai "Connecticut has the most to offer a industry planning to establish an E Coast branch."

Apparently in deference to t tussle between New York and Ca fornia lawmakers over geographic placement of defense contrac Ribicoff hastily added:

"I want to make it crystal cle that . . . we are not here on any i dustry raid. We are not asking an one to pack up and move to Conne ticut. However, a community of i



ANECHOIC chamber at CBS Labor tories, Stamford, used for quantitati checks.



XAMPLE of inter-industry cooperation in Connecticut is use of ultrasonic resonance gage developed by Branson Instruments, ic., of Stamford, to test wall thickness of *Nike-Hercules* nose cones built by Avco's Lycoming Division, Stratford.

rest exists already between our two ates . . ."

• **Alarm at DOD cut**—One Congressman, Rep. Frank Kowalski (D-onn.) is frankly alarmed at an apparent sharp cut in defense orders ping into the state. In his home town Meriden, Kowalski says, there are 500 unemployed defense workers. Moreover, he has compiled figures hich show that Connecticut has pped from $1.2 billion in defense ntracts—7.5% of the 1956 defense dget—to $897 million, or 4.3%, in 958.

He expects the state's share of the fense dollar this year to be even less about $500 million.

"This means a shift of 40,000 jobs t of the state," Kowalski told M/R. am against this kind of whipsawing, th the defense industry shifting to alifornia for two years and then ifting back. It is jerking the hell out our economy."

Kowalski says DOD should strive create more stability of the day-day variety in defense manufacture. nd he adds, "Maybe we need a ecial agency to plan for the *present*."

The lawmaker concedes, however, at missile component manufacture is king up the slack and that the reduction in defense contract dollar lume may not tell the whole story. The difficulty is, though, you can't ally determine just where we stand," said.

• **UA missile build-up**—At the oment the volume of missile busiss shows every indication of continuing to boom. Here's what is happening around Connecticut:

United Aircraft President William P. Gwinn two weeks ago announced that the company will spend $68 million to expand and modernize production and experimental facilities to handle its bigger role in missile/space work. All four operating divisions—P&W, Hamilton Standard, Sikorsky and Norden—are being geared to bid as a prime systems contractor.

Several thousand of UA's more than 45,000 employes are involved in missile manufacturing operations. There are 10,000 in P&W engineering sections.

Heading UA's Missiles & Space Systems Division, which was formed a year ago and is now working up steam, is aircraft propulsion wizard Wright A. (Parky) Parkins. His 200-man engineering division at East Hartford is making weapon and space proposals and has "several" classified contracts under negotiation.

"We are hopeful this will grow into a real program and Connecticut will benefit in a large way," says Parkins. He explains that the overall plan will see P&W, which now builds *Hound Dog* J-52, and *Snark* J-57 engines, providing both liquid and solid rocket propulsion systems; Hamilton-Standard—controls, air conditioners and other accessories; Sikorsky—airframes, and Norden—electronics and guidance.

UA's United Research Corp. at Menlo Park, Calif., is actively pursuing propellant research, on both a long- and short-range basis. Parkins told M/R UCR is setting up a multi-million dollar facility for solids development. The effort is strictly R&D and production will be handled by P&W in Connecticut.

P&W right now is developing rocket cases of titanium and steel in a "cold-flo" turning process. These are second- and third-stage cases for *Minuteman, Pershing* and *Polaris* under sub-contracts with Aerojet-General, Thiokol, the Navy's BuOrd, and Hercules Powder.

At Middletown, UA has 1500 employes in the Connecticut Aircraft Nuclear Engine Laboratory. CANEL is a "hot lab" owned by the Air Force and has been in operation since 1950. Various other engineering sections of UA also are working on advanced propulsion systems—ion, plasma, solar—and lead boundary layer devices.

• **Norden consolidation**—Norden-Ketay, acquired by UA a year ago, is in the process of being brought under one roof. Facilities at Stamford, Milford and White Plains, N.Y. may be moved to a new plant at Norwalk, Conn., although no site has been picked yet. The division's 2300 employes are turning out gyros, synchros, analog-to-digital converters, pressure ratio transmitters and indicators, gas pressure systems, servo motors, resolvers and other components. These parts all have been designed specially for *Atlas, Polaris, Thor, Nike, Terrier, Tartar, Redstone, Jupiter, Talos, Bomarc, Regulus, Snark, Hound Dog, Tall Tom* and *Swallow* missiles.

The Hamilton-Standard Division, which was hit by a curtailment in aircraft propeller demand, is making a comeback in the missile controls area and now employs 7000. H-S officials are excited by a new "Min-IR-Cooler" for IR detection and satellite applications which was developed with Arthur D. Little, Cambridge, Mass. The division is producing auxiliary power

emphasis on cooperation . . .

packs and is on the Boeing team to make environmental controls for the global boost-glide *Dyna-Soar* space vehicle.

Leaning back in a chair in a paneled office once occupied by aircraft pioneer Chance Vought, Parkins observed recently that the Missiles & Space Systems Divisions real job is to "unite and exploit the capabilities already in UA—and we're on the spoor."

MSS, incidentally, is not tied to UA's other operating divisions in putting together a missile/space system. "We're free to go," says Parkins, "anywhere we can find a better mousetrap."

• **Big Avco contract**—Avco's Lycoming Division at Stratford is the production arm of the company's big R&D laboratory at Wilmington, Mass., along Boston's "Golden Industrial Semicircle." It also has outside contracts. Just three weeks ago, Aerojet-General signed the division to a $6 million order for second and third rocket chambers for *Minuteman* and *Polaris*. The unit's 3700 employes also are busy producing *Titan* and *Minuteman* re-entry vehicles, *Nike-Hercules* nose cones and the forward diffuser for the Bendix *Talos* surface-to-air missile.

In 1958, Avco-Lycoming had 1750 suppliers to whom it paid $12.3 million. Some 500 of them were in Connecticut and received $4 million. The company says there will be a "lot more" this year.

It was H. Webster Crum of Avco-Lycoming who spelled out the proposal of the eight Connecticut manufacturers to the Springfield Ordnance District just two years ago. Others joining in the now-famous "Southern New England Missile Resources Group" were American Machine & Foundry, which has a substantial R&D laboratory of 1100 at Greenwich, Conn., Kaman Aircraft—now working on highly classified *Polaris* electronic countermeasures; Electric Boat, Landers Frary & Clark—now making small rockets; Norden-Ketay, Manning Maxwell and Moore Inc., Stratford—researching high pressure/high temperature and controls for chemicals, power and other applications, and Sperry Products, Inc.—electronics and data processing.

• **EB payroll $60 million**—Electric Boat's huge shipyard at Groton is a beehive of activity in the big push to launch fleet ballistic missile submarines to carry the Lockheed *Polaris*. Some 10,000 employes—2000 of them commuters from Rhode Island—are hard at work on the 380-foot, 5600-ton Patrick Henry, sister ship to the first FBM sub, George Washington, which was launched June 9. (M/R June 8, p. 31.)

With a 1958 payroll of $60 million, the yard has contracts to build two more FBM subs, first of a new class. EB has on the ways two other revolutionary nuclear subs. They are the high-speed Triton, which has two reactors for propulsion, and the Tullibee —the nation's first atomic-powered "killer sub" for anti-submarine warfare.

All of the subs are costing around $100 million, and the Navy has provided more than $2 billion so far for the entire FBM program. EB, incidentally, says that through January, 55% of its direct purchase orders under the FBM program went to small business. These suppliers also received 38% of stock inventory dollar volume.

• **Wealth of specialties**—The multitude of small, growing firms which make up the fabric of Connecticut's missile industry produce products which read like a rocket hardware store. At Middletown you will find Safeway Heat Elements making heaters and heating pads; Hart Mfg. at Hartford turns out relays; Hi-G, Windsor Locks, is producing capacitors. Vickers Inc. Marine & Ordnance, a division of Machinery Hydraulics, is a ground handling and launching equipment fabricator.

In the Waterbury area, there is the Bristol Co., with 1400 employes producing high-speed relays and choppers at Danbury. Barden Ball Bearing makes miniature instrument bearings for missile applications, and Reeves Soundcraft, telemetry tapes and product control systems.

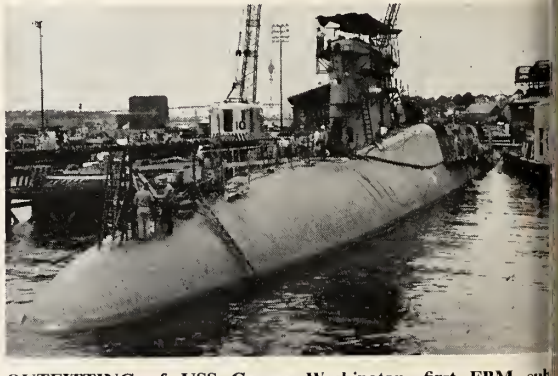
The Perkins-Elmer Corp., Norwalk, an old established company is in the missile business with tracking theodolites and infrared systems.

To test the wall thickness of Avco Lycoming's *Nike-Hercules* nose cones Branson Instruments Inc., Stamford has developed an ultrasonic resonance gage. These cones must be held to a variance factor of ±0.006 in. A new company ready to make itself available to other Connecticut missile men is Propulsion Test Facilities, New Haven, an affiliate of MB Mfg. Co. This firm offers complete environmental test facilities for checking component reliability under simulated space conditions.

The Rogers Corp., Rogers, supplies the duroid in the *Thor-Able* telemetry system, playing a small but important part in the recovery of the test missile's nose cone. The tiny 2-ounce motor which drove the miniature tape recorder in the *Vanguard II* weather satellite was made by the A. W. Haydon Division of Consolidated Electronics Industries Corp., Waterbury.



JET ENGINES for *Hound Dog* and *Snark* are turned out at Pratt & Whitney's Aircraft Division in East Hartford.



OUTFITTING of USS George Washington, first FBM submarine at EB, Groton. Sister ship is under construction.

Vehicle Requirements Are Tricky

A look at some of the myriad problems involved in designing mobile systems and an outline of some of the vehicle combinations that may be chosen.

by John J. MacRostie

SAN JOSE, CALIF.—One of the major problems in the testing and deployment of large missiles is transporting them over land.

Difficult obstacles must be overcome. Specialized support vehicles are needed to overcome them.

The Preliminary Design Department of **Food Machinery and Chemical Corp.'s Ordnance Division** has conducted extensive studies in order to meet this challenge. The results show the great complexity of the problems involved.

To begin with, in order for a missile system to be mobile there must be the capability of moving missiles from the launch area to another on short notice even during adverse weather conditions. Careful consideration must be given to the ground over which the equipment must travel.

Here are some of the possible terrain conditions:

- Good, hardtop roads exist between all possible launching sites, and there are *no* bridges nor underpasses with limited clearance.
- Good, hardtop roads exist between all possible launching sites, but there *are* bridges or underpasses with clearance limits.
- Good, hardtop roads exist over part of the area, but secondary dirt roads must be used in other parts. These secondary roads are good in dry weather, but will become muddy during prolonged use in rainy weather.
- Both hardtop and dirt roads exist in the area but the tactical situation demands that the equipment must at various times be moved over open country where no roads of any type exist. Under this general terrain situation, the ground may be hard-packed and will support the equipment during dry weather without excessive sinking, or sandy soil may exist causing high rolling resistance even during dry weather, or mud conditions may exist over most of the terrain during wet weather, creating extreme mobility problems.
- Good roads in the area, but during the winter (even in the southern U.S.) there may be snow conditions at certain times of the year.
- There are normally good roads available, but, due to man-made or climatic damage, the roads must be detoured in certain areas either via secondary dirt roads or via open field terrain.
- The slopes that exist in the area must be considered. If there is rolling terrain with severe grades, then greater tractive effort is required than would be required in flat areas.
- The final conditions to be considered is the width of the roads, radii of curves, and clearances at intersections. If the roads are narrow and meet at 90° intersections, then long trailers could not turn without going off the road, and if there are deep drainage ditches or other obstructions at these intersections, then, to insure adequate equipment maneuverability, a steerable trailer suspension must be provided.

In establishing an equipment mobility concept, each type of terrain mentioned above must be considered to determine whether that particular condition would be encountered in the area of missile system operation.

If it is known that good roads will exist at all times, it is not necessary to provide equipment with a high degree of cross-country capability (which will cost more and be more difficult to maintain than simple highway-trailer type equipment). If, on the other hand, difficult terrain must be traversed, even for short distances, cross-country mobility must be incorporated into the design.

However, if a high degree of mobility is required for only short periods, the mechanism may be designed for low-speed operation and relatively short life. Or, if a high degree of cross-country mobility is required for all normal use, then the feature must be incorporated for full-life usage and must be effective in all speed ranges.

- **Combinations**—Many mobile equipment concepts, embodying varying degrees of mobility, are possible. In each case the prime mover—tractor—is a critical item, and its size, power and tractive capability must be considered relative to the weight and rolling resistance of the trailed load.

Here is a brief list of some of the possible equipment combinations which apply to 50,000-pound payloads or 100,000-pound payloads:

- A *highway type* semitrailer and a military wheeled prime mover which would utilize standard tire pressure (in excess of 30 psi) for highway use.
- A *wheeled* semitrailer and a trac-

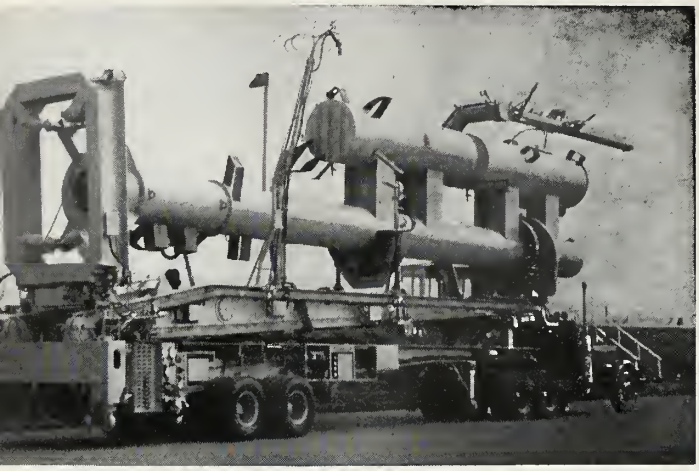
About the Author

John J. MacRostie is manager of the Preliminary Design Engineering Department of the Ordnance Division of Food Machinery and Chemical Corp. Before this assignment, he was Chief of Preliminary Design. In his nine years with FMC, MacRostie was an engineering group leader on the M-59 and T-93 vehicle programs and was project engineer in the Navaho missile support equipment program.

The FMC Ordnance Division has for over 17 years devoted much of its design and manufacturing capabilities to providing mobility for U.S. Armed Forces. It has done considerable work in the past four years in the area of wheeled transporters for large missile systems.

FMC, under a contract with North American Aviation, designed and manufactured the transporter erector launcher for the G26 Navaho, and subsequent to that designed the transporter erector launcher for the G38 Navaho and was actively engaged in that program at the conclusion of the overall Navaho program. In the field of IRBM's, FMC, under contract to Douglas, developed and manufactured the transporter erector launchers for the Thor system.

wide choice of equipment . . .



HEAVY equipment used by FMC's Ordnance Division was instrumented for shock testing during the company's work under the *Navaho* program.

tor; using large-diameter, off the road low-pressure (under 15 psi) tires on both the tractor and trailer.

• A wheeled semitrailer with a *tracked* prime mover. In this case, the tracked vehicle ground pressure would be less than 10 psi, and the trailer tire pressure would be under 15 psi.

• A wheeled semitrailer with *power-driven* wheels combined with either a wheeled or tracked prime mover which would supply power to all of the wheels. The trailer wheel drive would be used for *all* speed ranges, and the tire pressures again would be under 15 psi.

• A wheeled semitrailer similar to the above, but with power applied to the trailer wheels *only at speeds below 5 mph* to provide traction for difficult terrain. Above that speed, the wheels would be free-wheeling.

• A *track* type prime mover and a *tracked* semitrailer with power at the trailer track through all speed ranges.

• A tracked semitrailer similar to the above, but with power at the trailer track at speeds only below 5 mph.

Let us now consider the reasons that would cause us to use the various combinations.

• Standard highway tires (pressure over 30 psi) have large carrying capacities for a relatively small size. The small size is an advantage in keeping the vehicle width and height to a minimum, but if the vehicle is to go off the highway, small, high-pressure tires will be a severe disadvantage due to their small area of ground contact. For special usage, it is helpful to reduce tire pressure in the highway type tires —but tests have shown that for a specific tire diameter and load condition, reducing the pressure beyond a certain point will actually increase the rolling resistance in soft ground.

• Large-diameter, low-pressure tires offer low rolling resistance across soft terrain and thus afford good cross-country mobility. Their large size, however, means that the equipment must be considerably wider and higher. The wheels must be placed far apart to permit sufficient room between the tires to accommodate the payload—in this case, the missile. For large tires approximately 7 to 10 feet in diameter, stability considerations generally preclude placing the entire payload above the tires—hence the vehicle must accept increased width.

• **Aircraft problems**—This width factor is particularly critical when air transportability is required. The largest cargo aircraft today will accept a load 144″ wide—and load height is also a design factor.

To overcome this limitation, thought must be given to the possibility of disassembling equipment (in a short period of time and with simple tools) to reduce over-all package dimensions.

• **Track suspension?**—A tracked trailer might be used for this application. Although it is not a common trailer design concept, this type of vehicle has been manufactured in the past for the U.S. Army. It has several advantages, primarily in the area of low ground pressure for soft soil, sand, or mud.

A tracked suspension is available for static loads up to 120,000-pound load capacity (M-48 tank), and this capacity could be increased. The tracks could be placed entirely under the payload, since a 60-inch-high deck would clear the entire suspension, thus permitting a narrower overall vehicle width.

One objection to the track suspension is that compared to wheeled vehicles, it has a rather high rolling resistance on hard-surface roads. Here again the probable terrain must be considered.

In line with the tracked trailer idea, tracked prime movers must also be considered. A tracked vehicle will outperform a wheeled vehicle of the same weight and power over difficult terrain; if maximum drawbar pull per pound of dead weight of prime mover is required, tracked vehicles should be selected. Alternatively, if most of the trip is to be made at high speed (above 30 mph) and on hard-surface roads, wheeled vehicles should be considered.

• **Choice of drive**—Once a suspension has been selected, we must consider the drive mechanism. If the equipment is to traverse cross-country terrain, power should be provided to all wheels of the prime mover and trailer. Without power to all wheels, even large-diameter, low-pressure tires will provide only limited performance on soft ground, sand, or mud. Within the powered-wheel concept, there are two primary approaches:

• Power to the trailer wheels for all speed ranges.

• Power to the trailer wheels only for low speed (under 5 mph).

Before a drive method can be chosen, operational requirements of the trailer drive must be determined. Either the trailer drive will function through all speed ranges from 1 to 40 mph, or it will be used only for low speed, high-tractive-effort travel (below 5 mph).

In the latter case, it is assumed that: if the terrain is such that the tractor can pull the trailer at speeds above 5 mph, it doesn't need the help of the trailer wheel drive; terrain conditions requiring tractor drive at speeds under 5 mph will be limited; and time delay due to lower speed will not be a large portion of overall transport time.

The reason for offering this low-speed alternate is that, for speeds from 1 to 5 mph, no complex gear shifting is required, since either an electric or hydraulic motor can regulate speed internally in those ranges and still give good output efficiency. A greater range of self-regulation is possible, but unless the motor size is increased to give reasonable torque at high speed, some performance will be sacrificed at the high and low extremes of speed, if a 40-to-1 speed relation is required.

There are three basic methods of providing power to the trailer wheels:

1. Mechanical drive to a standard

ruck-type axle, with power supplied y either a separate engine on the ailer or a mechanical drive shaft rom the prime mover.

2. Electric motor drive for each heel, with power provided by a generator mounted on the prime mover.

3. Hydraulic or air motor drive for ach wheel, with power provided by hydraulic pump mounted on the rime mover.

• **Mechanical**—The mechanical rive has several disadvantages: The rive-shaft from the prime mover to the actor would require a very complex ower take-off coupling on the prime over, the drive shaft would be exssively long for the trailer length that required for this program, and the lative angle between the prime mover nd the trailer would be restrictive, verely limiting the maneuverability of e equipment. A separate engine on e trailer is rather redundant, since ime movers with adequate surplus wer for this requirement are availle. The problem is not power but nverting to useful tractive effort.

• **Electric**—An electric-motor drive r each wheel is now becoming quite mmon, at least in prototype equipent, and the state of the art is suffiently advanced to make this method actical. One disadvantage of the elec- c drive is the weight problem, since e generator and drive motors are relvely heavy items. On the other nd, performance of electric drives is cellent, affording a good range of rque-versus-speed performance, with e proper "gear range" being selected tomatically, and thus reducing the ver-skill requirement. Dynamic brak- reduces wear on friction-brake linrs and offers greater braking ability r prolonged periods of time during ended down-hill operation.

• **Hydraulic**—A hydraulic-motor ve for each wheel will offer performce somewhat similar to the electricotor drive, at least for low-speed opetion. In this system, vehicle speed is proportionate to pump output lume, and vehicle torque or pulling ver is proportionate to pump output ssure. At high speed, the volume of flow for large equipment would reire large-capacity pumps, valves, and ing. Therefore, there is a flow rate ond which it would *not* be econically feasible to operate, and this w rate would dictate the maximum icle speed.

If used in the speed range which is conomically feasible, the hydraulic ve may prove to be a lightweight em with performance comparable an electric drive.

• **Prime movers**—So far, we have ussed some of the factors to be sidered in arriving at an overall concept for the transporter-erector-launcher for a large mobile missile system. Now let us look at the problem of selecting a prime mover or tractor that will propel the unit.

The results of an FMC survey of prime movers resulted in the data presented on p. 20. Time did not permit an examination of all vehicles which may be available, but the broad cross section obtained was sufficient to establish a working base considering performance, physical characteristics, availability and cost.

Let us examine a hypothetical case involving a missile that weighs 75,000 pounds—midway between the 50,000 and 100,000-pound load discussed previously. These basic calculations will aid in selection of a prime mover:

G = Incline of Grade, in per cent
X = Coefficient of Rolling Friction
R_r = Rolling Resistance, in pounds
Θ = Horizontal Incline of Road, in degrees
W = Vehicle Weight, in pounds
U = Tire-adhesion Coefficient
R_g = Grade Resistance, in pounds
R_a = Air Resistance, in pounds
D = Drawbar Pull, in pounds

The following weight assumptions are made for this calculation:

Item	Weight
Missile	75,000 lbs.
Transporter-Erector-Launcher	45,000 lbs.
Sub total	120,000 lbs.

It is desirable in the case of a semitrailer to distribute the 120,000 lbs. so that approximately 1/3 is on the tractor's 5th wheel and 2/3 is on the trailer wheels. The semitrailer approach is favored for cross-country operation, since some of the towed weight can be put on the tractor to add to its draw bar capability.

Load Distribution

Item	Weight
Tractor 5th wheel load	40,000 lb.
Trailer running gear load	80,000 lb.

From the chart on p. 20 it can be seen that there are several tractors in the proper size area. (Assuming a 5000-pound overload is permissible, then a tractor with 35,000 pound rating is usable.)

Total Highway Load

Item	Weight
Missile & trailer	120,000 lb.
Tractor (Caterpillar DW-20)	29,000 lb.
Total	149,000 lb.

The vehicle required gradability performance must now be predicted. Below are some standards that can be applied:

Description	Grades "G" Maximum
Super Highway	6%
Mountain Highway	12%
Desired for our system	20%

(The 20% maximum grade was selected for our system as the unfavorable field condition most likely to be encountered if some reasonable planning can be followed in selection of terrain.)

The resistance due to grade can now be computed using $R_g = \frac{WG}{100}$ which is the simplified form of $R_g = W \sin \Theta$ and is sufficiently accurate for grades less than 20%.

For total load of tractor plus tractor plus missile

$$R_g = \frac{WG}{100} = \frac{149{,}000 \times 20}{100} = 29{,}800 \text{ lb.}$$

For towed load, which will give drawbar pull requirement due to grade,

$$R_g = \frac{WG}{100} = \frac{80{,}000 \times 20}{100} = 16{,}000 \text{ lb.}$$

To the above must be added the rolling resistance due to soil or road conditions. Assuming a tire pressure of approximately 25 psi

SUMMARY OF PRINCIPAL STATE HIGHWAY VEHICLE RESTRICTIONS

DESCRIPTION	CALIFORNIA	MAXIMUM	MINIMUM	PREVALENT
WIDTH	8' 4"	8' 6"	8' 0"	8' 0"
HEIGHT	13' 6"	N. R.	12' 6"	12' 6"
LENGTH				
Single Unit	35' 0"	N. R.	35' 0"	35' 0"
Tractor and Trailer	60' 0"	N. R.	45' 0"	50' 0"
MAXIMUM AXLE LOAD (LB.)				
Single	18,000	22,400	18,000	18,000
Tandem	32,000	40,680	26,080	32,000
MAXIMUM GROSS WEIGHT (LB.)				
3 Axle T. S. T.	76,800	86,400	45,000	73,200
4 or 5 Axle T. S. T.	76,800	86,400	56,000	73,200
Highest Weight Possible	76,880	88,000	55,980	73,200

T. S. T. = Tractor, Semitrailer
N. R. = No Restriction
Reference: American Trucking Association, Inc., November 1958
California Trucking Association, Inc., September 1957
S.A.E. Handbook, 1957, Page 1029

some non-engineering problems . . .

Surface Description	Coefficicent X lb/lb vehicle wt.
Highway	.017
Road hard gravel	.025
Off highway medium	.040
Off highway soft or sand	.200

From the above, the total rolling resistance can be computed. $R_r = WX$. For the tractor plus trailer plus missile: $R_r = 149{,}000 \times .200 = 29{,}800$ lb. For the trailed load: $R_r = 80{,}000 \times .200 = 16{,}000$ lb.

The factor which is of interest at this time is the draw bar requirement placed upon the tractor due to the trailed load. It is a summation of the grade resistance R_g and the rolling resistance R_r.

$R = R_g$ plus $R_r = 16{,}000$ plus $16{,}000 = 32{,}000$ lbs.

It can be seen from the chart below that the Caterpillar DW-20 has a draw bar capability of 35,300 pounds. This is more than we require, but the figure is for *ideal* tractive conditions and it must be recalled that we used the ground condition of soft soil or sand. Let us now compute the draw bar capability using data from the following chart.

Tire Adhesion coefficient U

Surface description	U (static)	U (sliding)
Highway paved	.85	.70
Road hard gravel	.60	.60
Off highway medium	.60	.50
Off highway soft	.40	.20

For the Caterpillar DW-20, assume that 20,000 pounds of the tractor weight and 40,000 pounds of the trailed weight is on the rear driving wheels. Then the tractive ability on off-highway soft conditions is

$P = 60{,}000\ U_{st} = 60{,}000 \times .40 =$ 24,000 lbs. for static friction

$P = 60{,}000\ U_{sl} = 60{,}000 \times .20 =$ 12,000 lbs. for sliding friction

Since the tractive ability of 24,000 lb. for even the most advantageous static friction condition is less than the draw bar requirement of 32,000 lb. this tractor will not be able to pull the load up a 20% grade in soft dirt. In this case, power would have to be supplied to the trailer wheels if th terrain is to be traversed using th particular tractor.

The foregoing discussion presen merely a few of the problems in pr viding mobility for larger missile sy tems. These problems, however, ca be solved with equipment and desig that are well within the present sta of the art.

Aside from the engineering pro lems, there are several other problen listed below:

- Snow and ice conditions will b encountered at certain times of th year.
- Elevation above sea level wi proportionately reduce the engi horsepower output of naturally-aspirate engines. Turbocharged engines ha been evaluated, since their horsepow output is not appreciably reduced b the higher elevations.
- Minimum road widths, radii, an clearances at intersections must b studied. Maximum wheelbase wa found to be approximately 60′ 0″. T insure adequate equipment maneuve ability above this dimension, steerab trailer rear suspension was provide
- Maximum speed on the pave highway was established at 40 mp

(Continued on Page 40)

Comparison of Vehicles

VEHICLE TYPE	MANUFACTURER AND MODEL	H.P.	DRIVE	VEHICLE WEIGHT (LB.)	TIRE SIZE	SPEED (M.P.H.)	DRAWBAR (LB.)	PAYLOAD (LB.)	HITCH	REMARKS
2 x 2	CURTISS-WRIGHT J	375	Converter	44,000	33.5 x 33	5.7 min. 34.4 max.	47,500 max. 3,300 min.	35,000	Kingpin	
	CATERPILLAR DW21	320	Gear	26,000	29.5 x 29	3.2 min. 28.0 max.	34,100 max. 3,900 min.	20,000	Kingpin	
	OTAC GOER	330	Electric	20,000	.....	4.0 min. 30.0 max.	....	15,000	Kingpin	Drawbar can be i creased by motori ing trailer.
	GENERAL ELECTRIC 765	600	Electric	55,000	44.5 x 41	0.0 35.0 max.	60,000 max. 6,000 min.	60,000	Kingpin	Max. D.B. can b doubled by motori ing trailer.
	MICHIGAN 310	375	Converter	30,000	33.5 x 33	3.9 min. 31.2 max.	60,000 max. 2,000 min.	33,000	Kingpin	
4 x 2	MRS 250	600	Gear	61,600	14.0 x 25 (F) 33.5 x 33 (R)	2.5 min. 34.0 max.	64,500 max. 5,000 min.	Towed	Drawbar	
	K-W DART 70S	430	Converter	44,500	18.0 x 33 Duals (R)	7.8 min. 32.0 max.	49,000 max. 4,450 min.	100,000	Fifth Wheel	600 hp Option
	CATERPILLAR DW20	320	Gear	29,000	14.0 x 24 (F) 29.5 x 29 (R)	2.6 min. 29.0 max.	35,300 max. 3,100 min.	35,000	Kingpin or Drawbar	
	GENERAL ELECTRIC 765	600	Electric	60,000	16.0 x 24 (F) 44.5 x 41 (R)	0.0 35.0 max.	60,000 max. 6,000 min.	80,000	Kingpin or Drawbar	Max. D.B. can b doubled by motori ing trailer.
4 x 4	MRS 200-4	335	Gear	45,500	20.5 x 25 (F) 29.5 x 25 (R)	2.4 min. 35.1 max.	38,200 max. 2,900 min.	Towed	Drawbar	
	MICHIGAN 480	600	Converter	85,000	33.5 x 33	3.6 min. 28.6 max.	....	41,000	Optional	
	COLEMAN D400	450	Converter	60,000	24.0 x 25	1.0 min. 30.5 max.	45,000 max.	Towed	Drawbar	
TRUCK	OTAC M123 6x6	256	Gear	30,400	14.0 x 20 Rear Duals	..... 42.0 max.	40,000 max.	30,000	Fifth Wheel	
TRACKED VEHICLE	M45	500	Gear	60,000	Track	5.5 min. 30.0 max.	26,000 max. ..... min.	30,000	Fifth Wheel	
	T99E1	440	Converter	30,000	Track	2.5 min. 35.0 max.	54,000 max. ..... min.	30,000	Fifth Wheel	
	M8A2	363	Converter	44,500	Track	..... 41.0 max.	51,600 max.	Towed	Drawbar	

Now you can design silicon infrared optical systems with greater flexibility than ever before. Hughes has developed a new technique for *casting* pure polycrystalline silicon of the highest optical quality. Starting with cast silicon blanks — in shapes of flats ... domes (to 9" in diameter — and larger) ... lenses ... prisms ... Hughes can greatly reduce the necessary grinding. Result: economical silicon applicable to a wide variety of problems.

The high quality of these cast silicon parts has been established through extensive laboratory research. Spectrophotometric and scattering tests have proven that the optical properties of cast polycrystalline silicon are identical to those of single crystal silicon.

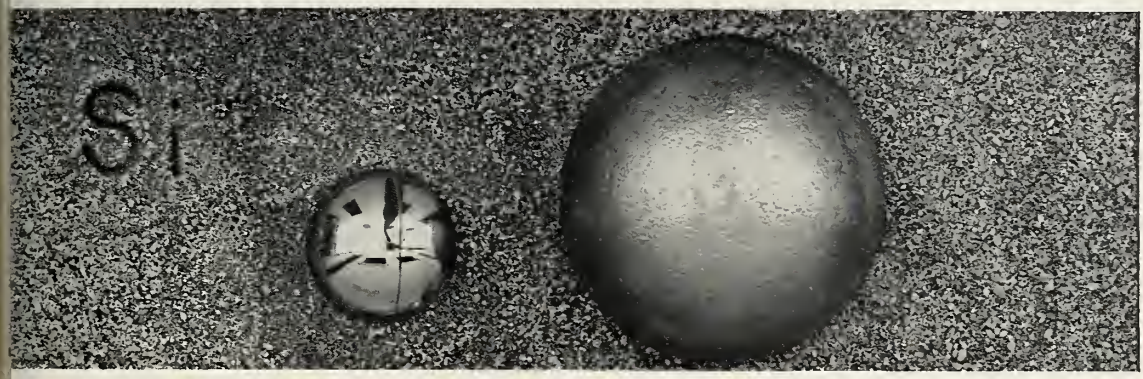
Wide variations in grain size proved to have no effect on scattering characteristics.



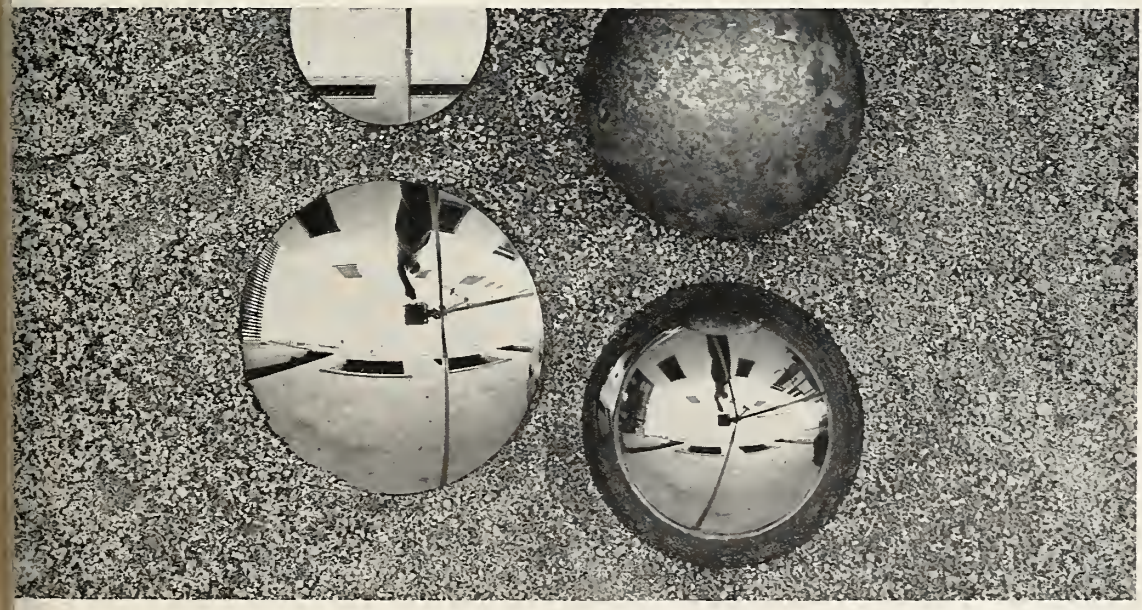
For additional information or more detailed test results please contact the Hughes sales office nearest you. They are located at:

BOSTON, 4 Federal Street; Woburn, Massachusetts; WOburn 2-4824. **MINNEAPOLIS,** 6121 Excelsior; Minneapolis 16, Minn.; WEst 9-0461. **NEWARK,** 80 Mulberry Street; Newark 2, New Jersey; MArket 3-3520. **SAN FRANCISCO,** 535 Middlefield Road; Palo Alto, California; DA 6-7780. **SYRACUSE,** 224 Harrison Street; Syracuse 2, New York; GRanite 1-0163. **CHICAGO,** 1515 N. Harlem Ave.; Oak Park, Ill.; NAtional 2-0283. **CINCINNATI,** 816 Swiftan Center; Cincinnati, Ohio; ELmhurst 1-5665. **PHILADELPHIA,** 1 Bala Avenue; Bala-Cynwyd, Penn.; MOhawk 4-8365. **LOS ANGELES,** 690 N. Sepulveda Boulevard; El Segunda, California; ORegan 8-6125.

Or write: Hughes Products, Marketing Department, **SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA.** *For export write: Hughes International, Culver City, Calif.*



SOPHISTICATED SILICON IN A VARIETY OF SHAPES



Creating a new world with ELECTRONICS

HUGHES PRODUCTS

©1959, HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE® OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS

The Search for Space Vehicle Power

Government and industry strive to find sources of electrical power that will allow man and his vehicles to undertake prolonged space missions

by Paul Means

WASHINGTON—Generation of electrical power during space flight is one of the vital obstacles to be overcome before man or his vehicles venture very far into space.

Manned space expeditions will either have to take along enough stored power, or generate enough power in flight to provide for communications, navigation attitude and flight control, fire control, and environmental control.

And electrical power needs will increase sharply in advanced space vehicles motivated by electric propulsion. According to studies by the Air Research and Development Command of the U.S. Air Force, power requirements for an electrically propelled manned deep space expedition could be as high as 30 megawatts.

Satellites are presently powered by chemical batteries, some rechargeable by solar cells. But the weight factor of chemical batteries and the inability of solar batteries to give large amounts of power instantaneously are drawbacks to their sole use in advanced vehicles and missions.

To meet the power needs of future space vehicles, industry, the services, and the National Aeronautics and Space Administration are experimenting with many different types of power supplies and converters. These include: advanced electric generators and chemical batteries, solar cells, thermionic converters, thermopile generators, thermoelectric generators, fuel cells, atomic power units (both isotopes and reactors) and magnetohydrodynamics.

• **Future needs**—How much electrical power will be required to run the equipment aboard space vehicles and missions planned for the next ten years?

According to an ARDC study, the secondary power needs of equipment aboard space vehicles now in the planning stage could vary from as little as two or three watts for certain reconnaissance equipment to upwards of 100 kilowatts for electric propulsion devices.

Specific secondary power requirements, according to ARDC, would amount to about one kilowatt for satellites in 300-mile orbits, hard impacts on the moon, and unmanned flights to the moon and back.

A soft landing or a manned flight to the moon and back would take about 1.6 kilowatts of secondary power, as would semi-hard or soft landings on Mars or Venus. About five kilowatts is needed to power the equipment aboard a stationary equatorial satellite, unmanned trips to Mars and Venus and return, and manned trips to the moon. Soft landings on Mars and Venus and back would require about 10 kilowatts.

Secondary power requirements increase many times if electric propulsion equipment is utilized to correct the trajectories of long duration space flights and to correct orbits of long duration earth satellites.

ARDC figures indicate that approximately 80 kilowatts of electrical pow will be required to obtain one pou of thrust from an ion propulsion devi with a specific impulse of 3000 se onds. If the specific impulse is increas to 20,000 seconds, the power requir jumps to 550 kilowatts per pound thrust.

Since a secondary power generati plant could not meet these demands, is suggested that a slight increase wou be made in the capacity of the genera ing equipment for the electric propu sion system in order that it may al serve as a source of secondary pow for the vehicle.

The ARDC study gave particul notice to the "specific power" requir to perform various missions. An ou put of 7 kilowatt hours per pound secondary power generating equipme is acceptable for most of the missio during the next few years, but lat missions will require from 50 to 2 kilowatt hours per pound of secondar power generating equipment. Syste weight in mechanical systems shou decrease during the same period fro 300 pounds per kilowatt to from 50 t 100 pounds per kilowatt.

• **20 KVA capacity**—The stud indicates that an advanced space v hicle of the 1965 era will need a ce tral power source with an entire sy tem capacity of at least 20 KVA.

In a study of the requirements c an electrical system for Air For weapons systems to be operational 10 to 15 years, a total environment w determined (see table). This enviro

Specific Secondary Power Requirements

MISSION DESCRIPTIONS	Secondary Power	
	Continuous Output	Specific Power (KWH/LB)
SATELLITES (ORBIT AT 300 MI) HARD IMPACT ON MOON AROUND MOON AND RETURN	1KW	7
SEMI-HARD OR SOFT LANDING ON MARS OR VENUS SOFT LANDING ON MOON AROUND MOON AND RETURN (MANNED) CONTROLLABLE ORBIT SATELLITE (APPROX. 22,000 MILES ALTITUDE)	1.6KW	50
ORBIT OVER ONE EQUATORIAL POINT (APPROX. 22,000 MILES ALTITUDE) SPACE STATION MANNED (APPROX. 22,000 MILES ALTITUDE)	5KW	100
SOFT LANDING ON MOON AND RETURN (MANNED) AROUND MARS OR VENUS AND RETURN (UNMANNED) SOFT LANDING ON MARS OR VENUS AND RETURN (UNMANNED & MANNED)	10KW	250

Prepared by ARDC

ADVANCED VEHICLE POWER REQUIREMENTS
(both secondary & primary)

Mission Profile	Electrical Kilowatts
Earth Satellites	1-50
Unmanned Planetary Probes	10-500
Manned Reconnaissance Vehicles (No Landings)	500-5000
Manned Expeditions	5000-30,000

Prepared by ARD

ent imposes the most severe condi-ons that all of the vehicles studied uld have to withstand.

Though some of the criteria would less extreme for certain space re-irements, the ARDC study recom-ends that all materials, components, d other hardware be tested in these al environment extremes and not be nsidered acceptable unless they with-nd all of the extremes.

In evaluating the different compo-nts that may generate the necessary wer for future space vehicles, the mary and most important criterion i weight. Depending on the type of ssion, the ability to produce large aounts of power instantaneously may an important criterion. Also, the tal amount of power needed in the hicle may decide which type of com-nent will be used.

As Dr. S. Fred Singer, Professor Physics at the University of Mary-ad pointed out in an article in M/R December, 1956, different power s>plies require different amounts of c>rhead, e.g. the initial weight invest-nt for a nuclear or fusion power s>ply is very large so that the supply b>ome economical only if the power r>uirements are fairly high.

Following is a survey of the vari-o> components that may be used as p>er sources in space vehicles, their o>imum applications, and their present s>te of the art.

• **Chemical batteries**—Non-charge-a e chemical batteries have applications f short space flights. They are always r dy for use, require no preparation, e lve no gas, pose no radiation haz-a , and have a reasonably long shelf li .

Mercury batteries are presently u d in satellites and will be for many y rs to come. One advantage is that th ir voltage does not drop off until n r the end of its useful life.

However, as the included chart pre-p ed by ARDC indicates, chemical b teries are not competitive with other t es of power systems if the flight is t last longer than ten days. For dura-ti s of over ten days, the specific w ght of the chemical systems in-c ases very rapidly but the specific w ght of the solar and nuclear sys-t s increase only slightly.

Rechargeable chemical batteries, i cluding fuel cell batteries, could be u d in conjunction with other power g eration devices, such as electric and th rmoelectric generators, solar, or n clear power.

• **Solar cells**—Solar cells are being c tinually improved and show many sp ce applications. In the photovoltaic c s (solar battery) presently in use, p oton energy from the sun disturbs th solid state equilibrium of the cell

Energy Output of a Power Supply Divided by its Weight

	Watt-hour/lb	Power Range (Watts)
Dry battery	14	<10
Activated battery types	25	<10
Re-chargeable nickel-cadmium battery	12	<10
Fuel cell battery	60	>100
Radioactive battery	10^4	<10
Nuclear reactor power supply	5×10^9 (max)	>100
Fusion power supply	5×10^{10} (max)	>100
Solar battery	infinite	<100

Prepared by Dr. S. Fred Singer

material, and an electric potential is generated which will cause a current to flow in an external circuit.

The solar energy input at the top of the atmosphere is 1400 watts per square meter (130 watts per square foot) and the measured efficiencies of present silicon junction photocells is about 10 percent. This gives an electrical power output of about 100 watts per square yard of battery.

Larger amounts of solar power can be produced if a number of cells are connected in series-parallel combinations. The two present disadvantages of such a system are present component weights, which would require 1000 pounds per kilowatt, and the old Christmas tree bulb problem. That is, if one of the cells is destroyed by meteoric impact, the total output of the series is destroyed.

Studies are also being made to determine the practicability of using concentrated solar energy as the heat source for a closed thermodynamic cycle. Using liquid or gas as the working fluid, the system uses a parabolic reflector to concentrate the sun's energy on the boiler of the system. The heated fluid from the boiler is expanded through a turbine which drives the alternator and the compressor or pump, and then waste heat is rejected in the radiator prior to sumping the fluid back to the boiler. Such a system would have an overall efficiency of 10%.

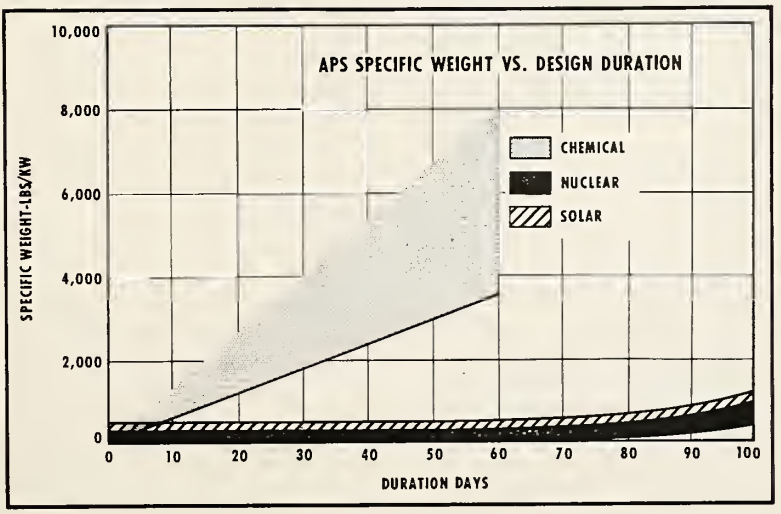
ARDC studies indicate that it would take about 80 square feet of concentrator projected area per kilowatt of generated electrical power. But the weight of the radiator make such a system impracticable until newer fluids and newer materials resulting in higher operating temperatures are found.

Before solar energy becomes a major power source for space vehicles, a heat storage unit must be devised which would not be subject to degeneration on re-cycling.

• **Electrical generators**—The Thompson Products Division of **Thompson Ramo Wooldridge Inc.,** has recently published a paper on the problems to be overcome in developing electrical generating equipment for space systems. Such generators, whether electrostatic, or electromagnetic, according to the Thompson report, will probably have to use direct radiation cooling, either directly from the motor frame to the ultimate heat sink of space at a temperature of about 40 F or from the motor frame to the vehicle skin which radiates to space.

According to the Thompson report, the alternator showing the greatest promise is the inductor-type having no rotating windings, no brushes, and capable of withstanding a high temperature environment without cooling, exposure to working fluids, and capable of high rotating speeds.

The type of generator used may depend on the type of propulsion system used. Ion types of propulsion, requiring high voltages and low currents, which is characteristic of the electrostatic generator. Plasma propulsion



QUANTITATIVE DEFINITION OF HYPER ENVIRONMENTS FOR ELECTRICAL SYSTEMS

Environments	Values
CONVENTIONAL	Existing Documents (MIL-E-5272, MIL-E-4970)
OZONE	11 parts/million at 13 mi to 21 mi
HIGH TEMP—AERODYNAMIC	0 to 47 mi 125°F to 932°F +
SHORT TERM RE-ENTRY ENVIRONMENT	60g deceleration and 932°F +
LONG TERM RE-ENTRY ENVIRONMENT	8g and 932°F
HIGH VACUUM	Approximately 0 pressure and 0 density
HIGH TEMPERATURE	5 Min to go from —68°F to 932°F, held at 932°F for 10 min, reduce to 752°F, hold for 1 hour, reduce to 702°F, hold 4 hours.
SOLAR RADIATION	1 to 100,000°A (Maximum Intensity at 4500-5000°A) as radiated by a "black body" of 6000 to 6500°K.
MECHANICAL VIBRATION	5 to 55 cps at 3/8 in. double amplitude
ACOUSTICAL VIBRATION	190 db, 30 to 10,000 cps
SHOCK	50 to 200g for 11±1 m.s.
ACCELERATION	8g for 1 min to 60g
ZERO GRAVITY	0g
EXPLOSIVE ATMOSPHERES	High Energy Fuels and Fluids
IONIZED GASES	Number of Electrons 1.5 x 10^4/cm^3 at 38 mi to 1.5 x 10^6/cm^3 at 159 mi
DISASSOCIATED GASES	Atomic oxygen particles 1 x 10^{12}/cm^3 at 56.5 mi to 5 x 10^{12}/cm^3 at 75.5 mi Range 50% to 100% atomic Atomic Nitrogen Particles 1.4 x 10^{12}/cm^3 at 56.5 mi to 1.2 x 10^8/cm^3 at 113.5 mi
AURORAE	565 to 285 mi 10^8 electrons/cm^2/sec at 100,000 ev 285 to 565 mi 10 to 100 kev X-rays with intensities of 1000-100,000 Photons/cm^2/sec
SOLID PARTICLES	.2 Microns to 8 cm Particles
MAGNETIC FIELD	2.5 Mev Protons above 250,000' to 500,000 feet (10^8 Protons/cm^2/sec)
EXPLOSIVE DECOMPRESSION	8,000' to vacuum instantaneously (10.2 psi) 932° to 1.9 x 10-12 psi
TEMPERATURE SHOCK	—65°F to 932° in approximately 2 min
PRESSURE SHOCK	S.L. to vacuum in 3 to 5 min
NUCLEAR RADIATION	Dose Rate Integrated
NEUTRON	2 x 10^{14} neutrons/cm^2/sec 7.5 x 10^{17}/neutrons/cm^2
GAMMA	4.5 x 10^9 roentgen/hour 2 x 10^{11} roentgen

Prepared by ARDC

systems, on the other hand, require low voltages and high currents, characteristic of electromagnetic generators.

The Thompson study points out that both types of generators have disadvantages to be overcome, and that the existing state of the art "falls far short of meeting the requirements of electrical generation in space systems."

The bulk of available equipment according to the Thompson study, has been built to specification MIL-G-6099, which requires only that units operate at barometric pressures ranging from 30" of mercury to 3½" of mercury, with the aid of 120C cooling air at sea level and 40C cooling air at 50,000.

Furthermore, present generators require too much cooling air, and are too bulky.

In order to meet these problems, the Air Force is sponsoring a program, sometimes called "Hotelec", to achieve a 600 F capability for the components normally associated with an electrical generation system.

Thompson has announced the development of an electrical insulation for motors, generators, and transformer solenoids suitable for 1000° F applications.

• **Thermoelectric generators**—The recent announcement by the Atomic Energy Commission that they had achieved practical power generation from the SNAP III thermoelectric generator demonstrated the feasibility of using thermoelectricity as a power source for satellites and space craft using nuclear energy and solar radiation. (See M/R, Page 29, June 22.) A thermoelectric converter or generator is essentially a number of thermocouples which are series parallel connected to obtain the voltage and current desired.

In a space vehicle, cold junction temperatures would be maintained by radiating heat from the cold junctions into space. The system is highly reliable because there are no moving parts. As in the case of the photovoltaic cell, this system requires series connection to obtain high voltages.

Because the converter is almost entirely an integral part of the reactor, it is unlikely that any part of the electrical circuitry would be damaged by meteorites. Although the specific weight of this system is presently rather high —about 1500 pounds per kilowatt— very large reductions are theoretically possible.

The **Westinghouse Corp.** recently completed a 100-watt unit for ARDC, called the TAP-100, which uses gas for fuel and is claimed to have an efficiency of about 8 percent. The thermoelecti material is a combination of sen conductors in cascade. An advanc version will use a nuclear isotope f source of heat.

• **Thermionic converter**—This cor ponent utilizes the same principle us in the familiar vacuum tube. He boils off electrons from the catho which then move to the anode setti up a potential difference between tl plate.

This potential is dependent on tl difference of the work function of tl materials utilized for the cathode ar anode. The greater the work functic of the cathode, and the smaller tl work function of the anode, the great the potential will be.

According to the ARDC study, e perimental devices have attained ove all efficiencies of over 8 percent, wi 30% theoretically possible.

Ultimately, the weight of this sy tem, according to ARDC, may be th least of all those considered. Both tl thermionic and thermoelectric co verters can be used with solar energ for the heat source, although the i creased probability of meteorite dan age reduces the attractiveness of th type of installation.

• **Fuel cells—The General Electri Company** recently announced the di

velopment of a practical fuel cell generating directly from hydrogen and oxygen in the air. Future progress could produce a chemical re-chargeable battery having great potential as a source of space vehicle power.

Basically the fuel cell converts the chemical energy of recombination of hydrogen and oxygen directly into electrical form. The output therefore consists of electrical energy and water. The water could then be circulated to a nuclear power source to be decomposed again into hydrogen and oxygen.

According to the ARDC study, storing of gaseous hydrogen at 6000 psi inside a tank of liquid oxygen at 500 psi (both at 150°K) could produce from the fuel cell as much as 100 to 120 watt hours per pound. A better approach, the ARDC study reports, could be the liquid storage of both hydrogen and oxygen with an output of 105 to 815 watt hours per pound depending upon duration of mission and year of mission (and current state of the art). The problem with this method is that hydrogen must be stored at –400° to 475° F and at that temperature its critical pressure is only 188.2 psi, too low for use in the high pressure cell without compression or super heating.

According to the ARDC study, the Redox (reduction-oxidation) cell offers great advantages over the hydrogen-oxygen cell in that it eliminates gaseous electrodes and can use cheap, crude fuels, such as kerosene, alcohol, etc. This cell promises from 266 to 860 watt hours per pound, and in cases where atmospheric "air" will always be available, it could produce up to 1200 watt hours per pound.

Limitations of fuel cells is their necessity to carry all the necessary fuel for the entire mission. One answer is to have a nuclear installation convert the water back into water and hydrogen in a closed cycle. ARDC estimates that a solar regeneration reactor could handle fuel for 10 watts per pound.

The thermal or nuclear regenerative fuel cell is in the early stages of R & D, and problems yet to be solved include the control of the rates and flow of both hydrogen and oxygen in the proper ratio to meet the required load, decomposition of the catalyzing electrodes in the electrolyte, fuel storage, and system weight reduction.

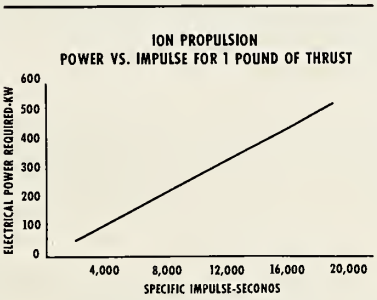
• **Magnetohydrodynamics** — Scientists are presently interested in the probability of generating an electric potential by passing a conduction fluid, a gas such as mercury at 2000° K through a magnetic field. According to the ARDC study, this principal seems to offer a specific power in the range of 100 to 1000 kilowatt pounds per hour. Work on this process is in the very early stages of research and development.

• **Atomic batteries**—Undergoing R&D at the present time, atomic batteries have only specialized applications for space flight in that they deliver only microwatts or possible milliwatts of power.

• **Nuclear reactors**—Probably the greatest supplier of both primary and secondary power for future space vehicles will be nuclear power from both isotopes and reactors.

In applications requiring more than 100 to 1000 watts, nuclear power is practically without competition. It also can be used to generate electrical power through the use of either static or mechanical power conversion devices as was the case with solar power.

Essentially the nuclear reactor acts as a heat source, approximately one billion B.T.U.'s are produced for every ounce of uranium which is fissioned. The engine itself can be run hot, limited only by the strength of materials at high temperatures.



The two major problems with a nuclear power source is heat dispersal and radiation. In his article, Dr. Singer proposed that nearly all of the heat could be radiated away into space, keeping the exhaust temperature in the vicinity of the freezing point of water if the satellite is built large enough with a large radiating surface. Dr. Singer states that the area in square yards is given approximately by expressing the energy to be radiated in kilowatts.

The shielding problem reduces the attractiveness of the nuclear system for manned flights with low secondary power requirements. But shielding increases only slightly with increased output and at high power levels is only a small fraction of the total weight.

One solution to the radiation problem for space flights not requiring large accelerations has been proposed by Dr. Singer. His idea is that the reactor power supply on take-off could be integral with the space vehicle but would be shut off, all of the power being furnished by batteries.

On reaching orbit or whenever the propulsion system is off and the acceleration becomes zero, the reactor would be removed to a safe distance from the space vehicle, with only a cable connecting the two. Then the reactor can be turned on by remote control and electricity piped into the space vehicle. Similarly, for landing, the reactor would be shut off first before it is brought close to the vehicle.

Steel Melting Processs Avoids Contamination

PITTSBURGH—Firth Sterling Inc. has developed an arc melting process for purifying steel that avoids contamination with refractory compounds.

The process, invented by Firth Sterling's R. K. Hopkins, involves melting an electrode under a controlled slag at a controlled rate in a water-cooled mold.

The molten slag protects the metal from the atmosphere. In addition, Firth Sterling reports, the composition of the slag is such that it neither adds undesirable elements to the metal nor removes desirable elements. Furthermore, the slag provides an ideal ionized path for the support and stabilization of the arc.

When melting titanium-bearing minerals, or any materials having elements that react with the oxygen or nitrogen of the air, the slag blanket is very effective in removing the resulting refractory compounds. Air melted material, which ordinarily is used for electrode stock in consumable electrode processes, invariably carries non-metallic inclusions, the company noted.

The inclusions are broken up and dispersed but are not eliminated in vacuum arc melting. In the Hopkins process, Firth Sterling said, the inclusions float to the surface of the molten metal and then are absorbed by the slag blanket.

An improvement in macro and microstructure is realized, the company declared, particularly in large ingots. Firth Sterling says it is making further improvements in melting to produce fine grained ingots, and the fine grain, with proper forging and rolling technique, can be maintained through to the finished product.

The company said the steels and alloys produced by the Hopkins process are A-286, 16-25-6, Discaloy, Waspaloy, Inco 901, PWA 1002, SAE 9310, SAE 4340, SAE 3312, tool steel and high-speed steel.

NEWS IS HAPPENIN



RADIOPLANE CREATES FIRST FAMILY OF UNMANNED AIRCRAFT TO T

Radioplane is the world's leading producer of drones and space age recovery systems. As live targets, drones perform as aircraft—then can be recovered by parachute. As evaluators, drones simulate the appearance of the enemy threat while they score our weapon systems' effectiveness. On surveillance missions, drones are zero-length launched, fly cameras, take photos, and return with information within minutes.



Typical of the high-performing Radioplane targets is the RP-76. This smallest target yet fired upon by missilemen is rocket powered, and it has the radar appearance of a large aircraft.

T NORTHROP



Radioplane drones shown left to right: XQ-4B; RP-76; RP-77D; OQ-19; SD-1

, EVALUATE WEAPON SYSTEMS, AND SURVEY ENEMY TERRITORY!

ates Army requirements
surface-to-air missile target
fo Mach .85 to .89 perform-
t 0,000 feet altitude. After
nc, the proposed target mis-
as o have a powered flight
on of eight to nine minutes.

tl direction of U.S. Army
nc, Radioplane produced
P- target missile which has
exceeded all of the perform-
sp ifications. Performance of the complete RP-76 system, including flight operations, is particularly impressive in view of the anticipated low production and operational cost.

Radioplane's leadership in the field typifies the years-ahead thinking that continues to produce design concepts for tomorrow, hardware for today – developed, produced, and delivered on time – at minimum cost to the taxpayer.

RADIOPLANE

Van Nuys, California, and El Paso, Texas

A Division of **NORTHROP CORPORATION**

Hope Sustains Monopropellant Work

Despite their many disadvantages, the odd fuels continue to attract government and private researchers who hope for a 'near-miracle' to boost their I_{sp}

by S. David Pursglove

WASHINGTON—How do monopropellants figure in the nation's missile plans? Where will these handy, one-squirt propellants be used in our defense and space sciences programs?

The answer, in a nutshell, appears to be, "they won't."

They won't figure in our plans, they won't be used in our rockets. That sums up Washington's best-informed opinion on the current state of monopropellants. That's the answer, stripped of platitudes, euphemisms, and apologies from officials of the three services, the National Aeronautics and Space Administration, a handful of propellant firms, and government-contract study organizations.

Why, then, are almost all of these people engaged, to some degree, in monopropellant research?

• **A someday thing**—The answer to that question is the same answer that could be used in reply to the question, "Why research at all?" for hundreds of years, past and future—hope.

One official sums up the typical government feeling: "Even though the specific impulse of all practical monopropellants is very low, and probably will remain low, the government recognizes their advantages and hopes that some near-miracle will bring about a marked increase in specific impulse."

He cautions that none of his people who are authorities on propellants knows of any breakthrough in the offing. "For this reason," he says, "government interest is flagging considerably, but there always will be a small spark of interest."

"Small spark" is just about all the government interest amounts to right now. We queried a top Air Force official about monos, and he had this to say: "Sure, I can talk to you about them—there's nothing worth keeping secret. Seriously, though, I can't discuss the amounts of money we're spending on research contracts because that would reveal the level of our effort."

By the time we had talked with him and several others, it was apparent that the Air Force level of effort is extremely low. (The Navy's is a little higher.) But, on every hand—here too—we ran into this "We'll maintain a spark of interest" attitude.

Why any interest in monopropellants at all? Why should the fact that official U.S. interest in monopropellants is lagging even be worth a news story?

The answer lies in accepted descriptions of "monopropellants." There are no widely accepted, simple, compact definitions of monopropellants—it is more what they *aren't* than what they *are*. For example, one author distinguishes between the two major classes this way: A bipropellant is a system of a fuel and an oxidizer, whereas when the fuel and oxidizer are wrapped up in a single molecule, the propellant is a monopropellant. This is true—but does not cover all cases. However, a monopropellant does involve just one homogeneous solid mixture or compound, or just one homogenous liquid, although the homogeneity may be the result of thorough mixing of several ingredients.

Examples of true monopropellants include the solid nitrocellulose (a single molecule capable of sustaining its own combustion), and the liquids nitromethane (a single molecule) and nitropropane-nitric acid (a homogeneous mixture of a fuel in an oxidizer.)

• **Advantages**—Now, what is so great about this? In the case of solid propellants, not much. But, in the case of liquids, the monopropellant requires only one storage tank, one pumping system, one filling hose, one filling operation, one tank within the missile, one pump within the missile, one route to the combustion chamber. On the other hand, a propellant system of a fuel and an oxidizer—kerosene-LOX, etc.—requires *two* of everything.

The monopropellant saves considerable weight within a rocket. Equally important, it saves storage space and cuts down handling problems at launching sites. This is important when it comes to shipboard missiles, and explains why the Navy is devoting more attention to monopropellants than does the Air Force which can operate from fixed, land-based sites.

It may also provide a clue to the Army's thinking about mobility, or to the Army's missile plans. Monopropellants, logically enough, would be of great value to a mobile army. However, the Army went on the record with M/R this way: "The Army has a very small interest in monopropellants—the interest is mainly in the Air Force and Navy."

Nonetheless, all missile-oriented agencies have a continuing interest in monopropellants for another use. These handy propellants are used to operate auxiliary power systems; most often they decompose to provide expanding gases which operate turbine pumps or generators. The monopropellant allows engineers to hold APU size and weight to a minimum.

How Do Monopropellants Compare?

Specific impulse of monopropellants under study versus I_{sp} some typical bipropellants

Propellant	Appx. I_{sp} (sec)
Monopropellants	
nitromethane	190-230
ethylene oxide	160-190
hydrazine	160-190
hydrogen peroxide	160-190
Bipropellants	
aniline-nitric acid	220
JP-4-nitric acid	200-230
hydrazine-nitric acid	230-260
gasoline-LOX	240
RP-1-LOX	300
hydrazine-LOX	315
hydrogen-ozone	400
hydrogen-fluorine	410

• **And disadvantages**—If monopropellants have so many advantages, why aren't they widely used—why so little interest?

This is the easiest question to answer in the entire missile business: the disadvantages outweigh the advantages. Those disadvantages fall into two major categories:

(1) The monopropellants just aren't powerful enough.

(2) They are too hard to handle; detonate too easily.

None of the near-practical monopropellants can hold a candle to most of our widely used bipropellants (see box).

The handling problems are explained by a paradox in the requirements for a monopropellant: It must be stable enough to store, yet be highly combustible without an added oxidizer. So far, most monopropellants have sacrificed handling safety for combustibility.

• **Three classes**—In general, there are three types of monopropellants, classified according to the way they function:

• Single molecules containing both the fuel and oxidizer. Popularly, this is visualized as a molecule "with the fuel at one end and the oxidizer at the other."

• Compounds (as opposed to mixtures) which undergo exothermic decomposition as a result of molecular structure. These single substances decompose to release heat because the arrangement of atoms is not stable

• Mixtures of fuels and oxidizers.

Monopropellants and Industry

These firms have monopropellant interests

*Aerojet General • Air Products Corp. • Allied Chemical • American Rocket Co. • *Atlantic Research Corp. • Becco Chemical Div., FM&C • Dynamic Devices, Inc. • Fulton-Irgon Corp. • *Hughes Tool • Olin-Mathieson Chemical • *Pennsalt Chemical • *Phillips Petroleum • *Rohm and Haas Chemical • *Rocketdyne • Shell Chemical • Special Products Lab., FM&C • *Stauffer Chemical • *Thiokol Chemical • Topper Manufacturing*

*Known to be doing considerable work in monopropellants

Here the paradox of requirements discussed above really comes into its own. Naturally the fuel-oxidizer must be a combustible mixture, but on the other hand, it must be possible to mix, store and handle it without danger of combustion.

• **Some examples**—One of the most famous monopropellants of the first class above is nitroglycerine. It is too unstable for use as a liquid monopropellant, since the reaction from the liquid state is detonation rather than combustion. However, just as clay or sawdust slow down nitroglycerine in dynamite, so do certain plastics and rubbers slow it down to make it an effective ingredient of some solid propellants.

Hydrogen peroxide, usually thought of as an oxidizer in a bipropellant system, is a monopropellant when its decomposition is catalyzed. The catalysts usually are permanganates, often calcium permanganate as used by Germany in World War II.

A more recent monopropellant under serious consideration is ethylene oxide. This is an important industrial chemical, the starting point or major intermediate in many commercial processes. Therefore, when new ethylene oxide plants, or expansions of existing plants, are announced, there is no reason to believe they are to supply the missile industry.

This, by the way, is true also of nearly every chemical propellant. Some of the major industrial chemicals that mislead followers of the missile industry into believing the quantity and variety of propellants are expanding, are nitric acid, liquid oxygen, hydrogen peroxide, and ammonia.

Ethylene oxide is produced in the laboratory and in some plants by reaction of ethylene chlorhydrin with an alkali. Most plants, however, produce it by direct oxidation of ethylene. This process route will keep the petroleum industry interested in missiles even after kerosene and other petroleum fuels are no longer used. Ethylene oxide has one drawback. Its low boiling point of 51°F means that it must be refrigerated for use as a liquid.

The most widely discussed monopropellant is nitromethane. It detonates very easily, and is quite hard to handle. A saving grace is that the nitromethane molecule exhibits a semi-polar double bond. The double character contributes the kind of instability necessary in a monopropellant; the semipolarity aspect makes it miscible with other polar compounds, including water and alcohols.

Diethyleneglycol dinitrate (DEGN), like nitromethane, is a nitrated hydrocarbon. However, the DEGN molecule is more complex. It is made by the direct nitration (with nitric acid) of diethyleneglycol vapors. Like nitroglycerin, to which it is close kin, DEGN is a very unstable liquid, but can be controlled as an ingredient of solid propellants.

• **Government approaches**—Here is a summary of what the various government agencies are doing in monopropellants, or say about them:

The AIR FORCE is still interested in monos because of their obvious advantages, but interest is at a low ebb because of the higher specific impulse of other, easier-to-handle propellants. AF is looking at hydrogen peroxide, propyl nitrate, and ethylene oxide. Nitromethane is about out of the pic-

Project MAST Being Stockpiled



ATRAN guidance systems produced for the Air Force's *Mace* system are being warehoused by Goodyear Aircraft along with support equipment. Unique world-wide military electronic supply program is dubbed "MAST," for Missile-Automatic-Supply-Technique. It brings "push-button" notice when parts are needed anywhere on globe.

rundown of company effort . . .

ture because of handling difficulties.

Fiscal Year 1959 contractors are **Pennsalt Chemical, Hughes Tool,** and **Phillips Petroleum.** On June 1, the AF announced invitations to bid on research in high-energy monopropellants, including solids and storable liquids. Conventional storables will occupy Air Force interest for the next five years. By then there might be a breakthrough in monos. Biggest monopropellant interest right now is amines.

The ARMY has little interest in monopropellants, and is willing to let the Air Force and Navy blaze the trail. However, **Rohm and Haas Chemical** is doing monopropellant work for the Army at Redstone Arsenal.

NASA has little interest because much of its work on chemical fuels is actually done by the services. However, NASA personnel formerly with other agencies have carried with them a strong interest in monos, and the space agency is conducting some work in the field.

The NAVY's Bureau of Aeronautics has a keen interest in monopropellants. Naval Ordnance Laboratory is doing some work, and Naval Research Laboratory "has a couple of old projects kicking around." The Navy sponsored a monopropellant symposium in New York May 5-6. An official of a government contract study organization says the Navy is by far the most interested Federal agency.

The Navy talks a lot about having made a breakthrough—a monoprop that has a high specific impulse and is safe to handle—but, since no details are available and since Navy scientists can only allude to "our secret discovery," many chemists ignore the talk.

Commerce Department's OFFICE OF TECHNICAL SERVICES prepares continuing bibliographies of work in government laboratories or in private labs under government contract. Although there have been many reports on propellants in recent years, there have been none exclusively on monoprops.

• **Industry effort**—Here is a rundown of what some of the companies are doing:

Thiokol Chemical is doing a lot of research, but is not running any engines on monopropellants. The firm is looking at high-energy, stabilized monopropellants that are safer and more powerful than nithromethane. One engineer describes them as having "bastardized molecules." By this, he says, Thiokol is synthesizing hopefully ideal monos. Chemists at Denville (N.J.) start by describing the desirable characteristics of a monopropellant, then try to build the molecule.

A Thiokol spokesman says the known compounds are no longer useful—they have been surpassed by missile needs. The chemist then has two choices: Look for other compounds; synthesize.

Rocketdyne "is very definitely in monopropellants," says a spokesman, but the company is not able to describe its work in detail.

Astrodyne has no interest in monopropellants as they are usually thought of—as liquids—since the company is limited to solids. However, Astrodyne is interested in the solid equivalent of monos: homogeneous solids.

Phillips Petroleum is very active in monopropellant research for the Air Force. The firm's special interest is in high-energy monoprops.

Aerojet-General is doing "practically nothing" in monopropellants right now, a spokesman says, but does support a continuing program on the chemistry of nitro-compounds for possible monopropellant use. In the past, Aerojet has looked at nitromethane, but decided its detonability and generally dangerous handling properties could not be overcome. The company still is interested in ethylene oxide and propylnitrate for a gas generator.

If Aerojet chemists develop an acceptable monopropellant, it might be either a liquid or a solid, but probably will be a straight organic compound—nothing fancy.

Atlantic Research recently developed a heterogeneous liquid monopropellant, Arcogel. **Thompson Products** holds exclusive licenses on both the gel propellant and burner system. Thompson plans gas generating and propulsion applications.

Stauffer Chemical is one of the firms most interested in monopropellants. Stauffer was host at the New York symposium sponsored by Navy BuAir.

Wyandotte Chemical is working with ethylene oxide and other monopropellants. The company's other monoprop intcrests cannot be identified, but some work is being done for BuAir. Industry sources believe this is under a contract that calls for development of a monopropellant with an I_{sp} exceeding 250 seconds.

Air Reduction Company has done some almost basic research that was applied to monopropellants. Combustion and Fuels Technology enginee G. A. Mead wrote on "Compressio Sensitivity of Monopropellants" in th American Rocket Society Journal June, 1959. However, his work wa done in 1958.

Among other recent papers o interest is "Improvements in th Operating Characteristics of n-Propy Nitrate," W. H. Lawrence and W. P Knight, Aerojet-General, in AR Journal, January, 1959. They sum marize Aerojet-General's work on a gas generator designed to use propy nitrate.

The Navy's "breakthrough" mono propellant is described by J. D. Clark Naval Air Rocket Test Station, in Astronautics, September, 1958 (p. 34)

Aerojet Courts Goodwill of Its Workers' Wives

SACRAMENTO—Planned tours of the rocket plants here are being conducted by **Aerojet-General Corporation** in an effort to reduce dissatisfaction among wives of employes who work long hours. The evening tours attracted over 500 wives during the first month of the schedule.

The highlight of each tour is the firing of a liquid rocket engine in the test area, which the wives watch from the observation post. The company reports that the tours have resulted in increased apprcciation by wives of the need for long hours put in by company personnel.

Storable Oxidizer Has High Oxygen Content

NEW YORK—Hummel Chemical Co. reports that its propellant oxidizer Tentranitromethane, $C(NO_2)_4$ is a stable, storable liquid with an active oxygen content only a little less than liquid oxygen.

In a new technical data sheet, Hummel says TNM has 1.07 G/CC of active oxygen, compared with 1.14 for LOX. However, TNM has a density of 1.64 G/CC, almost 50% higher than LOX's 1.14.

TNM can be stored for long periods below 40° C in mild steel drums or tanks, Hummel says. The oxidizer is stable up to 100° C. It melts at 12.5–13.7° C and boils at 125.7° C. Hummel reports pure TNM is relatively insentitive to impact or adiabatic compression, but the sensitivity is greatly increascd in mixtures with hydrocarbons or entrapped air. TNM is available in commercial quantities.

The Role of Solids Is Growing

Survey shows they are involved in virtually all weapon systems and the problems connected with their use—including I_{sp}—are finding solutions

by Frank G. McGuire

LOS ANGELES—"Given the same development time and research funds that liquid propellants have had, solid propellants should someday be able to do almost any job the liquids can do," says Dr. Cledo Brunetti, Vice President and General Manager of **Grand Central Rocket Company.**

"For immediate and any conceivable future military applications, solids will play a very significant part, and we further intend to strengthen their role in this area. As far as space applications, I think there will be a substantial amount of solid rocket motors used," says Dr. E. R. Roberts, Manager of **Aerojet-General's Solid Rocket Research and Development Division.**

These are the general reactions of two companies with heavy business investments in solid propellant rocketry. Despite the 100-seconds-higher specific impulse that solids still must concede to liquids, there are no plans afoot to "scuttle" the solid-propellant business. On the contrary, Grand Central has invested $3 million since September in new facilities to carry out the aim of its vice-president and general manager.

There are solutions now in existence, or in sight, for many of the problems that have plagued solid propellants in the past. Nozzle-cooling is virtually solved, combustion instability has been eliminated, reliability is over 99%, grain size is practically unlimited, and temperature ranges have been greatly expanded, these authorities say.

• **A place for both**—It is conceded that solids still must make considerable progress before displacing liquids in those applications where high specific impulse is the prime requirement for the mission. The general picture is, however, that for military purposes, nearly all new systems now under development call for solids *(Minuteman, Polaris, Pershing,* et. al.). It is therefore very difficult to say "it is all liquids" or "it is all solids" when looking at the future of propulsion for the next decade or so.

Grand Central and Aerojet officials were interviewed in connection with this survey because their work is typical. As the story indicates, other companies are involved.

Until recently, there was still a fairly clear-cut division where the large units needing high I_{sp} were liquids, and the small tactical rockets, which needed instant readiness characteristics, were solids. We have now reached the point where it is possible to produce huge solid-propellant rocket motors and still retain the advantages of reliability and instant readiness. By steadily increasing specific impulse levels, the solid-propellant people hope to eliminate all the disadvantages of solids, relative to the liquid systems.

• **Shifting border**—There is considerable optimism that this will be done, and it appears that the borderline between the two systems is shifting back and forth with the intermingling and overlapping of the respective systems and their missions. So it is now necessary, not only to determine whether solids or liquids should be chosen, but also exactly what propellants can be tailored to the job.

There are few large firms in the field of solid propellants that do not also have an investment in liquids to some extent. Aerojet-General is definitely in all type of propulsion. Grand Central's parent companies, **Tennessee Gas** and **Food Machinery & Chemical,** are both in the liquid-propellant field, and Thiokol has its liquid-oriented **Reaction Motors Division. Astrodyne,** jointly owned by **North American** and **Phillips Petroleum,** has strong ties through both Phillips and NAA's **Rocketdyne Division.**

It can be seen that none of these firms can afford to ignore the advantages of liquids, and must therefore "keep both feet on the ground," when evaluating various systems. All are in business to stay. As Grand Central's Dr. Brunetti puts it: "We expect to be in the solid propellant business for a long, long time and we are tied to the economics of it."

• **Performance**—The highest level of specific impulse reached to date is above 250 seconds, well over what was thought to be the solid-propellant "bar-



MIXING blades in Grand Central's 350-gallon mixer, ground to extremely close tolerances and constantly X-rayed for signs of weakness.

rier" of 240 seconds. New propellants and techniques are incrementally raising this level. The goal set by ARPA for the immediate future is 280 seconds, and this is expected to be reached in substantially less than five years. Specific impulse of 300 seconds is hoped for in a few additional years, and this would involve as yet unexplored techniques of separating the extremely energetic ingredients, one from the other, in solid-propellant systems.

Specific impulse importance varies with the stage under discussion. On the *Minuteman*, for example, the exchange ratio of range to specific impulse is more important on the first stage than on succeeding stages, merely because of the greater amount of propellant involved. It is therefore desirable to have higher I_{sp} in the first stages because of the more favorable exchange ratio. On the other hand, the exchange ratio for burnout weight (the penalty in reduced-range paid if the burnout weight of any given stage is increased) makes it important to reduce burnout weight in succeeding stages. Mass fraction is expected to increase from the present level (around .93) to .96 in a short time.

The increases in performance expected of solid-propellant rockets generally varies with the timetable given. There is a lag time estimated at from two to four years between laboratory achievement and production-motor achievement of specific impulse levels. However, according to Aerojet's Dr. Roberts: "It is evident that we are going into larger and larger sizes, but it might not be so evident that the physical properties will be a more significant parameter than the specific impulse, the burning rate, or any other parameter, which in the past used to be the primary concern."

• **Propellants**—Raising the I_{sp} levels will undoubtedly depend primarily on propellants and their processing. In this respect, the greatest advances in propellants in the past year have been in physical properties, temperature ranges, etc., and the best propellant for maintaining ability to withstand thermal stresses in case-bonded motors appears to be nitropolyurethane. With certain additives, it appears to have an all-around bright future.

Aerojet's work with the nitropolyurethanes stems from research sponsored by the Office of Naval Research. The polyurethane propellants being studies at AGC result from basic work done by the **Jet Propulsion Laboratories** in Pasadena. Most of Grand Central's work in composite propellants has been on ammonium perchlorates with rubber binders. (A composite propellant is one which has a crystalline oxidizer with a rubbery fuel binder. Instead of the two high-energy components, nitroglycerine and nitrocellulose, which characterize the double-base propellants, it has discrete particles of oxidizer embodied in a rubbery binder.)

Further work at GCR is aimed at four fundamentally different types of rubber binders of a high-energy nature. It is from this work that GCR expects to get ten to fifteen seconds more I_{sp} than from regular rubber binders. (Also, through some "rather interesting" approaches to design, GCR hopes to drastically improve mass ratio.)

Both Aerojet and Grand Central Rocket Co. have been working on new processing methods for solid propellants. One more advanced than most is the continuous mixing process, which allows propellant-mixing right at a launching site, if necessary. The capacity of the system depends on the type of propellant being mixed. Aerojet says it has demonstrated a pilot-plant operation of the continuous mix process. Grand Central has also been at work on the technique for some time, and pioneered the method.

In addition to the continuous mixing process, the development that has pointed the way to the huge solid-propellant motors is the technique of producing fuel systems which can be made to solidify without evolving heat.

Development of various techniques has allowed production of large propellant grains that do not create sufficient heat to warm the grain. Hence it is possible now to create grains of almost unlimited size, and cure (or solidify) them without fear of a combustion disaster.

In addition to work with nitropolyurethanes, polyurethanes, modified nitropolymers, and hydrides, AGC is looking forward to adaptation of the high-energy components of liquids into solids, a field in which Grand Central is also strongly interested. As things now stand, it is not possible to calculate a system using solid propellants which would give the same order of specific impulses as a liquid system, regardless of the solid propellant used in the calculations.

• **Combustion stability**—Once a plague on the solid-propellant field, combustion instability is said to be non-existent in modern propellants. One of the best cures for the problem was addition of metals to the propellant to raise the specific impulse level. The metals, the most common of which aluminum, also solved the combustion instability problem through happy coincidence. Quality control has also helped. According to Grand Central, once a motor and propellant are designed, tested and kept under tight quality control, the problem of unstable burning, once eliminated from early test models, is permanently absent.

• **Temperature range**—"More than half our problems are associated with the requirement that we operate within –65° to 165°F, and this requirement is expanding," says a harassed solid-propellant engineer. "We are being asked to meet temperatures of 250°F, and for very special applications, up to 400°F."

In the low I_{sp} areas, from 200 to 230 sec., great temperature ranges have been met. Examples are the *Sidewinder, Zuni, Asroc, 2.75* rocket etc. In the *2.75*, the propellant operates the same from –30°F to 130°F and through chemistry doing the job performance-wise in the missile, over 150 pounds of fire-control and other electronic equipment has been eliminated from aircraft.

• **Nozzle cooling**—The evolution in nozzle cooling has reached the point where Grand Central Rocket considers it "quite obsolete" to route fuel or oxidizer through the nozzle walls for cooling, when there is a lightweight plastic nozzle available for liquids as well as solids. (With the exception of the extremely large liquid engine.) Among the methods used in conjunction with the plastic nozzle are film cooling, ablation, transpiration and auxiliary propellant charges.

Film cooling, in which a film of material is introduced between the flame and the nozzle, utilizes a material which is solid in storage, but which liquifies under high temperature and flows across the surface to be cooled. The nozzle developed by **Douglas** for use with the GCR *Nike Zeus* motor is an end-grain refrasil, essentially a fibreglass material with a high-grade resin.

A combination system using the self-cooling nozzle with some auxiliary film cooling does not appreciably downgrade the I_{sp}, and represents one of the methods which prevent heat from getting to the nozzle in the first place. The problem is not one of cooling (a heat-sink nozzle would do that), but one of cooling lightly and efficiently.

• **Reliability**—"To state it fundamentally, when you are using a solid propellant motor, you are using the product of a chemical plant which is still back at the factory. When you are using a liquid rocket, you are dumping raw materials into the missile, which then must act as a chemical plant."

metering, mixing and controlling the fuel and oxidizer. There are a lot more things that can go wrong when your chemical plant is airborne, then when it is sitting on the ground and you control the product." This is the case for reliability as the solid-propellant-rocket manufacturer sees it.

If a solid-propellant system is properly designed, thoroughly tested and tightly controlled for quality, there is no resaon why 99% reliability cannot be attained, they say, and point to the outstanding records already established. The *Viper* rocket, produced for sled use by GCR, has demonstrated reliability in excess of 99% in a long series of runs. (In discussing reliability, sources made it clear that they were not including JATO units, and other low-performance solid-propellant motors in the reliability factor.)

The Air Force clustered 21 of the *Viper* motors on a sled four times and 39 motors once during the first week of June, to drive test sleds at high Mach numbers. About 700 of the *Viper* motors have been fired. They are not the "workhorse" type rocket, but are a recently developed, high-performance motor having a performance index of over 160 . . . considered very high.

In the clusters fired at Edwards, Holloman and other bases, reliability is vital, because of the expense of sleds, their special design, etc. Of 162 rockets ordered by Edwards AFB since last February, not one has failed to fire. They get GI handling, and are production rockets, not specially "mothered" laboratory models.

• **Casings**—Thin-walled motor casings, another shining goal of solid-propellant men, has reached the state where Grand Central Rocket is working with casings having thicknesses of less than 100 mils, and Aerojet's Aerowrap process, involving spiral wrapping of the steel casing, has produced .015″ walls.

Although Aerojet says it is not now employing the Aerowrap process, the company is believed to have produced a considerable number of casings by the method with wall thicknesses of less than .050″. Design strength of the casings was said to be 250,000 psi yield strength, but actually is 265,000 psi, and "ultimate failure has been occurring between 300,000 and 330,000 psi." Once the desired thickness is determined, the spiral wrapping of steel is begun and the necessary amount of layers added until the thickness is as specified.

• **Hybrids**—In the midst of the solid/liquid melee stands the poor relative of both: the hybrid rocket. Grand Central Rocket Co., noting that the most vulnerable parameter of solid-propellant rockets is thrust-level control, is strongly considering the hybrids. The firm "has some ideas" about the system and may come up with a unit having liquid oxidizer and solid fuel (which would also serve to pressurize the liquid propellant tank). The system is expected to provide a three-to-one thrust-control capability which would be adequate for many applications.

No hybrid systems are being considered by Aerojet, which feels that a hybrid system "buys the disadvantages of both liquids and solids." No other techniques for thrust-level control are being pursued at AGC except complete termination of combustion.

• **Costs**—One of the hottest topics tossed about during M/R's interviews was the subject of costs. The major points of difference that solid-propellant men have with their liquid-propellant counterparts are: "It is not necessarily what system will put the biggest payload on the moon?", but the question is "What will it cost?" The other point is "It's not the propellant cost we have to worry about, it's system cost—or mission cost."

J. J. Crowley, Vice President—Project Management and Marketing for Grand Central Rocket Co., feels there is reasonable doubt that the amount of cost per pound for payload on the moon is clearly an advantage of the liquids. His company feels that the best way to determine which system to employ in any space application is to conduct an operations research study, to show the total cost of delivering whatever payloads are called for. This would cover every cost connected with the program, including development and ground support facilities.

Similarly, D. F. Sprenger, Associate Manager of Aerojet's Solid Rocket Research & Development Division (and head man on their *Minuteman* work), feels that a good example of low-cost space research with solids is the *Scout* program, the first major application of solids to this type of work. "Possibly a year from now, we will be able to more accurately assess just where solids fit in, but it looks to us right now as if it is a very low-cost method."

The actual development cost of a million-pound-thrust solid-propellant motor is "considerably lower" than the cost of a million-pound liquid engine, and Grand Central Rocket would "gladly" take a contract to build a 20-million-pound-thrust solid rocket, because of the relative ease with which it could be done, compared to a liquid engine with the same order of thrust.

"And in the future, it will be the development cost that really matters," says Dr. Brunetti, "because many of these things we are working on will never, in the true sense of the word, be 'produced.' We may make 200 development units of a very large rocket, then actually produce only 300 'production' units."

• **Problems remaining**—In the final analysis, there are several areas in which solids are making strong efforts to whittle down large advantages enjoyed by liquids. The areas of specific impulse, thrust-level control, acceleration control and similar characteristics, are among the most vital.

Asked what was the next hurdle they would like to see cleared in solid propellant technology, Aerojet spokesmen cited the need to find a method for coating hydrides, or the protection of high-energy materials so that they can be incorporated into solid propellants without prematurely reacting. This accomplishment would move the technology to the next major "plateau" of specific impulse. Grand Central's answer, while granting the need for a method of coating hydrides, was to raise specific impulse without compromising the temperature range of a missile, and actually to expand it.

Beyond these problems lie others, but the future looks promising. In the words of one company official: "What solid propellant rocketry would like to have is a solid form of high-density hydrogen."



TEST FIRING by Aerojet of large solid-propellant rocket engine for guided missile launchings. The company is working on the solid propellants for the Navy's *Polaris*.

Cooling Gear Gets New Emphasis

Experts say heating problems in missiles and support equipment will grow and design must be done early—first of a two-part survey

by Hal Gettings and Charles D. LaFond

WASHINGTON—Vital to the achievement of optimum performance is electronics cooling, a major link in assuring high reliability in missile electronic systems and components. A multimillion-dollar business, it is all too often a stepchild in early equipment and system design. An M/R staff survey into this very important area of missile and ground-support equipment design brought two similar responses from each of the companies queried:

1) As a result of increased component density in micro-miniaturized circuit design, increased power requirements per unit volume, and aerodynamic (environmental) heating will continue increasingly to cause system degradation in missile and ground-support electronic systems.

2) To combat this, systems should include at an early stage of design and throughout development the services of competent cooling-system design engineers.

We have long since passed the time when free convection would satisfy the requirements for cooling electronic equipment in the majority of existing and proposed future high-performance electronic systems. Unique operational requirements have resulted in unusual designs in cooling systems. To meet requirements, compact electronics cooling packages have been designed, utilizing liquid-to-air, oil-to-air, air-to-air heat exchangers plus the use of electric-driven fans and flow control valves in the electrical controls and switches.

New and better means to provide individual component cooling are currently being developed, including new applications of the Peltier effect for controlling temperatures in transistors (to be covered in part 2 of this survey).

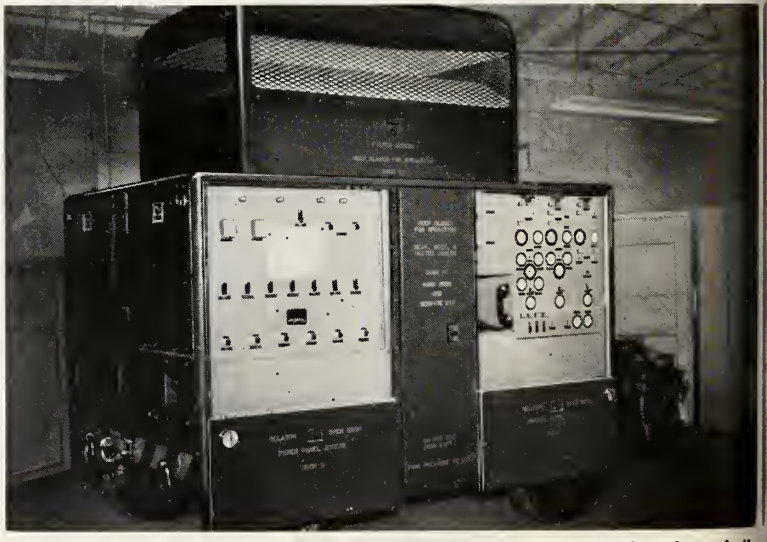
Electronic cooling packages can be grouped into two principal types: missile support equipment and missile carried equipment. While performing the same functions, it is obvious that cooling system configurations for the two types are considerably different. They range from the massive air-conditioning systems required for computer centers down to very small units for cooling infrared detectors.

As an example of the former, for the NORC computer center at Dahlgren Naval Proving Grounds, 50 tons of cooling equipment are contained in the computer system itself while 40 tons are required to cool the room in which NORC is installed. On the other end of the scale is the recently announced 8-ounce "min-IR-cooler" developed by **Arthur D. Little, Inc.,** of Cambridge, Mass., and currently being manufacturer by **United Aircraft Corp.'s** Hamilton Standard Division as an IR detector-cell cooler.

The systems and components produced by **United Aircraft Products, Inc.,** of Dayton, Ohio, as summarized in Table 1, indicate roughly how diversified electronics cooling can be. The table shows only part of the picture, since the UAP also produces the various valves, hand pumps and other components and accessories to complement its systems.

• **Missile support**—Missile support cooling equipment, either ground installed or airborne, is designed to reject heat from the fluid which is cooling the missile components during preflight checkout operation to the ambient heat sink—that is, the atmosphere or the ocean. Thus the fluid on the heat-sink side is usually air or water. On the heat-source side (missile), the fluids generally used are air, water, water-glycol, high-temperature synthetic oil, and inert gases.

• Checkout cooling—The extent to which air conditioning of systems can be carried probably is best demonstrated by those produced by **C. G. Hokanson, Inc.,** of Los Angeles. To provide reliability for missile systems during checkout, the company has developed a



TRAILER-mounted air conditioning production unit made by Hokanson for *Thor* missile bases. The "snorkel" was designed to place the air intake above the LOX level.

whole line of specialized equipment, providing "tailored atmospheres" for many different missiles systems and aircraft.

In all of these systems, temperatures are held within very close tolerances. A pioneer in this field, the company completed the largest single air conditioning installation in the West for rocket test facilities at China Lake Pilot Plant, Naval Ordnance Test Station, Inyokern, Calif. Among many of its major cooling systems built since that time, Hokanson test and production units are currently employed in the **Douglas** *Thor*, **Martin** *Titan*, **Northrop** *Snark* and **Lockheed** *Polaris*.

For *Thor* during final checkout, the Hokanson system essentially consists of three different operational units. They are all integrated and combined into one single mobile chassis.

• The measurement unit provides continuous heating and cooling during storage, standby, and countdown.

• The guidance portion of the system provides both heating and cooling but only during countdown.

• The third portion of the system is for the engine which provides heat during the countdown only.

Air connections to the missile are provided with four 150 ft.-long lines, including three inlets and one return.

In the measurement-cooling system, temperature is controlled by means of a thermistor sensor in the missile. The temperature control point is 90°F ±20. The unit can provide 15,000 BTU/hour cooling capacity and 25,600 BTU/hour heating. This portion of the system employs an air-to-air heat exchanger to lower refrigerant-compressor operating time.

In the guidance-cooling portion of the system, fresh air can be delivered through the ducting at a rate of 800 cubic feet/minute against a static pressure of 13.5 inches of water. Again temperature is controlled by a thermistor sensor in the missile. An air blower supply is energized when the missile temperature reaches 80°F. The refrigerant cooling unit is energized when the missile temperature drops to 45°F. A warning system is actuated when missile temperature falls outside of the range of from 33°F to 124°F. Cooling capacity of this portion of the system is 36,000 BTU/hour.

In the engine-cooling portion of this system, fresh air input is at the rate of 1,000 cubic feet/minute against 13.5 in. of water. Control and regulation of temperature is initiated at the air conditioner with a range of from 40° to 200°F. Blower start and stop on lower speeds are actuated from the missile automatically. Again, a warning signal is produced if missile temperature goes below 5°F. This portion of the system can provide 225,000 BTU/hour heating capacity.

Heat for the air conditioning system is provided by a small electric fluid emersion heater which is divided into three-25kw stages. The fluid consists of a 50-50 mixture of ethylene glycol and distilled water. This is circulated to all three parts of the system by means of two pumps. More accurate temperature control is obtained through forced circulation by the dual pumps.

Reliability of the system is good. Specifications for the measurement unit provided for a 500-hour non-stop operating time, 100 hours at high speed and 300 hours at low speed in the engine unit, and 200 hours in the guidance section. The system is capable of 10,000 hours operation before the need for scheduled overhaul and its built-in test equipment permits monitoring of components not in continuous operation.

• **Missile cooling**—Because of the singularly unique operational requirements of the various systems, the environmental conditioning equipment carried in short-time flight has assumed practically every thermodynamic configuration possible. These requirements include flight time, whether in terms of minutes or hours, and an enormous, repetitive checkout period.

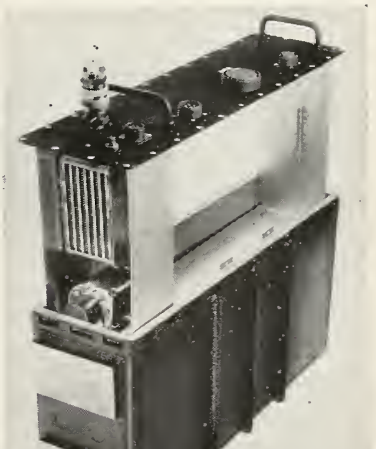
Installations have been designed by **Garrett Corporation's AiResearch Manufacturing Division**, a well-known leader in the field, utilizing only the thermal mass of the pre-cooled structure. Most installations however, said a company engineer, require the missile to carry an expendable evaporant in order to adequately cool the equipment. AiResearch ranks pure water, pure ammonia, and a solution of water and ammonia and water-glycol in that order as the most advantageous evaporants to use.

Water has the lowest thermal pressure and a good heat evaporation. Ammonia has low heat sink but high pressure. However, its storage and use is disagreeable to animal life.

Most problems which dictate unusual solution are high voltages in a small package requiring a high dielectric strength cooling medium and cooling specifications requiring close temperature control in order to minimize instrument drift. AiResearch said it

Table 1. Summary of Electronics Cooling Systems and Components Produced by United Aircraft Products, Inc.

		MISSILE TYPE								PROPULSION						GUIDANCE				
		Surface-surface	Air-surface	Air-air	Surface-air	ICBM	IRBM	Drone	Tactical	Liq. fuel rocket	Solid fuel rocket	Booster	Ram jet	Turbo prop	Gas turbine	Radar	Inertial	Infrared	Radio	Ground Support
SYSTEMS	MECHANICAL REFRIGERATION				X	X						X	X			X			X	
	EXPENDABLE REFRIGERATION	X			X	X														
	CRYOGENIC					X				X								X		X
	HEAT TRANSPORT							X												X
	CONSOLE COOLING	X		X	X		X		X	X	X					X	X			
	EVAPORATIVE	X			X			X						X					X	
COOLING	LIQUID/AIR	X	X		X			X		X		X	X			X	X		X	
	AMMONIA/GLYCOL	X																		
	LIQUID/GAS												X							
	EVAPORATIVE		X																	
	LIQUID/LIQUID	X	X		X							X			X		X			X
	LIQUID AMMONIA/LIQ. OXYGEN					X				X						X				
	HOT GAS/NITROGEN TETROXIDE				X															
	AMMONIA/AIR				X								X			X				
	COLD PLATE (CONDUCTIVE)	X		X							X					X	X			



AIRBORNE pressurized cooling package by AiResearch. It uses water-glycol.

three approaches to radiation . . .

has maintained temperatures within ±1°F for electronic equipment dissipating from 10 watts to 10kw.

One unique feature of missile-carried equipment is that environmental conditioning equipment usually performs double duty as a cooling or heating system while providing structural mounting for the components being conditioned. For example, several AiResearch systems have taken the form of breadboards, container walls and other unique configurations. For this reason, they have vigorously attempted to educate electronic firms into consulting environmental-control firms at an early development stage in order that the environmental system may be feasibly designed into the package itself.

A typical example of an environmental conditioning system for electronic equipment involved a low total-head dissipation aboard a high-altitude missile.

AiResearch selected an open-cycle cooling unit because it is much lighter and less complex in operation than closed cycle systems. Net heat rejection was 85 w and it used an ammonia (NH_3) evaporant to cool nitrogen circulating over heat-generating electronic components. The system included an NH_3 storage tank, pre-cooler superheater, associative components. Specifications are shown in Table 2.

• Radiation cooling—In the missile-cooling applications above, energy transfer to the heat sink was by means of convection or conduction. This is quite satisfactory in flights of short duration. But, in space vehicles this transfer to the heat sink must be by means of radiation since the lack of an atmosphere removes the mechanism for convection and conduction.

Table 2. AiResearch performance specifications for missile-borne cooling system

Heat Transfer Data	Hot Side	Cold Side
FLUID	NITROGEN	NH_3
FLOW RATE	3.22 LB/MIN	0.016 LB/MIN
TEMP IN	57.7°C	-32°C
TEMP OUT	53.7°C	-35°C
PRESSURE IN	14.7 PSIA	17 PSIA
PRESSURE DROP		2 PSI
PROOF PRESSURE		800 PSI
Fan Data		
TYPE	VANEAXIAL	
TEMP IN	53.4°C	
PRESSURE IN	14.7 PSIA	
PRESSURE RISE	1.7 IN. H_2O	
POWER SOURCE	3 PHASE, 400 CPS, 115V	
POWER REQ.	40 WATTS	
Valve Data		
TYPE	PORTIONAL-INTEGRATION MODULATION	
CONTROL	FIXED ±2°C	
MAX. TEMP.	800 PSI	

Thompson Products Div. of **Thompson Ramo-Wooldridge, Inc.,** Cleveland, in a report titled "Electrical Generating Equipment for Space Systems" has indicated that there are three possible (and practical) means of providing for this heat radiation cooling: employ a radiator designed to collect heat from the vehicle and its equipment and radiate its energy into space; employ the outer surface of the vehicle as a radiator; or, use a combination radiator and radiating vehicle skin.

Key to direct radiation cooling, according to Thompson, is the provision of equipment designed to withstand high operating temperatures. Their reason: thermodynamically, the higher the operating temperature of the equipment the greater the amount of heat transfer. Biggest advantage in radiation cooling would be the great savings in weight.

Space Technology Laboratories, Inc., of Los Angeles, recently revealed the development of new coatings for satellite skins that are capable of controlling internal temperatures in flight. Developed by Rudolf X. Meyer, a scientist in the company's Physical Research Laboratory, the coatings change color with temperature change such that they become light with an increase in heat and darken with heat loss. Thus they compensate for the temperature change by reflecting or absorbing heat radiation as required.

Meyer has found nearly 35 substances, either paint-like or plastic that have this "chameleon" ability. In using polymer compounds, he said use is made of the reversible transition from the "sol" state to the "gel" state as the temperature increases.

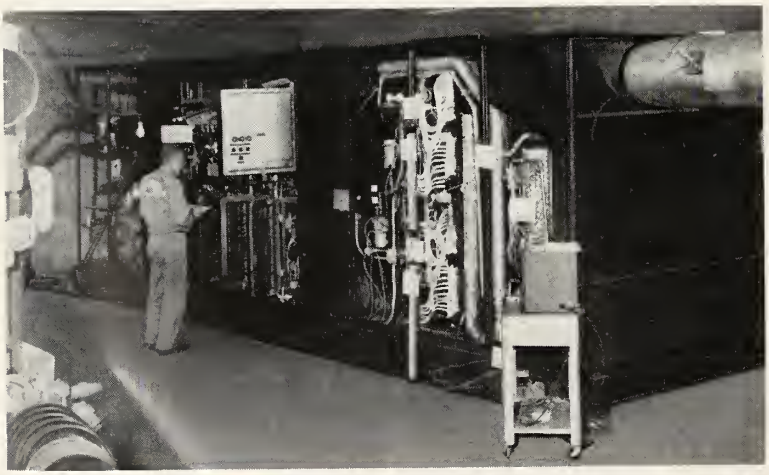
• **Heat exchangers**—An innovation in heat exchanger equipment is the heat transfer surface called "Inner-fin" developed and patented by **Dunham-Bush** of West Hartford, Conn., which is achieving marked success. The Inner-fin coils have proven to be one answer to the space and weight problem so significant in adapting cooling equipment to the relatively confined spaces associated with electronic equipment in missiles and aircraft.

The company has indicated that the use of their special coils has reduced necessary size by as much as 60%, still maintaining the same air and liquid pressure drops through the coil as obtained in standard finned tubes.

The exchangers are of all aluminum dip-brazed construction. Units finding direct application in the missile and aircraft business have been ethylene glycol-to-air, and oil-to-air heat exchangers. The Inner-fin construction has also been applied to Freon-to-Freon and air-to-air heat exchangers for airborne conditioning system components and ground support electronics cooling respectively.

Basic principal in the patented Inner-fin is the arrangement of longitudinal fins inside a tube in conjunction with outer fins. A small inner tube is mechanically expanded which locks the longitudinal Inner-fins in close contact with the inner wall of the outside tube and the outer wall of the inside tube. This type of construction provides greater surface area and smaller hydraulic radius. Thus the transfer of heat is more rapid. The longitudinal arrangements of the Inner-fin keep pressure drop at a minimum.

(Part 2 next week: Cooling missile components)



COMBINED air conditioning and water chilling units designed and built by Hokanson Co. in support of *Titan* program. It yields unprecedented amount of dry air.

Eyelets vs. Plated-thru Holes

A report on a comprehensive test in which all located failures were in eyeletted phenolic boards —last of two articles on printed circuitry

by Bernard C. Alzua, Jr.
Motorola, Inc.

PHOENIX—The most costly and me-consuming operation in the as-mbly of an electronic unit or chassis the hand wiring of the circuit. It is so the source of frequent errors, ecessitating costly inspection proce-ures.

The development of circuit boards id printed wiring has done much to leviate this situation. In fact, the high olume production techniques of cir-uit boards for radio and television assis is no longer a "state-of-the-art" ethod but more a mechanical process hich turns out quantities of 5000 to),000 units a day.

The use of circuit boards for mili-ry applications in missile and air-aft equipment, however, presents a ifferent set of requirements. Here the ctors of reliability and quality con-ol are paramount, and costs are sub-rvient to reliable performance. It is vth these high-quality, high-reliability pes of boards that this article is con-rned.

• **Reliability factors**—The cost of inted wiring is high, especially when liability is a "must." The cost of the ost expensive board, however, is latively little when compared to the st of a reject board that is completely embled and contains 75 or more ounted components.

To the Army Ordnance Missile mmand, Huntsville, reliability means "the positive assurance that the weapon will function effectively whenever required." The military demands that reliability be achieved during the R&D phase of each weapon system through quality-assurance and quality-control programs.

Accordingly, exhaustive flight testing is the rule in current programs. For example, an average of 230 individual measurements are obtained during each flight of the *Redstone* missile.

• **The controversy**—One of the most important debates relating to reliability of circuit boards is over the use of eyelets or plated-thru holes. At **Motorola's Western Military Electronics Center** in Phoenix, our Reliability and Components Group has been conducting a lengthy and comprehensive evaluation of the relative merits of each.

In the past few years, many users of printed boards have had so much trouble with plated-thru holes that they want no part of them in the future. We have found grounds to indicate that the trouble is not so much with the basic technique as it is with such deficiencies as poor quality holes, contamination and insufficient copper in the holes. It will be shown that we have, indeed, used the technique of plated-thru holes in several high-reliability applications with outstanding success.

A missile, rocket, or aircraft has numerous printed wiring boards—indicating that hundreds and thousands of eyeletted or plated-thru holes would be involved. Without attempting to be complete, the following report on comparative tests presents the most significant results obtained thus far.

Before these tests were made, several versions of wall thickness of plated holes were made and analyzed. Failures were located and their causes traced. We finally struck upon what we feel is an optimum thickness, and this was used in the test program.

• **Test program**—The objectives of the performance tests were:

1) to determine the relative ability of properly installed and soldered eyelets and of properly plated holes to maintain electrical continuity through epoxy glass boards; and

2) to evaluate, in the same manner, properly installed and soldered eyelets in XXXP phenolic printed wiring boards.

• **Environmental tests**—Briefly, eighteen epoxy glass eyeletted printed boards and three epoxy glass plated-thru hole boards (each board having a total of 100 holes) were subjected to the following environmental procedures:

1) thermal cycling, 15 cycles from -65°C to 125°C in air;

2) vibration, 10g 20—2000 cps and at their resonant frequencies for one hour, while carrying 30 ma-dc;

3) humidity exposure 91% RH 70°C, for ten days while carrying 30 ma-dc; and

4) immersion-vibration cycling, three cycles, each compromising three days of water immersion at 70°C followed by the vibration cycle.

Three standard eyelets were chosen for the tests because they fell within the average and standard hole sizes. Type 1, Circon #CE-34 was tooled to obtain serrated flanges on both sides. Type 2, American Brass #E-3700, was tooled to obtain funnel flanges on both sides. Type 3, United Shoe #S-5862, was tooled to obtain a rolled flange on one end and serrated flanges on the other.

Three hundred plated holes, gold finish, were compared with the same quantity of each of the eyelets just mentioned.

An equal number of phenolic boards was eyeletted and all of the boards included in this test were soldered and fitted with leads in the following manner. Approximately one-quarter (25)

The author is manager of the Printed Circuit Facility at the Motorola Western Military Electronics Center, Phoenix, Ariz. A mechanical engineer, he has an extensive background in photography and photographic methods. Formal training: University of Arizona, the Kodak Institute, Rutgers University.

cracks between flange and solder . . .

of the holes in each board were prepared with each of the following variables:

1) Holes were filled with 60/40 solder from both sides.

2) Holes were filled with solder from one side using the blind technique.

3) Component leads were inserted and soldered from both sides.

4) Component leads were inserted and soldered from one side.

• **Comparative results**—The comparisons that can be made from our test results obtained to date are shown in Figs. 1 through 6.

From Fig. 2 it can be seen that the most significant number of failures occurred in funnel-flange eyelets installed in phenolic boards.

All located failures were on eyeletted phenolic boards. Microscopic examinations showed that cracks had developed between the eyelet flange and the adjacent solder. Similar cracks have developed on many other eyelets in both XXXP and epoxy glass boards which have not yet failed.

All failures of eyelets in epoxy glass boards were classified as unlocated because, though definite circuit interruptions had occurred during vibration, the continuity was restored when vibration ceased.

Specimens prepared with blind soldering techniques had more failures than those that were soldered from both sides.

At present, we have found that G-10 and G-11 laminate series have been the most satisfactory to use on military type printed boards, particularly if the application involves a missile or aircraft device.

As far as printed-board materials for the future are concerned, I believe that the industry will gradually go in the direction of boards that can withstand higher temperatures and shock.

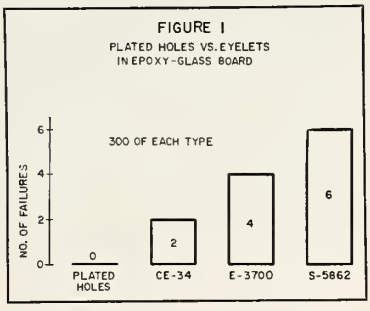
Of the several methods to produce a printed wiring board, we have found the copper-clad and etching method to be the most reliable. Remember that I am considering military-type boards only.

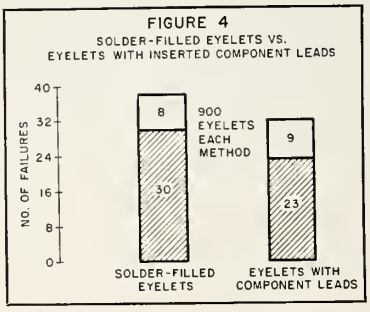
Some other methods involved have shown signs of potential breakdown either in a cold-copper joint, or erratic adhesion to the laminate and other fabrication defects.

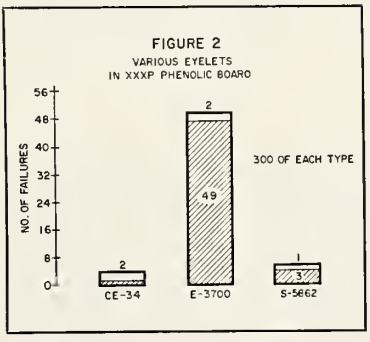
To produce a high-quality military-type printed-wiring board is definitely a "state-of-the-art" program and shall continue to be so as long as reliability is the key to the success of missile/aircraft vehicles.

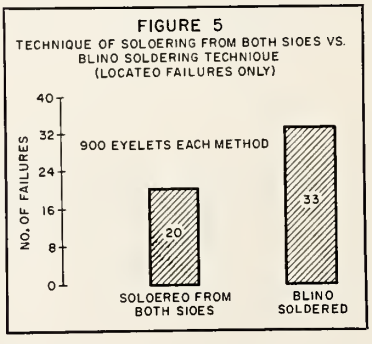
TEST RESULTS

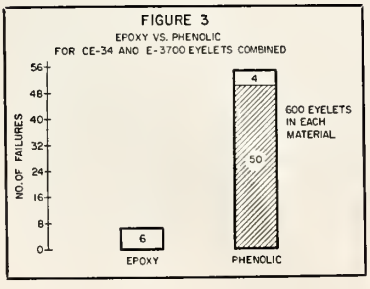
Light areas show unlocated failures; shaded areas show located failures.

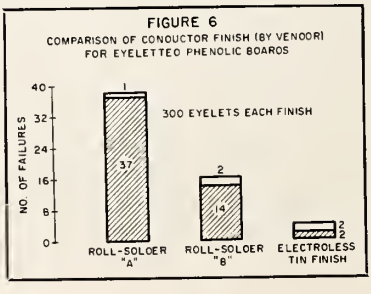












ITT Monitor Guards Launch Communications

CHICAGO—An automatic monitor to watch over and switch communication lines in case of trouble has been developed by **International Telephone and Telegraph Corp.** for the *Atlas* project. Designed primarily to assure uninterrupted voice communications during missile launches, "Commswitch" has possible future applications in such areas as teleprinter circuits, telemetry, and stock tickers.

In its present application, the unit "listens" to a phone conversation and automatically switches to an alternate line in case of excessive noise, change in transmission characteristics, distortion, or line break. Maximum operating distance—either on landline or equivalent microwave relay—is 60 miles.

Circuit Elements Mounted in Module

MENLO PARK, CALIF.—A new "window frame" technique for mounting transistor circuit elements in a compact module has been devised by **Stanford Research Institute.**

Two sets of eight elements are mounted back to back in the hinged frame and one connector serves all 16 circuits.

RAF Thor Base

(continued from page 11)

rons, Nos. 1 and 2 got individual training in the United States and crew training actually on the job in England. Nos. 3 and 4 got or are getting individual training at the U.S. plants and crew training at Vandenberg AFB, Calif. All of the crews will rotate back to Vandenberg for practice firing training.

In discussing the entire RAF missile training program for the *Thor*, Duncan Sandys, British Minister of Defense, said that he was immensely impressed by the speed with which it has been carried on and he paid especial tribute to the USAF and to the Douglas training program. He thought the *Thor* tests carried out in the States proved that it was becoming more reliable every day and that we were rapidly approaching the day when it would be regarded as a normal operational weapon, much as today's bombers are regarded.

Sandys referred to the missile, incidentally, as a successor to the manned bomber, although his RAF leaders feel —as do most USAF generals—that it now only complements the manned aircraft and will do so for a long time.

• **Made in Britain**—As a follow-on to the *Thor*, Defense Minister Sandys said the RAF has coming up the *Blue Streak*, a 2000-plus-mile missile, 10 feet in diameter and about 60 feet long, roughly the size of the *Thor* but more powerful. It will also be used for scientific experiments, Sandys said, adding that the Woomera Test Range had been extended to test it. Making the one-stage *Blue Streak* are **de Havilland Propellers Ltd.** and **Rolls Royce,** with **de Havilland Aircraft** and **Sperry Gyroscope Ltd.** as associated contractors.

Air Vice Marshal Gus Walker, the RAF's new chief of information, came up with a new definition of an effective deterrent force for a group of American newsmen recently. He said:

"When Russia sets up a war game against the West, plays it and *loses*—then you have an effective deterrent."

The World War II RAF hero also noted the part the British Bomber Command plays in this deterrent force. It is "several times" as large as the SAC contingent stationed in England, he said, can carry either British or American nuclear bombs and—due to its forward location—would be the first manned force to strike the Soviet Union in case of war.

Mc/S/A Controlled Explosive Ordnance

for Missiles, Rockets, and Space Vehicles



GAS GENERATORS



EXPLOSIVE BOLTS



SAFE/ARM INITIATORS



PRESSURE CARTRIDGES



IGNITERS

Reliability



Modern Plant Facilities



Team



Our team of qualified Scientists and Engineers are trained to handle the most complicated problems encountered.

McCormick Selph Associates

HOLLISTER AIRPORT/HOLLISTER, CALIFORNIA

Vehicle Requirements

(*continued from page 20*)

with a nonstop range of approximately 250 miles. The range and speed both decrease as the travel conditions become unfavorable with increases in grade and/or rolling resistance. The range may be readily increased, if desired, by increasing the fuel capacity.

• Consideration was given to the various U.S. state highway regulations, since the vehicles will travel on the highways. For the heavier missiles, it will be necessary to upgrade, by special permit, the highway size and weight restrictions. Farm and construction equipment criteria will be used. The study will include separate delivery of the missile and booster to reduce G.V.W. and size.

• The chart on p. 19 is a summary depicting the principal state highway restrictions currently in effect. The summary is severely condensed, since the individual state highway regulations would fill several publications.

• Eight feet is the maximum prevalent vehicle highway width allowed today. With special permit, excess width allowance is granted by the various states to farm, earthmoving, and construction vehicles. In general, 12 feet is the maximum width allowable for mobile equipment subject to rail shipment, due to the restrictions of tunnel and multiple, parallel-track side clearances. Certain of the FMC concepts have exceeded the 12-foot width to obtain other design advantages.

• Height limitations vary from 12'6" to 13'6" in the various state highway laws. The height limitations are established from subway and underpass dimensions, public utility lines, traffic signal, electrolier, etc., clearances. Careful consideration has been given to the extreme length required for the transporter.

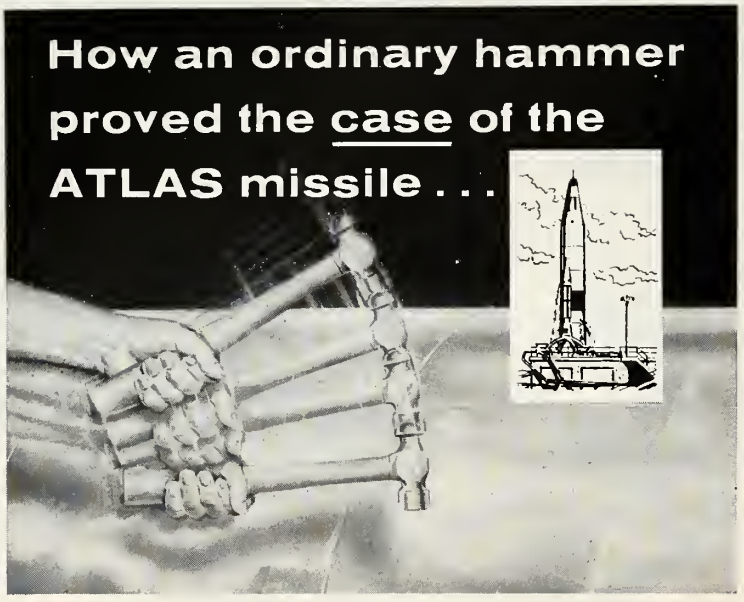
• **Shock effects**—The final problem that we will consider is the effect on the missile of shock imparted from the road as the wheels pass over various bumps or obstacles. At our high-speed test track and cross-country test course of FMC's Ordnance plant, we have performed tests to determine the shocks imparted to missiles under various transport situations.

During the *Navaho* program, the equipment shown in photo (p. 18) was instrumented for shock testing and tests were performed for highway transport. At speeds up to 15 miles per hour on our paved test track, the maximum shock load was .230; however, this was under the equivalent of good highway conditions.

We recently completed test for a 14,000 lbs. missile load equivalent being carried on a tracked vehicle. Under normally severe cross-country conditions it was found that a maximum of 3 g loads are to be encountered. Under severe tests which went beyond the realm of reasonable usage, shocks of 5.8 g were encountered for periods up to 20 mili seconds.

In summary, it can be seen that there are many factors to be considered if a large mobile missile system is to be designed. A careful study must be completed to predict operational requirements before military characteristics can be written for transport equipment. Predicting overly severe conditions will lead to overdesign—with increased cost and weight. On the other hand, if too optimistic views are entertained, the system will fall short on performance when severe conditions are encountered.

It can be readily seen that one important factor is relating the missile's physical characteristics to operational requirements for mobility. If the missile and its components cannot withstand the expected shock loads, then despite the mobility that is inherent in the equipment, the system will not function when required at a critical time.



The body of the missile, essentially one big fuel tank, is similar in principle to an inflated football. Convair-Astronautics broke new ground in missile design by developing a super-strong structure with a comparatively thin stainless steel skin to keep weight to a minimum. This stainless steel skin is so thin that the interior has to be pressurized to preserve the shape of the body as propellants are consumed in flight, or when the missile is being transported on the ground.

Some critics, however, thought the body was too fragile—"You could dent it with a hammer." So, recently, when the Scientific Advisory Board, engaged in a re-evaluation of all missile programs, arrived at Convair-Astronautics to take a reading on the ATLAS, they found that Convair had thoughtfully placed a number of hammers within easy reach of a finished missile. "Go ahead, bash it," invited Convair. The SAB members swung lustily. *Not a dent was registered*, for, although the walls are thin, the stainless has a minimum tensile strength of 200,000 psi.

This stainless steel skin material, supplied by Washington Steel, required extremely close control of mechanical properties and gauge tolerance which are regularly produced through Washington Steel's long experience with precision rolling equipment.

Stainless Steel—the Space Age Metal

Washington Steel Corporation

7-H Woodland Avenue
Washington, Pa.

soviet affairs . . .

By DR. ALBERT PARRY

The Red version of Project *Mercury* . . .

how well has it fared compared with the choice and training of our seven astronauts? The Soviets say and publish very little on their part in this momentous race. They talk instead about the training and flights of their twelve dogs and one rabbit.

Yet, Soviet spacemen-in-training do exist . . .

We hear that Moscow did sometime ago select five men for such conditioning. One of the five has since been killed in an accident, the nature of which had not been revealed. All five were World War II flyers, decorated for their feats in air combat. This much was told by Soviet space-medicine experts to our Brigadier General Don Flickinger, medical assistant to the commander of the U.S. Air Force's Air Research and Development Command, on the general's recent trip to Moscow.

Older than Project *Mercury* airmen . . .

Russia's would-be-spacemen were perhaps not as carefully selected as our seven candidates. General Flickinger concluded this, in part, from a certain surprise evidenced by the Soviet space-medicine men to whom he talked: they voiced their interest in the fact that the seven U.S. astronauts had particularly high IQ's. Was this a requirement? they asked. No, our general replied, it just happened that the American candidates who passed the stiff requirements of psycho-physical fitness have those high IQ's as well.

As to the Soviet yardsticks . . .

for their spacemen, it may be argued that if the Soviets had similar tough standards of psycho-physical fitness for their candidates, the latter might have also possessed keen intelligence and the Moscow doctors would not have been surprised by our men's IQ's.

On the other hand, we may speculate that the Soviet spacemen are not only flyers but have also been specifically trained in various advanced astro-sciences. This would make them almost invariably older than our men, and thus spared anything like our exacting standards of psycho-physical fitness applicable to younger men only. Yet, the older Soviet spacemen may be every inch of their brain as intelligent as our younger ones. The Moscow doctor's interest in our men's IQ's may be due to the fact that in Russia generally, IQ tests are seldom, if ever, used.

Soviet interest in *Mercury* is high . . .

This is seen particularly from the recent article in *Sovetskaya Aviatsia* on American methods of selecting and training of "cosmonauts," written by Dr. V. Borisov, a space-medicine expert.

An American film shown in Moscow recently was judged as of great value to Dr. Borisov and his fellow space-medicine men. This was the movie brought by U.S. delegates to the May 25-June 1 conference of the International Aeronautical Federation held in the Soviet capital. Dr. Borisov wrote that during the period of weightlessness, shown in the film clearly by the floating of a few unattached objects in the plane's cabin, the American flyers who were being tested "worked on a special installation with a large number of buttons and levers"—and the Soviet viewers obviously admired our flyers' movements "which were quick and well coordinated."

Particular impression in Moscow was made . . .

by these U.S. ways to overcome weightlessness: Item One—training an astronaut to float in the cabin during his weightlessness. This floating, Dr. Borisov observed, was done "dexterously," the floater's cycle of movements "greatly resembling the ordinary movements of a swimmer." Item Two—the use of special shoes with magnetic soles. Item Three—combatting the difficulty of drinking liquids while weightless. Dr. Borisov wrote approvingly of special vessels from which U.S. astronauts squeezed water directly into their mouths.

— review —

Forty-two years ago the Bolshevik leaders of the Soviet Union faced a hostile world with an air force limited to some 300 obsolescent foreign planes, a few Ilya Muromet bombers and a lack of spare parts.

Today the Soviet Air Force—with its bombers, its tactical fighters, its troop-carrying jets, its ICBM's and IRBM's—is the terror of the earth.

The detailed story of how this has come about is the core of *The Soviet Air and Rocket Forces* (Praeger, $7.50), an excellent new symposium edited by British Aerospace Expert Asher Lee.

But Lee, a former British intelligence officer and wing commander, and his fellow writers also do much more. Along with one of the best histories of modern Soviet air power to date, they also provide a provocative series of chapters which explore the Russian military mind and its effect on air strategy and tactics. In the end, a remarkably clear picture of the future of Soviet air power emerges.

Undoubtedly one of the most important conclusions that can be drawn is that if Lee and his associates are correct the United States will be most foolish indeed to write off the threat of Soviet manned bombers at least anytime in the next decade.

The book brushes aside Soviet Premier Khrushchev's statements that the bomber belongs in a museum as so much propaganda.

At the same time, Lee & Co. raise an even more ominous threat: The missile-launching Soviet submarine.

Soviet work on launching long-range missiles from submarines is, unlike the U.S. *Polaris* program, no comparatively recent development. Instead, it dates back to work by German scientists at Peenemunde in 1945.

So far, Russia has been developing two series of submarine missiles: the *Golem* and *Komet*, designed for firing from submerged submarines.

Lee and Robert Stockwell state in a chapter on Soviet missiles that the Soviet Union today probably has only a few dozen submarines capable of firing long-range missiles with any accuracy. However, they add: "With each year that passes the long range attacking power of Soviet submarines will become more important to overall Soviet strategy."

Finally, another warning from this many facted book is based on Russia's growing fleet of jet transports. These would be capable of rapidly transporting large numbers of Red Army units to distant points for seizing key positions—vital in a future atomic war.

—moscow briefs—

by Dr. Albert Parry

In summarizing the NATO's plans for rocket bases, two Soviet officers write in *Krasnaya Zvezda*, the daily organ of the USSR's Ministry of Defense, that "by the end of this year the United States proposes to implement 35 rocket bases in the countries of the NATO"; also that at the present time there are stationed in Europe 30 NATO divisions armed with missiles, which number by 1963 is to be increased to 100 divisions. The authors of the *Krasnaya Zvezda* article, Colonel V. Nagrebetsky and Lt. Colonel A. Kashcheyev, express their alarm and indignation over the increase of rocket armaments in Great Britain, Italy, Greece, and Turkey. They refer also to the American "pressure" on Norway to accept nuclear warheads for her missile weapons. In addition, they dwell on U.S. efforts to expand "the building of American rocket-nuclear bases and storehouses" in Canada, and to change the role of Canadian infantry in Europe by arming these troops with rocket-nuclear weapons "so as to enhance the attacking capacity" of Canada's foot-soldiers.

In another issue *Krasnaya Zvezda* reports that West Gemans are planning to have nine nuclear-rocket divisions, with 26 missile-launching sites and 288 rocket weapons "which will be delivered from the United States." *Krasnaya Zvezda* also estimates that nearly 1000 West Germans are now being trained in the United States to handle "military rockets with atomic warheads," and that some 2000 such West German officers and soldiers, completing their missile training in America, have already returned home, ready for their new duties.

The "militarization of the 49th state" is described in compact but ample detail by Lt. Colonel P. Kondrat'yev in *Sovetskaya Aviatsia* in a special article devoted to Alaska. He calls the newly admitted state "the springboard of American aggression in the Arctic . . . aimed to attack the Soviet Union and other Socialist countries." In his listing of U.S. bases and arms in Alaska he mentions the presence of the *Falcon* as a notable operational Air Force air-to-air missile.

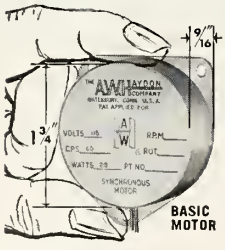
• **Rocket lit. watched**—U.S. and other Western literature on rocketry is being carefully watched in Moscow by the staff of *Izdatel'stvo Inostrannoi Literatury* or the Foreign Literature Publishing House, which, as ever other publishing establishment i Russia, is of course owned and run b the Soviet government. Books an articles deemed to be most importan are selected for translation into Russia for early Soviet publication. An out standing project is a nine-volume serie to which the Moscow editors gave th inclusive title of *Foundations of De signing Missiles*. The first of the nin books came out in 1958; the secon has just been published in Moscow.

This volume II is made up of trans lations from the English of articles b several authors, under three categories "Research of Operations," "Warheads," and "Launching of Missiles." It ha drawn a detailed review in *Sovetskay Aviatsia* by Lt. Colonel V. Tyurnin o the Soviet engineering troops, who i also a candidate of the technica sciences and holds a teaching post a *dotsent* in one of the academies. H pays particular attention to the book' data on ground-to-air missiles; also praises the "original and very simpl method of defining areas of possibl attacks by missiles" as explained i the volume.

But a greater part of the review i belligerently negative. Lt. Colone Tyurnin criticizes the "low scientific level" of the book, its "inexact expres sions and vague definitions," its gener alizing about missile warheads with out giving more precise details abou them, its paucity of information on re sistance of materals used in missil making. The Soviet reviewer com plains: "The small amount of valuabl data contained in the book is dissolve in the many pages of little or no worth." He also rebukes the Soviet translator and editors for preserving intact th original author's Western political viev of the Cold War. The *Sovetskay Aviatsia* writer warns the Moscow editors and publishers of Western litera ture to cut and prune while translating in sum, to be more "discerning."

• **Future sciences**—Astrogeology astrogeography, and astroclimatology are the sciences of the future, the foun dations for which are being laid by Soviet savants right now, according to I. Zabelin, a candidate of the geographic sciences writing in *Komsomolskaya Pravda*. The three new branches of human knowledge are concerned with novel methods of probing into our planet's structure and climate by comparing them with those of the Moon Mars, Venus and other planets. The writer names B. L. Lichkov and G. N. Katterfel'd of Leningrad and M. V. Stavos of Dnepropetrovsk as three of the Soviet scientists in the forefront of these new interests and techniques.

ANOTHER FIRST...



THE ONLY *Electro-Reliable* A.C. TIMING MOTOR

Thinner . . . Quieter . . .
More Reliable . . . More Versatile

FINGER-THIN . . .
Only 9/16 Inches Short . . . Only 1¾ Inches in Diameter . . . very compact . . . reduces the size of your equipment.

WHISPER-QUIET . . .
Strictly an electrical motor . . . practically noiseless . . . no rattling of gears or ratchets.

HIGH TORQUE . . .
¼ oz. inch at the rotor with an instantaneous start and stop . . . requires only 2½ watts . . . can replace larger motors in recorders, controls and telemetering equipment.

HIGHEST RELIABILITY . . .
Longer life . . . no one-way gears or ratchets to fail . . . provides millions of operations without any trouble.

SPECIFICATIONS

Standard Voltage Ratings: 6, 12, 24, 115, 230 Volts
Frequency: 60 CPS Standard, 25, 50 CPS Available
Power Input: 2.5 Watts Maximum (60 CPS)

BASIC MOTOR
Weight: 4 ounces
Speed: 300 RPM
Torque: ¼ oz.-in.
Length: 9/16 inch

WITH INTEGRAL GEAR TRAIN
Weight: 5 ounces
Speed: 300 RPM to 1/6 RPH
Torque: 30 oz.-in. @ 1 RPM
Length: ⅞ inch


WITH INTEGRAL GEAR TRAIN

© 1959

Send for Special Illustrated Bulletin AWH MO-806

The A. W. HAYDON Company
231 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Custom Design & Manufacture Of Electronic And Electro-Mechanical Timing Devices

NAA Help Wanted Ad Probed by Congress

A **North American Aviation** newspaper advertisement seeking a "military advisor to advise-counsel-report on high level management on military matters as they apply to long-range planning . . ." was poorly worded, a company official conceded to House investigators last week. The ad in the May 7 Wall Street Journal also said applicants should be "personable with high degree of speaking and writing ability" and have an Air Force colonel or Navy captain background, preferably with Joint Chiefs of Staff experience.

W. H. Yahn, vice president and general manager—NAA Columbus Division, in response to questioning told the Hébert Armed Services Investigations Subcommittee Joint Chiefs experience was sought because the company wanted a man who "plans ahead" and who could anticipate military needs by 5 to 10 years. The ad drew 70 responses, Yahn testified, adding that three men were under consideration. In an exchange with subcommittee counsel John Courtney, Yahn said the cost of the ad was charged to company profits instead of to allowable overhead on government contracts, and was probably an error. If that was true, said Courtney, NAA appeared to be promoting its own business with government funds.

Another witness, Gen. Omar Bradley, chairman of the board of the **Bulova Watch Co.** and head of the company's R&D laboratories, said no one in or out of the service had ever attempted to pressure him when he was a five-star general. Noting that several other witnesses had testified in the same vein, Rep. Porter Hardy (D-Va.) commented the investigation may be a "tempest in a teapot." But Chairman F. Edward Hébert (D-La.) said it was still the subcommittee's duty to air fully charges that firms were employing ex-military men to influence defense contract awards.

Ablating *Atlas* Recovered

The *Atlas* re-entry vehicle recovered July 21 after a 5000-mile flight down the Atlantic Missile Range was the biggest yet flown by the U.S., according to the **General Electric Co.**

Vehicle was more than 12 feet long, an elongated cone with a rounded nose constructed of ablation materials. A spokesman of GE's Missile and Space Vehicle Department in Philadelphia said the vehicle came through the test in "good shape." The cone carrying data equipment in the warhead compartment is described as one of a series of experimental models leading to a second generation ablating type ICBM operational re-entry vehicle. Recovery system, including after re-entry parachute deployment, balloon support after impact and radio-flashing light-dye marker locating devices was by **Cook Electric Co.,** Chicago.

Sylvania Data Facility Size Doubles in Year

Sylvania Electric Products Inc. is adding another 67,000 square feet to its Data Systems plant, Needham, Mass., where it is developing data processing systems for BMEWS and MOBIDIC. The new addition, to be completed by Sept. 1, will bring the plant size to 212,000 square feet—more than double the original size when Sylvania moved in 12 months ago . . . **Kurz & Root,** Appleton, Wis., producers of electrical missile support equipment are opening a manufacturing facility in Burbank, Calif. . . . A new firm—**Production Machinery Inc.**—has been organized at Des Planes, Ill., to import and market West German metalworking machinery. . . . **Applied Electronics Corp.** of New Jersey has moved into a 4000 square foot plant in Metuchen, N.J. . . . and last week, **Reeves Soundcraft** stock moved up to the New York Stock Exchange for trading . . .

Purchase of **Applied Science Corporation of Princeton,** N.J., for $3.8 million has been contracted by **Electro-Mechanical Research Inc.,** Sarasota, Fla. The agreement is still subject to stockholder approval. Both firms are in telemetry field.



Corvus Is Launched Successfully

POINT MUGU, CALIF.—*Corvus,* an air-to-surface missile for use by carrier-based Navy aircraft, has been flown successfully for the first time at the Pacific Missile Range test center.

The Navy, in announcing the July 18 firing, ended almost two years of speculation with the announcement that *Corvus* has a pre-packaged liquid engine. However, the propellant ingredients were not disclosed. Before the announcement, it had been generally believed that *Corvus* has a solid propellant system.

Temco Aircraft Corp. of Dallas, Tex., has the contract for development. **Thiokol** is providing propulsion. *Corvus'* guidance system will home on enemy radar. **Texas Instruments** and **W. L. Maxson** are working on electronic components.

The test vehicle was fired from a Navy A-40 Skyhawk jet fighter over a sea test corridor just west of here against an undisclosed target. *Corvus* is designed for attacking heavily defended areas, including surface ships.

Hearings Start on Nuclear Plane

by Erica M. Karr

WASHINGTON—Political, economic, military and technical questions are all wrapped up in development of the nuclear-powered aircraft, the Joint Atomic Energy Committee was told when it reviewed at public hearings, as M/R went to press, the 13-year old ANP program. This was the first public hearing after almost 50 executive sessions in the last 12 years.

The political question simply stated is: "What would be the effect of a Russian flight of a nuclear-powered aircraft on world politics?" Russia's big 6-or-8-engined Bounder, which has been seen flying, is—or could be—a prototype for a nuclear-powered aircraft.

Economic questions are also relatively simple. Estimates by Dr. Herbert York, Director of Research and Engineering at the Pentagon, indicate that it may cost as much as $10 billion to develop a weapon system. Congress and the American people will have to decide whether the investment is worth making. So far, over the last 13 years about $1 billion has gone into development of the nuclear power plant.

• **Varied potential**—From a military standpoint, what would the investment buy? Its potential for many uses has been discussed frequently. Basically, however, the Air Force—which has supported the program over the years—conceives of CAMAL (continuous air alert and missile launch and low-level penetration) as providing the post-attack reconnaissance capability not available from any other type of equipment. Without it, the claim is made, the U.S. would be blind once an all-out attack were launched.

Other potential uses include continuous air alert (obviously outside the borders of Russia) to gather information to be used by *Polaris* submarines, *Minuteman, Atlas* and *Titan* bases after an attack is launched, or as a virtually invulnerable mobile missile warehouse/launcher. The Air Force feels such an airplane has as much ability to hide in the vast expanse of air as a *Polaris* submarine has to hide in the ocean.

• **Hold-ups**—What are the technical questions holding up the program at this time? Perhaps the most important one is the engine. The Air Force position is that the direct cycle reactor under development at **General Electric** is far enough advanced at this time to warrant building two prototype aircraft so that problems of logistics, ground handling, crews, ground and air safety can be proved out while the engine is perfected or improved. This is under the current AF doctrine of concurrency; The Air Force estimates that if a flight test vehicle program is initiated now, actual flight reactor tests could get under way within 3½ to 4 years.

Actually, the current reactor is a relatively crude one with its metallic core. A later reactor at GE would have a ceramic core follow. The other engine (indirect cycle) at **Pratt & Whitney** is merely described as a more advanced concept. The Navy wants a turboprop engine. AF is talking in terms of a turbojet.

The Pratt & Whitney engine is two to three years behind the engine a GE. Here the question is: Does th U.S. want to buy time or does it wan to wait for the engine?

Air Secretary James Douglas an Air Force Chief of Staff Thomas D White are urging the fly-early program They argue that the U.S. must start t fund the flight program now if an oper ational aircraft is to be available whe it is needed.

"You don't start with your fina product," said one official in the pro gram. "You start with your curren capability."

GE Sees Promise in 'Tunnel Diode'

SCHENECTADY—A significant new development in semiconductor devices —the "tunnel diode"—shows promise of outstripping its older brother, the transistor, in many applications. **General Electric,** at work over a year in a concentrated research program, has just announced that limited quantities of experimental samples will be available within a few months.

According to Dr. Guy Suits, GE v-p and director of research, the tunnel diode offers considerable advantage over transistors in several areas. First, energy motion within the device takes place at the speed of light in contrast to the relatively slow speed of electrical charge carriers in transistors. The resultant high-frequency response will allow switching speeds 10-100 time faster than transistors. Also, oscilla tion frequencies higher than 2000 m have already been obtained; 10,000 m are expected in the near future.

The tunnel diode—which operate on a different principle and is smalle than a transistor—is little affected b environmental conditions. It operate at 650°F and is more resistant t nuclear radiation by a factor of 100 to one.

Dr. Suits predicts that before lon the device should find its way int many applications including high-spee computers, television and communica tion equipment, nuclear controls, satel lites and space vehicles.



COMPLETE transmitter, no larger than a half-dollar, contains one variable and tw fixed ceramic capacitors, a coil, and tunnel diode (in "can" at center of device)

propulsion engineering

Petroleum industry arguments . . .

which urge long-range plans to continue use of petroleum-derived fuels instead of jumping into synthesized "pure" compounds emphasize the high performance of available liquid hydrocarbons, their low cost and abundance. The whole industry's argument is summed up by M. E. Conn and W. G. Dukek, **Esso Research and Engineering Co.** Their argument makes sense. It is unfortunate that they represent a major petroleum company, as this might be viewed as detracting from the impartiality of their comments. However, regardless of their industry affiliation, what they say will find ready agreement among chemists, missile designers, military planners, and economists.

Only the coal industry can object . . .

to the Conn-Dukek proposal to meet our future missile fuel needs by deriving hydrocarbon fuels from petroleum streams. This eliminates coal tar starting materials and intermediates that are being examined as sources for the so-called "pure chemical" fuels. The end results often will be the same: Commercially acceptable chemical compounds which could have been derived either from coal or petroleum. The difference is that by processing petroleum streams, chemists eliminate many steps and cut costs. Besides, the petroleum fractions already are passing through refineries, and some of them even are wastes.

Strongest point in the argument . . .

is that there really is a difference between theoretical performance and attainable performance of fuels. Some inorganic propellant systems offer higher theoretical impulse and heat content than the polycyclic naphthenes that Conn and Dukek discussed at the recent Society of Automotive Engineers meeting in New York. However, they point out, the attainable performance depends on many other factors: thermal stability, vapor pressure, combustion characteristics, viscosity-temperature relationship, density, specific heat. Also, ease and safety of handling are important factors to consider in choosing a fuel. Conn and Dukek say—and, by their own means, prove—that liquid hydrogen is all-around best, hydrocarbons are in second place, next down the scale is hydrazine. Metal slurries and metal hydrides are tied for the bottom of the list.

Logistics arguments . . .

are just as impressive as are the arguments relating to performance, handling ease, etc. Conn and Dukek say these arguments are even more important. They point out that the Air Force believes that within five or ten years its requirement for high performance fuels for air-breathing supersonic missions alone may reach 100 million gallons/yr. We'll need 25 million gallons of liquid rocket fuel just for testing and development by 1965. The advent of multi-million pound thrust engines, using fuel at 10,000 lb/sec., could more than quadruple the needs. The Esso R&E scientists believe that only the nation's huge petroleum refineries can guarantee a steady supply of fuel at low cost.

The picture is not complete . . .

without a look at the major disadvantage—if the word applies—of the polycyclic naphthenes. Since these are actually petroleum fractions cut out of refinery streams, and not compounds synthesized especially for the purpose, the petroleum industry cannot guarantee absolute uniformity or constant quality. However, test procedures are available to match the fuel to the engine or mission. Besides, Conn and Dukek point out: "Even the basically superior uniformity of pure compounds may be difficult to realize in practice." If enough meaningful specifications are developed and applied to manufacturing operations, they believe the batch-to-batch uniformity or petroleum fraction fuel can be controlled to a sufficient degrcc.

Exceptional openings for **ENGINEERS** and **SCIENTISTS** in the field of **ELECTRICAL WIRE** and **EQUIPMENT**

Boeing, a contractor on the Minuteman solid-propellant ICBM and an industry leader in the development of advanced weapon systems, offers engineers and scientists a number of outstanding openings in the field of electrical wire and equipment.

Challenging, long-range assignments are available to qualified applicants interested in coordination and optimization of design requirements, coordination of design with test laboratories, compatibility, reliability and integration of wire and conduit, junction boxes, switch panels and all components and major subsystems of the electrical power distribution system as related to missile programs.

At Boeing you'll enjoy the benefits of a dynamic career environment that is conducive to rapid advancement and deeply rewarding achievement.

For further information, write today to:

Mr. Stanley M. Little
Employment Administrator
Boeing Airplane Company
P. O. Box 3822 - MRB
Seattle 24, Washington



BOEING
...environment for dynamic career growth



missiles and rockets

2nd ANNUAL MISSILE SUPPORT ISSUE

SEPTEMBER 21, 1959

From the magazine which is first and best in Missile Support—the most accurate picture available of the tremendous Missile Support field, which takes a big slice of every missile dollar. Penetrating articles and reports by recognized experts and experienced M/R staff members help you reach the heart of this multi-billion dollar market . . . through the pages of the technical/news weekly of the missile/space industry. Contact your *missiles and rockets* representative today, and find out how you can put your sales message before the men who make the important decisions concerning Support System equipment and capability.

NEW YORK CITY: 20 East 46th Street YUkon 6-3900 • DETROIT: 201 Stephenson Bldg. TRinity 5-2555 • CHICAGO: 139 N. Clark Street CEntral 6-5804 • LOS ANGELES: 8929 Wilshire Blvd. OLeander 5-9161 • MIAMI: 208 Almeria Avenue HIghland 4-8326 • TORONTO: 12 Richmond Street E. EMpire 4-2001 • LONDON: 28 Bruton Street GRosvenor 8356 • PARIS: 11 Rue Condorcet Tru 15-39 • GENEVA: 10 Rue Grenus 34 66 73

ADVERTISING FORMS CLOSE SEPTEMBER 1, 1959

M/R

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

vest coast industry . . .

By FRED S. HUNTER

Douglas Aircraft Co.'s ALBM (air-launched ballistic missile) contract is a study contract, but there is little doubt it will develop into a research and development contract before too long. Personnel assignments made to the project make it plain Douglas is confident R&D funding will follow without mishap. J. A. Gorgenson, heading up the program, has been appointed weapon systems manager, reporting directly to Leo A. Carter, vice president and general manager of the Santa Monica division. Both Gorgenson and Victor E. Crosley, assistant weapon systems manager, were brought over to Santa Monica from the El Segundo division originally to participate in preparation of the proposal which won the study contract for Douglas.

Strong projecting engineering group . . .

also has been established by R. L. Johnson, Santa Monica division missiles and space systems chief engineer. J. C. Solvason, former project engineer on the *Sparrow* series, is chief ALBM project engineer. His aides: H. E. Bauer, a former *Thor* project engineer, on missile aspects; S. L. Gehring, with *Sparrow* II and *Thor* experience, on missile support equipment; C. E. Starns, who also has a *Sparrow* background, aircraft support.

One of Hughes Aircraft's most popular . . .

vice presidents, Clarence Shoop, is demonstrating a remarkable capacity for assuming added responsibilities. Shoop began his career with Hughes in 1947, mainly in the flying end. One of his early jobs was chief pilot. As Hughes Aircraft expanded into electronic activities, he became director of aircraft operations and flight test. Subsequently, he was put in charge of product reliability and elected a vice president, but still retaining flight test. The other day, when R. M. Russell resigned as vice president-sales and manager of the international division, Shoop took on the international division and on top of his other duties became responsible for Hughes Aircraft's activities outside the U.S. And in addition to wearing three hats at Hughes, he is air chief of staff for the California Air National Guard, an administrative job carrying the rank of major general.

For the sake of secrecy the U.S. may test . . .

some of its missiles at the Woomera test range in Australia. We've had a team of experts there looking the place over. Situated in the Great Desert of Western Australia, the Woomera range was recently extended to a length of 1250 miles, and next year Britain will use it to test its 1500-mile *Blue Streak*. Cape Canaveral is close to a populated area and on flat ground. Vandenberg and Point Arguello are better, but the other day a cabin cruiser with a dead engine drifted within the three-mile limit off Arguello without being detected. A railroad cuts through Vandenberg and various roads bisect the region.

Only real secrecy the U.S. has ever . . .

achieved in rocket firings was with three Project *Argus* nuclear rockets fired from a Navy ship and exploded more than 300 miles above the South Atlantic last summer. Partial secrecy was managed in firing hydrogen devices above Johnston Island in the Pacific, but the flash was visible in Honolulu. In contrast, Russia's launching areas for long-range missiles are at Kyzyl Kum, near the Aral Sea, and at Kapustin Yar, 60 miles south of Stalingrad. Known impact areas are those east and north of Yakutsk in northeastern Siberia and in the Anadyr region even farther east.

They let no grass grow under their feet . . .

at **Lockheed.** No sooner had Lockheed acquired the **Puget Sound Bridge & Dredging Co.** than its missiles and space division brought the new Seattle subsidiary into a joint venture bid for the design of ground facilities for the *Minuteman.*

OPERATIONS ANALYST

You are invited to investigate unusual career opportunities with excellent futures in the science and engineering Laboratories of IBM. You will find this to be a unique opportunity to contribute original thinking to several important projects.

Our Laboratories are engaged in research and development of advanced electronic digital computers and control systems for the exotic-fueled B-70 strategic bomber, being designed to operate at altitudes of 70,000 feet and at speeds of more than 2,000 miles per hour. We have, in addition, projects in progress on future strategic air weapons, including global satellites, offensive bombardment space vehicles, and missiles.

Should have the ability to simulate tactics involving advanced weapons systems concepts, and derive methods for evaluation of operational effectiveness of alternate design concepts. An M.S. in Mathematics, or Physics with a thorough background in mathematics, and at least two years' experience in applying advanced mathematical techniques to weapons systems evaluation is desired. A knowledge of probability theory and linear programming techniques is also desired.

Salary commensurate with experience. Advancement based on merit. Employee benefits are among the best in industry today.

Please write, including resume, to:

Mr. R. L. Lang, Dept. 604G4
IBM Corporation
Owego, New York

IBM®

INTERNATIONAL BUSINESS MACHINES CORPORATION

contracts

ARPA

$4,046,119—**International Telephone & Telegraph Co.**, for ground-based communication stations for Project *Courier*.

$3,614,515—**Philco Corp.**, for Project *Courier* communications equipment.

$1,283,740—**Radiation, Inc.**, for Project *Courier* ground-based antennas.

NAVY

$23,500,000—**Pratt & Whitney Div. United Aircraft Corp.**, for continued work on the J-52 turbojet engine used in planes and missiles.

$4,500,000—**Northern Ordnance Inc.**, Minneapolis, for engineering and production of *Tartar* surface-to-air missile launching systems.

$2,400,000—**Beech Aircraft Corp.**, Wichita, Kan., for design, development, fabrication and production of a missile target system, including one prototype target.

$2,000,000—**Packard Bell Electronic Corp.**, for design and production of the ancillary test console subsystem, a portion of the *Polaris* automatic checkout and readiness equipment (subcontract from **Lockheed Missile and Space Div.**).

$300,000—**Arnoux Corp.**, Los Angeles, for design, fabrication and installation of telemetry data, receiving and recording station to be installed at Point Mugu.

$200,000—**Aeronutronic Systems, Inc.**, Glendale, Calif., for additional Pacific missile range instrumentation study.

AIR FORCE

$42,101,389—**Federal Electric Corp.**, Paramus, N.J., for operation and maintenance of the Distant Early Warning Line.

$1,706,469—**Convair Astronautics Div., General Dynamics Corp.**, San Diego, for installation of a new improved *Azusa Mark II* missile tracking system.

$794,200—**Lumen, Inc.**, Joliet, Ill., for miscellaneous projectors, instruction books and progress reports (missile support equipment).

$600,000—**Coleman Engineering Co., Inc.**, Torrance, Calif., for design and construction of missile ground handling equipment (two contracts, one for lift and transportation trailers and workstands for *Hound Dog* air-to-surface missile and the other for a missile nose cone transportation trailer for **Avco Corp.**).

$328,630—**Alabama Bridge & Iron Co.**, Talladega, Ala., for trailer and lift for aircraft and missile engines.

$192,500—**Food Machinery & Chemical Corp., Westvaco Chlor-Alkali Div., N.Y.**, for 110,000 lbs. of unsymmetrical dimethyl hydrazine for evaluation studies as a rocket fuel.

$158,743—**Recordak Corp.**, N.Y., for printer-process viewers, microfilm type (missile support equipment).

$107,640—**Consolidated Systems Corp.**, subsidiary of **Consolidated Electro-dynamics Corp.**, Monrovia, Calif., for high-speed digital data recording system.

$82,491—**Bell & Howell Co.**, Chicago, for 320 amplifiers with cover for use in 16 mm motion picture sound projectors (missile support equipment).

$80,284—**Leeds & Northrup Co.**, Philadelphia, for precision potentiometers and accessories (in addition to a previous award of $233,000.).

$43,430—**Pilotless Aircraft Div., Boeing Airplane Co.**, Seattle for technical data for *IM99A* missile components.

$29,911—**The Houston Fearless Corp.**, Los Angeles, for replacement parts for A-9 and A-11 processing machines (missile support equipment).

ARMY

$7,132,408—**Blaw-Knox Co., Power Piping Div.**, Pittsburgh, for *SM-65* iauncher facilities, Fairchild AFB, Spokane, Wash.

$1,900,000—**Martin Co.**, Orlando, for electronic equipment used in air defense coordination systems.

$1,891,532—**Western Electric Co., Inc.**, N.Y., for *Nike* spare parts and components (six contracts).

$1,447,333—**C. H. Leavell & Co.**, El Paso, Tex., for construction of guided missile maintenance shop at Pueblo Ordnance Dept., Pueblo, Colo.

$1,064,969—**Fred R. Comb Co.**, Minneapolis, for construction of SAC missile facilities located at Minot AFB.

$958,942—**Technical Construction Inc.**, Mobile, Ala., for phase II equipment for preflight evaluation laboratory at Redstone Arsenal.

$400,000—**Parabam, Inc.**, Hawthorne, Calif., for production of astrodome type shelters for the protection of missile tracking instruments.

$397,566—**Norris-Thermador Corp.**, Los Angeles, for T-238 rocket motor assembly.

$384,911—**Emerson Electric Co.**, St. Louis, for facilities for production equipment of *Little John* program.

$242,896—**Whaley Co., Inc.**, Birmingham, Ala., for construction of propellant development facilities at Redstone Arsenal, Huntsville.

$199,523—**Redding & Co., Inc.**, Baltimore, for construction of special AAA *Nike* missile field maintenance shop at Fort George C. Meade.

$188,037—**Emerson Electric Manufacturing Co.**, St. Louis, for pre-production engineering studies for rockets.

$141,245—**Orlando Welding & Piping Contractors of Orlando, Fla.**, for construction of guided missile liquid fuel facilities at Cape Canaveral Missile Test Annex, Patrick AFB.

$129,224—**Douglas Aircraft Co., Inc., Charlotte Ordnance Missile Plant**, Charlotte, N.C., for *Nike* spare parts and components.

$100,000—**The Siegler Corp.**, for the manufacture of special electronic test gear for the *Sergeant* missile (subcontract from **Sperry Utah Engineering Co.**, subsidiary of **Sperry-Rand Corp.**).

$99,650—**Atlantic Research Corp.**, Alexandria, Va., for solid-propellant rocket sustainer motor for automet test vehicle.

$93,428—**Western Electric Co., Inc.**, N.Y., for semiconductor diode devices.

$92,004—**Teletronics Laboratory, Inc.**, Westbury, L.I., N.Y., for various type oscilloscopes.

$65,000—**Bowmar Instrument Corp.**, Ft. Wayne, Ind., for the manufacture of a miniature servo-package to be used in the guidance system of the *Pershing* missile.

$54,502—**The Hickok Electrical Instrument Co.**, Cleveland, for signal generators.

$54,179—**Southwestern Industrial Electronics Co., Div. of Dresser Industries, Inc.**, Houston, for design of servo amplifiers for Redstone Arsenal.

$51,188—**Gilfillan Brothers, Inc.**, Los Angeles, for research work for twelve months to survey guided missile design practices including technical reports.

$49,435—**Ampex Corp.**, Los Angeles, for video tape recorder and head assemblies.

$39,873—**Midwest Research Institute**, Kansas City, Mo., for research and development on loading missiles due to atmospheric turbulence and wind shear.

$28,780—**National Research Associates, Inc.**, College Park, Md., for design, construction and demonstration of an operating mock-up of a minimum ground pressure vehicle.

$27,516—**Heiland Div., Minneapolis Honeywell Regulator Co.**, Denver, for six direct writing oscillographs.

when and where

JULY

The Denver Research Institute of th University of Denver, 6th Annua Symposium on Computers and Dat Processing, Stanley Hotel, Estes Park Colo., July 30-31.

AUGUST

Institution of Investigation of Biologica Sciences, Sponsor: Air Force Offic of Scientific Research, Aeromedica Div., World Health Organizatio Montevideo, Uruguay, Aug. 2-7.

Association of the U.S. Army, Annua Meeting, Sheraton-Park Hotel, Wash ington, D.C., Aug. 3-5.

American Astronautical Society, Secon Annual Western Regional Meetin Ambassador Hotel, Los Angele Aug. 4-5.

William Frederick Durand Centennia Conference, The Problems of Hype sonic and Space Flight, Stanfor University, Stanford, Calif., Aug. 5-7

Institute of Radio Engineer's Professiona Group on Ultrasonics Engineering First National Ultrasonics Sym posium, Stanford University, Stan ford, Calif., Aug. 17.

Institute of Radio Engineers, Weste Electronic Show and Conventio Cow Palace, San Francisco, Aug 18-21.

AFOSR/Propulsion Research Divisio Directorate of Aeronautical Science Office of Naval Research, Office o Ordnance Research & National Aero nautics and Space Administratio Symposium on "The Dynamics o Ionized Cases," Northwestern Uni versity, Evanston, Ill., Aug. 24-25.

American Rocket Society, Gas Dynamic Symposium, Northwestern University Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Science National Specialists Meeting, Symposium on Anti-Submarine War fare, (classified), San Diego, Calif Aug. 24-26.

Army-Navy Instrumentation Progra Annual Meeting, Symposium and In dustry Briefing, Statler Hilton Hote Dallas, Tex., Aug. 31-Sept. 2.

International Astronautical Federatio 10th Annual Congress, Churc House, Westminster, London, Aug 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Researc and General Electric Company' Missile and Space Vehicle Depar ment, Conference on Physical Chem

istry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkeley, Calif., Sept. 2-4.

Air Force Association and Panorama: Send Reservations to AFA Housing Bureau, P. O. Box 1511, Miami Beach, Sept. 3-6.

AFOSR/Directorate of Aeronautical Sciences, Office of Naval Research, National Science Foundation, Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Sept. 9-11.

Institute of the Aeronautical Sciences, Western Regional Meeting on Frontiers on Science and Engineering, Los Angeles, Sept. 16-17.

Instrument Society of America, 14th Annual Conference and Exhibit, Chicago Amphitheatre, Chicago, Sept. 20-25.

Standards Engineering Society, Boston Section Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, Conference and Exhibit, Chicago, Sept. 21-25.

Advertisers' Index

Avco Corp. 51
Agency—Benton & Bowles, Inc.

Bendix Aviation Corp.,
Bendix Systems Div. 4
Agency—MacManus, John & Adams, Inc.

Boeing Airplane Co. 45
Agency—Fletcher Richards, Calkins & Holden, Inc.

A. W. Haydon Co., The 42
Agency—Cory Snow, Inc.

Hughes Aircraft Co. 21
Agency—Foote, Cone & Belding

International Business Machines Corp. 47
Agency—Benton & Bowles, Inc.

Ling Electronics, Inc. 52
Agency—John Ramsey Co., Adv.

Lockheed Aircraft Corp.,
Missile System Div. 8
Agency—Hal Stebbins, Inc.

McCormick Selph Associates 39
Agency—Aircraft & Missile Consultants

Minnesota Mining & Mfg. Co.,
Magnetic Products Div. 6
Agency—MacManus, John & Adams, Inc.

Northrop Corp. 10, 26, 27
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Servomechanisms, Inc. 2
Agency—Hixson & Jorgensen, Inc.

Washington Steel Corp. 40
Agency—Cabbot & Coffman, Inc., Adv.

Western Gear Corp. 3
Agency—Adams & Keyes, Inc.

EMPLOYMENT SECTION

Bendix Aviation Corp.,
Bendix Products Div. 49
Agency—MacManus, John & Adams, Inc.

CLASSIFIED

AN FITTINGS & HARDWARE

Stainless, Aluminum, Brass, Steel. All sizes—immediate delivery from world's largest shelf stock. Buy direct from manufacturer. Lower prices—quicker service. Send for free wall charts showing complete line of AN & MS fittings and hardware. We also machine parts to your own special print.

ROLLINS ENGINEERING CORPORATION
950 Washington Blvd., Culver City, California



. . . and there's big opportunity at BENDIX—prime contractor for the TALOS MISSILE

If you have the qualifications, you can build yourself an enviable engineering career with Bendix—and enjoy living in one of America's fine residential and recreational areas.

Bendix Missiles has opportunities now for engineers of exceptional ability. You'll be in the technical forefront of your profession at Bendix, working with men who have sparked some of the most important technological achievements of our time. You'll have the use of facilities and equipment that are unmatched.

You'll enjoy a pleasant four-season climate, have excellent educational facilities available to you and your family, and have easy access to Chicago. Most of all, you'll find satisfaction in doing important work alongside men who are professional engineers. Mail the coupon today for a copy of "Opportunities Abound at Bendix Missiles".

Bendix PRODUCTS DIVISION Missiles

Bendix AVIATION CORPORATION



Bendix Products Division—Missiles
412A So. Beiger St., Mishawaka, Ind.
Gentlemen: I would like more information concerning opportunities in guided missiles. Please send me the booklet "Opportunities Abound at Bendix Missiles".

NAME _____

ADDRESS _____

CITY _____ STATE _____

NATO's Strength Backs West Berlin

While the ministers of the world's major powers debate the future of Berlin, a problem which is unavoidably bound to the future of all of Europe, General Lauris Norstad goes quietly and almost relentlessly about his job of strengthening the NATO forces which keep the Geneva meetings a debate and not an ultimatum.

The sword and the shield of NATO have become so legendary in the ten years of their existence that it now seems almost impossible to separate them from the national forces of the NATO nations. France, Britain and the United States are the Western occupying powers which guarantee the freedom of West Berlin. West Berlin, strictly speaking, is not part of NATO, even though West Germany is. Nevertheless, NATO is on record as supporting the position of the occupying powers and—while an attack on West Berlin nationals per se *would not* be an attack on NATO, an attack on any of the troops of the three Western powers in West Berlin *would be*. So, inevitably, NATO links itself to the freedom of West Berlin and publicly recognizes that encroachment there is no different than encroachment on any other free territory in Europe.

This fact rarely if ever comes out in the discussions which are held between the ministers of the East and the West, but it certainly cannot be far from the minds of Soviet leaders that in the Berlin situation Russia faces not just the three occupying powers but 15 allied nations and probably the greatest military force the Free World has ever seen in peacetime.

The sword forces of NATO are the great retaliatory forces—the big bombers of SAC and Britain's Bomber Command, plus the atomic Navy forces in the Atlantic. Just added—and NATO-committed—are the four squadrons of *Thor* intermediate range ballistic missiles now operational or becoming so in England, an addition of 60 atomic warheads aimed at 60 predetermined targets (see page 11). Joining them within a year or so will be two squadrons of *Jupiter* IRBM's stationed in Italy. And a little later two more *Jupiter* squadrons—one each in Greece and Turkey, most likely. These latter four will be under General Norstad's actual command as Supreme Allied Commander Europe and will comprise the first actual NATO atomic force. (Other nuclear forces, while supporting NATO, are under the command of their national leaders.)

The shield forces of NATO are 22 divisions of ground forces strung from Turkey in the south to Norway in the north, with the heavy concentration in the center. Many of these ground units are equipped with nuclear missiles and rockets, more are becoming so. They are supported, again from Turkey to Norway, by fighter planes many of which also carry atomic weapons.

The NATO goal for this shield force is 30 divisions; while not more important than the retaliatory forces, it certainly is no less. These 22 divisions, as one official expressed it, give NATO political and military flexibility. It is the force the people of the NATO countries can see and know about, watch flying overhead or wheeling through maneuvers. It is their visible protection against limited aggression. Like the sword force, its ability to react must be immediate and effective. And it is NATO doctrine that any unit should have a nuclear delivery capability if that is necessary to the unit's mission.

"This shield force of 22 divisions," the official said, "represents the difference between all or nothing—the difference between all-out war and knuckling under to Soviet demands otherwise."

The forces of the three Western Powers—France, Britain and the U.S.—in West Berlin are negligible, and it is the shield force of NATO which gives strength to the arguments of the Western Ministers in Geneva.

This shield force General Norstad continues to build up with inflexible will. A unit of the Italian army recently was equipped with the nuclear-armed *Honest John* rocket and has been trained by its U.S. allies to use it expertly. The Greek Air Force has been practicing for months in the delivery of atomic bombs by fighter planes and will be nuclear-equipped as soon as bi-country agreements can be worked out. Similar negotiations are underway with Turkey. New weapons supplant old as fast as they can be procured.

No one talks about NATO in the Berlin situation. It is just there, providing a great measure of the strength from which the ministers of the West maneuver.

Clarke Newlon

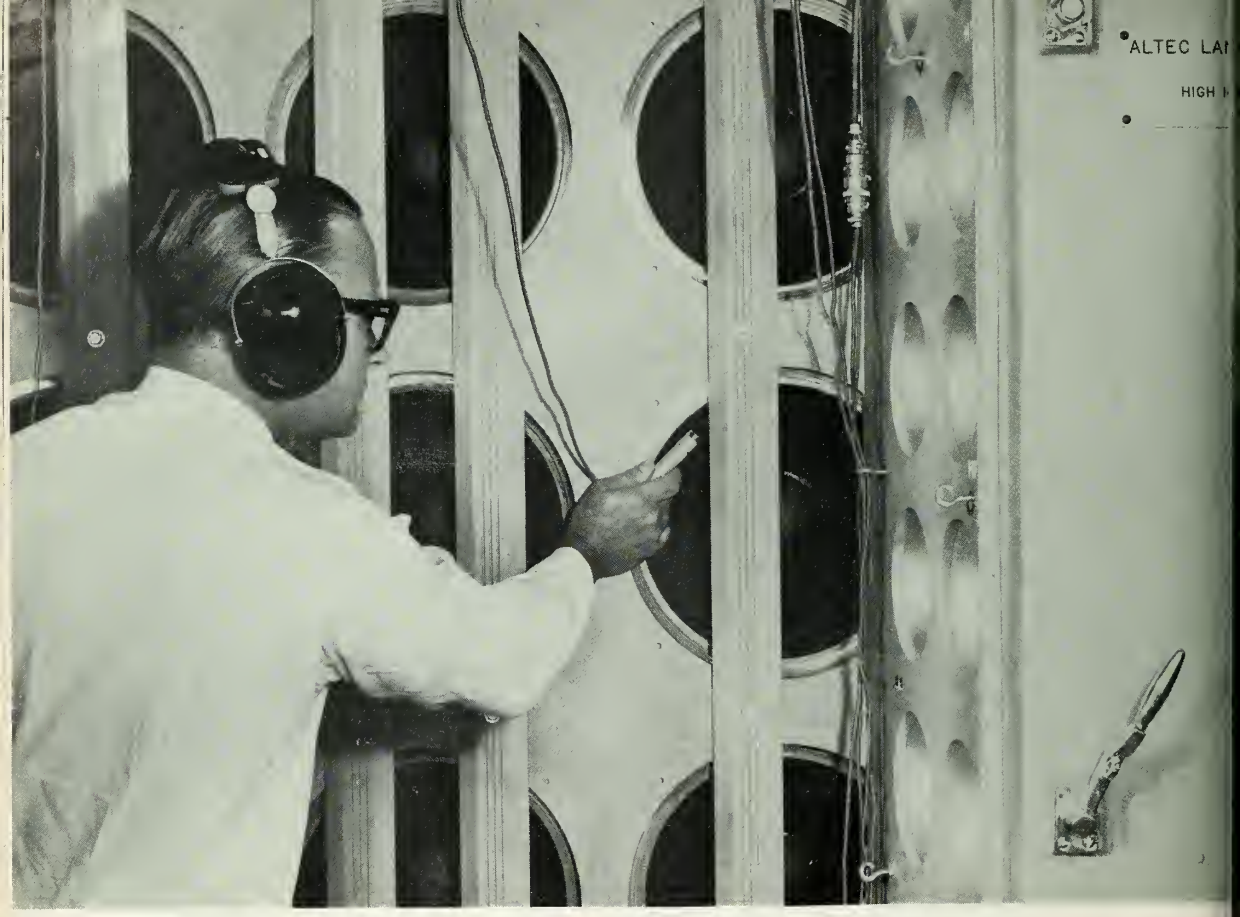


Avco and a Modern Minuteman—Recent work at Avco led to a solution of the missile re-entry problem, and to production of the nose cone for the Air Force Titan ICBM. Now the Air Force announces a development program for Minuteman, a solid fuel missile that will be capable of instantaneous firing with no preparatory fueling delays. Its nose cone, too, will come from Avco's Research and Advanced Development and Lycoming Divisions . . . implementing this modern Minuteman's vigilant defense of our shores.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY.

Avco

AVCO MAKES THINGS BETTER FOR AMERICA / AVCO CORPORATION / 750 THIRD AVENUE, NEW YORK 17, N. Y.



High Intensity Sound

a destructive, powerful force...a useful, versatile tool!

The destructive forces of high intensity sound – both in vibration and heat produced – are now better understood and better controlled through the use of testing chambers such as this latest Ling-Altec Reverberation Chamber.

Here, an Engineer adjusts one of the monitoring microphones in a chamber that can produce over 150 db of white noise – enough to equal the noise spectrum of the most powerful modern jet engines.

Even greater forces can be produced in Ling-Altec Plane Wave Tubes with air modulated devices which concentrate the power of high intensity sound many times.

These developments are a part of the continuing leadership of the Ling-Altec combination – high power electronics and high intensity sound!



LING

ELECTRONICS, INC.

Factory Sales Offices: 9937 West Jefferson Boulevard, Culver City, California
1515 South Manchester Avenue, Anaheim, California
120 Cross Street, Winchester, Massachusetts

AUGUST 3, 1959



ATOMIC ARMY'S
NEW REDEYE

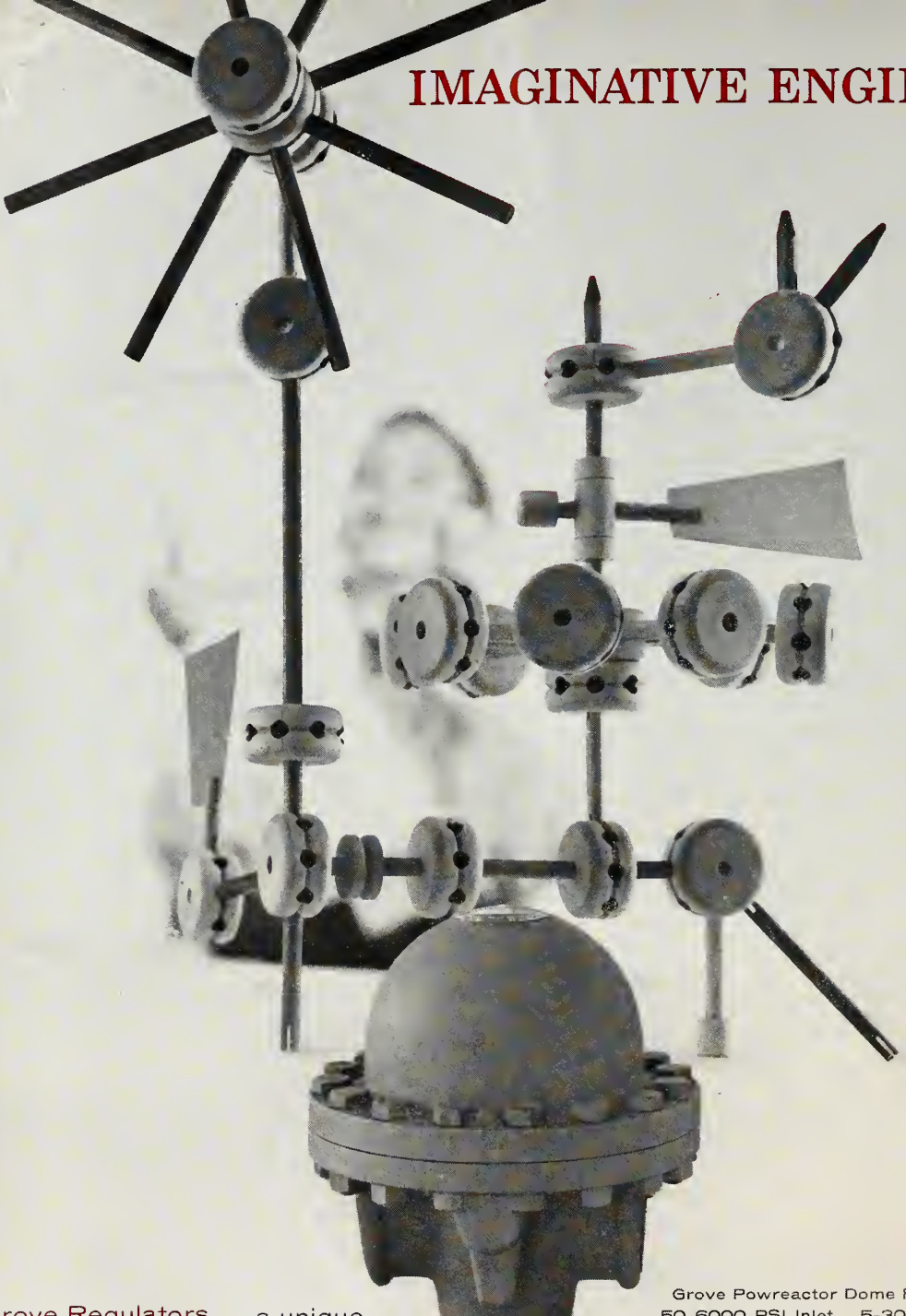
missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

ebert Intensifying Probe 10
laterials for *Dyna-Soar* 24
oblems of Electronic Cooling . . 38

AN AMERICAN AVIATION PUBLICATION

IMAGINATIVE ENGINEERIN



Grove Powreactor Dome Regulator Model GH-
50-6000 PSI Inlet...5-3000 PSI Reduced Pr
Grove offers a wide variety of regulat
various pressure and flow con

Grove Regulators . . . a unique engineering achievement which revolutionized the control of high pressure fluids. That's why for over 20 years—fro first missile experiments in the Navy Experimental Station at Annapolis, to the laun pads of Canaveral and Vandenberg, Grove has been setting the standards for the co of high pressure fluids. Grove Regulators—often imitated but never equalled in desig performance. Unmatched simplicity, accuracy, safety.

GROVE VALVE and REGULATOR COMPANY

6529 Hollis St., Oakland 8, California • 2559 W. Olympic Blvd., Los Angeles 6, California

Subsidiary of Walworth



for Communications

on the Missile Base Complex...

come to the experts!

DuKane electronic communication systems provide the vital network of instant voice communication which literally ties together such installations as Fort Churchill, Patrick AFB, and White Sands. DuKane offers the broadest, most flexible, most versatile line of custom-installed communication systems in the industry. For an installation involving a few persons, or hundreds, DuKane's experts can help you design and specify a communication system which will fill your needs. Why not ask for their help? *Write or wire DuKane Corporation, Dept.MR-6,St. Charles, Illinois*

If you specify electronic equipment, ask also for DuKane's chart of electronic equipment symbols.

DuKane Products are installed and serviced by a nationwide network of factory-trained experts

DuKANE CORPORATION
St. Charles, Illinois

...b-engineered sound installations ... Flexifone intercom systems ... Private automatic telephone systems ... Hospital ...mmunications systems ... Ionovac hi-fi tweeters and ultrasonic generators ... Sound slidefilm projectors for education and industry ... Electronic production facilities for industry and for defense.



Executive Editor .....CLARKE NEWL
Managing Editor ....DONALD E. PE

NEWS STAFF
News Editor .....REED BU
Defense and Legislative .....BETTY OSW
JAMES I
West Coast .....RICHARD VAN OS
Copy Editor .....ERICA E
Editorial Assistant .....DAVID NEWI

ASTRIONICS
Guidance and Control ....CHARLES D. LAF
Support Equipment .....HAL GETTI

ASTRONAUTICS ENGINEERING
Chemistry & Propulsion .....JAY HOL
Astrodynamics .....PAUL ME

MISSILE SUPPORT
Installations and Equipment
East Coast .....WILLIAM E. HOW
West Coast .....FRANK MCGI

BUREAUS
Los Angeles .....FRED HUN
Paris .....JEAN-MARIE RI
Geneva .....ANTHONY VANDE

CONTRIBUTORS
British Astronautics .....G. V. E. THOMP
Propulsion .....MICHAEL LORE
Industry .....JAMES J. HAGGERTY,
Soviet Affairs .....DR. ALBERT PA
Space Medicine .....DR. HUBERTUS STRUGE
Astrophysics .....DR. I. M. LE
Research .....HEYWARD CANNEY,

ADVISORY BOARD
DR. WERNHER VON BRAUN . ROBERT P. HAVIL
DR. PETER CASTRUCCIO DR. ARTHUR KANTROV
KRAFFT EHRICKE DR. EUGEN SAE
R. F. GOMPERTZ ALEXANDER S

PRODUCTION AND ART
Art Director .....WILLIAM MA
Assistant Art Director .....BACIL GU
Production Manager .....J. F. WA
Ass't Production Manager .....ELSIE G

BUSINESS STAFF
Publisher ..... E. D. MUHL
Advertising Sales Manager .....W. E. BR
Eastern Advtg. Manager ..... P. B. KIN
Circulation Director .....L. L. BRET
Promotion Manager .....J. E. MU
Advtg. Service Manager ..MRS. GLADYS BUS

ADVERTISING OFFICES
New York ..(17 East 48th St.) P. N. ANDER
A. B. SCHEF
Detroit ...(201 Stephenson Bldg.) K. J. WI
Chicago .....(139 N. Clark St.) G. E. YO
Los Angeles .(8929 Wilshire Blvd.) J. W. C
C. R. MARTZ,
Miami .....(208 Almeria Avenue) R. D. H
Toronto (12 Richmond St. E.) ALLIN ASSOCI
London .....(28 Bruton St.) NOBALL & F
Paris .....11 Rue Condo
Geneva .....10 Rue Gre

Missiles and Rockets Volume 5 Number

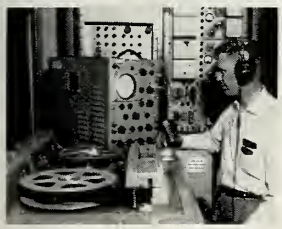
Published each Monday by American Avia Publications, Inc., 1001 Vermont Ave., N Washington 5, D.C. Wayne W. Parrish, *Pr dent*; Leonard A. Elserer, *Executive Vice Pr dent & General Manager*; A. H. Stackpole, S. Hunter, Eric Bramley, Robert R. Parr *Vice Presidents.*

Printed at the Telegraph Press, Harrisburg, Second class postage paid at Washington, D and at additional mailing offices. Copyri 1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Post Union Nations—1 year, $8.00; 2 years, $12.0 3 years, $14.00. Foreign—1 year, $10.00; years, $18.00; 3 years, $26.00. Single co rate—$.75. Subscriptions are solicited on from persons with identifiable commerci or professional interests in missiles a rockets. Subscription orders and changes address should be referred to Circulati Fulfillment Mgr., M/R, 1001 Vermont Av Washington 5, D.C. Please allow 4 wee for change to become effective and enclo recent address label if possible.



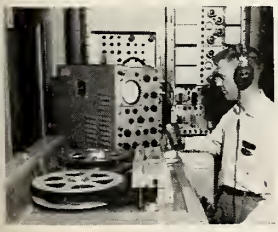
COVER: Details of Army's *Redeye*—fired like a bazooka, have been revealed. For this Convair development see p. 12.



BMD which is marking its fifth anniversary has had a radical approach to ICBM development such as the *Atlas*. See p. 11.



P&W's liquid hydrogen engine for tbe *Centaur* vehicle is undergoing full-scale test. For details see p. 20.



TAPE RECORDING industry is growing by leaps and bounds into multi-million dollar business. For details see p. 34.

missiles and rockets ®

MAGAZINE OF WORLD ASTRONAUTICS

AUGUST 3 HEADLINES

Hebert Has Hand Grenades Ready To Toss
'Munitions Lobby' inquisitors will try to match contracts with contracts and if they can—fireworks will start in earnest 10

BMD's 'Radical Approach' to ICBM Pays Off
Concepts of concurrency and central-direction responsibility produce ahead-of-time weapon systems 11

Redeye* and *Bullpup
Bazooka-type missile details released; Martin ASM becomes operational in Atlantic Fleet 12

ARPA Obligating $18 Millions for Solids Research 14

No Action Soon on Industrial Security
Three bills introduced in Congress but vote not expected before next session even in light of Supreme Court decision 16

ASTRONAUTICS ENGINEERING U. S. Reg. Pdg.

TV Watches Engine Case Tests
Newbrook Engine Corp. engineers learn how failure occurs by observing hydrostatic skin tests from safe vantage point 15

Centaur Engine Begins Full Scale Tests
Scheduling calls for P&W to deliver first operational liquid hydrogen engine to Convair in 1960 20

Inert Gas Brazing Room Proposed
Aerospace Industries suggest manufacturers study joint establishment of 'space room' for high temperature work on metals 22

What Can Withstand Re-entry Heat?
Bell Aircraft engineers find coated molybdenum, dense silicon carbide and coated graphite best for leading edge of boost-glide planes such as *Dyna-Soar* 24

MISSILE SUPPORT U. S. Reg. Pdg.

Where Are We Going in Fuel Handling?
The cryogenic engineer still must be a jack-of-all-trades with industry having to gear up for multi-million pound thrust boosters 28

ASTRIONICS

Detection of Nuclear Explosions in Space Possible by Optics
Two spectroscopes mounted in satellite proposed as method of surveillance 32

Magnetic Tape Recording Sales Booming
This year should see 700,000 units sold but most promising future applications will be in astronautics for photo-reconnaissance 34

New Techniques Aid Electronics Cooling
Basic methods of heat dissipation in components are the same but the applications can vary. Here are principal metbods 38

THE MISSILE WEEK U. S. Reg. Pdg.

Washington Countdown 7
Industry Countdown 9
More About the Missile Week 43

DEPARTMENTS

British Astronautics 31
Propulsion Engineering ... 42
Contracts 45
People 46
Letters 47
Missile Business 48
When and Where 49
Editorial 50

DOW | MAGNESIUM PRODUCTS



ARE YOU GETTING ALL THESE BENEFITS WITH YOUR MAGNESIUM CASTINGS?

Dow magnesium foundry offers experience, production capacity for sand and permanent mold castings of all sizes and shapes.

The unique capabilities of Dow's Bay City, Michigan, foundry help users of magnesium sand and permanent mold castings. Activities at this facility—largest and best equipped of its kind—run the gamut from large volume production jobs to one-shot "specials".

Huge or tiny castings. The foundry is capable of producing castings weighing in excess of 3,000 lbs. down to ounces—in all degrees of complexity. Experienced pattern engineers ensure that the best use of casting processes is made. This can result in either lower costs, improved quality, better deliveries, or a combination of all three.

Newest techniques. Many milestones in magnesium casting have been reached at this Dow foundry. In fact, Bay City has men permanently assigned to developmental work, keeping the foundry in the forefront of technological advances at all times.

Results of their work include special processes for cast-in inserts and tubeless passages, and improved melting techniques. Casting methods have been developed for many of the newer magnesium alloys, such as the elevated temperature group and the new high damping capacity alloy, K1A.

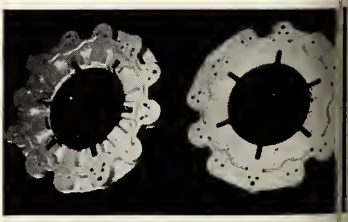
Quality control. A full time quality control team exhaustively checks all work, from alloy composition to the shipping dock. A direct-reading spectrometer makes rapid alloy composition analyses. Its speed is particularly valuable when alloying elements that are hard to hold in the molten state, such as thorium, are present. Chemical analysis is also frequently employed.

Testing facilities. Molding and sand cores are analyzed as a regular part of casting quality control. Radiography, fluorescent penetrant inspection and other testing facilities are used to check properties and specifications.

Experienced magnesium team. The foundry often draws upon the broad range of specialized experience available throughout the company. To Bay City customers, this means assurance of high quality work, done with utmost efficiency and economy. If your requirements involve magnesium castings, Dow can help you arrive at optimum casting design and reliably supply your production requirements.



THIS SAND CAST WAVE GUIDE was held to ±.0 on passageway dimensions. Surface smoothness quirements are 63 RMS. The foundry has governn approval for any phases of its operations where approvals are applicable.



THIS BRAKE CARRIER is sectioned to show how hydraulic lines were integrated by use of tub passageway casting techniques.



WRITE TODAY for this illustrated brochure discussing Dow foundry services. THE DOW CHEMICAL COMPANY, Midland, Michigan, Magnesium Product Sales Dept. 1303CLB-3.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGA

Washington Countdown

IN THE PENTAGON

A new type of guidance system . . . called *Fingerprint* is under consideration by the Air Force. **Chance Vought** is the developer. The system is proposed for use in *Slam*—the proposed supersonic low altitude missile that would be powered with a nuclear ramjet engine.

• • •

Project *Slam* . . . is still in the study stage. **Chance Vought, Convair** and **North American** are in the competition for the R&D contract. *Slam* apparently is being designed with the idea of getting past any Soviet-developed anti-missile missile.

• • •

Big new family of "pocket" missiles . . . designed for limited nuclear warfare can be expected to result from development of **Martin's** *Davy Crockett*. The secret Army missile with its fractional-yield nuclear warhead is designed to be fired like a rifle grenade. Next to be added to the new family of nuclear weapons probably will be **Martin's** *Bullpup*. (See page 12)

ON CAPITOL HILL

Deep slashes in the foreign aid bill . . . are worrying a number of defense-minded Democratic congressmen for political reasons. They fear the reductions in money slated to buy missiles for NATO undercut their fight for bigger defense expenditures at home.

• • •

Foes of a double congressional check-rein . . . on missile and aircraft procurement can be expected to try to kill it again next year. Meantime, it is certain to go on the law books with a 1962 effective date. The new provision will force the Pentagon to get congressional authorization of missile and aircraft procurement programs prior to getting Congress to vote the cash.

AT NASA

The proposed imperfect orbit . . . of the "paddle wheel satellite" *Thor Able III*, scheduled for launching Aug. 7 has been modified from an apogee of 30,000 miles and a perigee of 150 miles to an apogee of 20,000 miles with the same perigee. Reason: Though NASA scientists would like to test the multi-solar celled payload at the longer distance, the shorter apogee is designed to give the *Thor-Able* vehicle a better chance of performing the mission.

• • •

A competitor for *Thor-Delta* . . . the small satellite booster under development, is reported being proposed by ABMA and JPL. NASA recently cut *Juno II* and *Thor-Able* from its programs in favor of *Thor-Delta* on grounds they are uneconomical. ABMA now is proposing as a substitute a *Jupiter*-JPL 6K combination. The 6K is a second stage with an encapsulated, storable 6000 pound thrust engine.

• • •

Launching date censorship . . . of NASA space projects has put the space agency in the embarrassing position of having to deny what they know to be true. For example, English newsmen learned from NASA technicians at Jodrell Bank that *Thor-Able III* was to be launched June 7 and transferred this information to their American colleagues. NASA is under pressure from the White House and Cape Canaveral's Maj. Gen. Donald Yates not to release satellite launching dates before the fact.

AROUND TOWN

More large Soviet missile bases . . . are reported to be under construction in the Eastern European satellites. Iron Curtain sources report the Russians are closing off large tracts of land for the bases. The amount of heavy construction indicates that hardened sites are being built.

• • •

The Kremlin apparently decided . . . in advance of Vice President Nixon's Soviet tour that it might be a good idea to let him see a missile launching. A top Soviet source says Nixon's chances of seeing one looked good . . . all he had to do was ask.

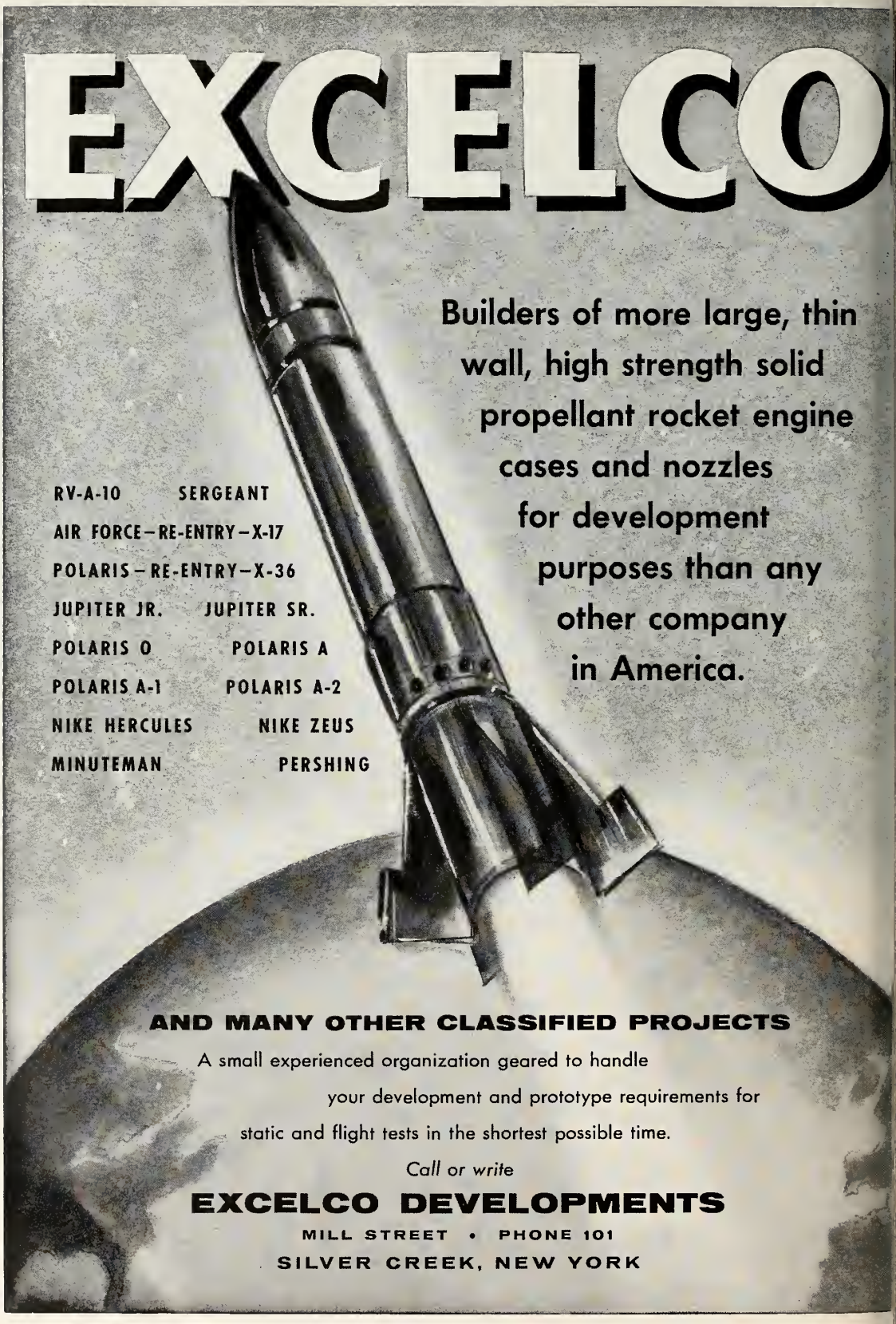
Some of the reports . . . that are being passed as the "latest" in the nation's capital:

. . . The Administration is determined to hold the budget line next year for the presidential campaign. It looks now as if only a major international flareup can change the decision.

. . . The U.S. radar net in Turkey has detected more than 30 Soviet failures to launch either ICBM's or space vehicles.

. . . Red China is putting new pressure on the Soviet Union for red missiles.

EXCELCO



Builders of more large, thin wall, high strength solid propellant rocket engine cases and nozzles for development purposes than any other company in America.

RV-A-10 SERGEANT
AIR FORCE – RE-ENTRY – X-17
POLARIS – RE-ENTRY – X-36
JUPITER JR. JUPITER SR.
POLARIS O POLARIS A
POLARIS A-1 POLARIS A-2
NIKE HERCULES NIKE ZEUS
MINUTEMAN PERSHING

AND MANY OTHER CLASSIFIED PROJECTS

A small experienced organization geared to handle your development and prototype requirements for static and flight tests in the shortest possible time.

Call or write

EXCELCO DEVELOPMENTS

MILL STREET • PHONE 101
SILVER CREEK, NEW YORK

Industry Countdown

STRUCTURES

Combat *Atlas* ICBMs . . .

are now in the hands of 704th Strategic Missile Wing missile troops at Vandenberg AFB. While Air Force is still ironing out bugs which showed up during recent test failures, these **Convair**-made missiles are considered "ready to shoot" in event of war. All changes resulting from tests are being programmed immediately into these missiles. Unit will not be declared operational until after the 6300-mile *Atlas* passes four or five more flight tests.

• • •

Proposals are descending . . .

on NASA at rate of 60 per month. About 250 have been submitted since January—two-thirds of them from universities and remainder from industry. Average proposal would cost $102,000. They range from such basic research projects as the physics of certain structures under stress to the R&D of instruments to be used for a space vehicle landing on another planet. NASA officials report that they are funding about 34% of the proposals at an average of $62,000 each. Their big problem: money. "We have more good proposals than we know what to do with," says one expert. "We can't afford to sponsor them all." Funding of proposals from universities comes from special $3 million account, while industry proposals are paid for out of R&D money.

• • •

The French will activate . . .

first *Nike* and *Honest John* missile battalions this autumn . . . Britain's **Bristol Aeroplane Co.** is running a feasibility study of Mach 7 commercial transport that would take off pick-a-back style with a separable booster weighing 250,000 pounds. Plane would be powered by both turbo-jets and rockets.

• • •

Answer to maiden's prayer . . .

or *Jupiter* nose cone production problem: **C. T. L. Inc.,** original developer of this country's first ablation nose cones for ballistic missiles, uses hand held hair driers to soften the glass phenolic laminate layers during stretching over *Jupiter* cone forms.

PROPULSION

Magnetic ramjets may be . . .

involved in new contract to **Fluid Dynamics Division of Ryan Aeronautical Co.** for development of Ryan "MiniWate" hollow core material as high-altitude propulsion device. AF Office of Scientific Research, ABMA and NASA's Ames Laboratory (which placed the contract) long have been interested in possibility of utilizing ionized upper air as a boost to efficiency of systems based essentially on ion acceleration. NASA-ONR-AFOSR sponsored symposium on dynamics of ionized gases Aug. 24 and 25 at Northwestern University may produce some interesting leads.

• • •

Process for electroplating . . .

metals on almost any material—including paper—has been developed by **Ethyl Corp.,** maker of gasoline additive. **United Car Snap Corp.** developed a method some time ago for electroplating metals on plastics. Such processes hold hope of weight reduction in solid rocket nozzles, which seem to be getting heavier and heavier as motor case weight goes down.

• • •

Way to overcome melting . . .

of aluminum powder in new solids, which reduces combustion efficiency, may be through alloying aluminum with zirconium, magnesium or lithium. Government researchers say this also may yield greater I_{sp}. But there is a problem—how to produce ultra-fine powders (say, 10 microns) of these alloys, particularly when Al-Li has the same nasty characteristics as Li alone.

ELECTRONICS

Look for Soviet approach . . .

perhaps at London IAF Congress next month for pooling of U.S. and Russian satellite tracking facilities. Reds admit they feel lack of tracking stations in Non-Communist world; figure U.S. would appreciate tracking data on Russian space vehicles. Pool would require prior notice of shots on both sides. The Russians make no mention of extending cooperation to military satellites.

• • •

EIA is supporting . . .

the Saltonstall bill designed to revamp procurement. EIA believes S.500 will provide flexibility in procurement by specifically authorizing competitive negotiation on an equal basis with formal advertising; and will speed up weapon system deliveries by eliminating advance determinations in making cost-reimbursement type contracts for R&D.

(Continued on page 43)

Hebert Has Hand Grenades Ready To Toss

by James Baar

WASHINGTON—So far the House Armed Services Subcommittee investigation of the so-called "munitions lobby" has taken on the aura of a relatively pleasant tennis match.

However, Subcommittee Chairman F. Edward Hébert (D-La.) can be expected shortly to try serving up a few hand grenades.

The subcommittee has spent most of the month since it opened its investigation listening to testimony from other congressmen, top military officials and retired high-ranking military officers now holding key jobs in the defense industry.

Both the unsensational conduct of the hearings and some superficial reports have given the impression in a number of quarters that the whole investigation is preparing to wander off somewhere and die.

This impression is very misleading. Actually the subcommittee has proceeded according to pre-established plans.

The subcommittee has sought to hear first from the number of prominent figures whose names were tossed about in the noisy developments that brought on the hearings. The second phase is scheduled to involve detailed examination of specific cases.

• **Testimony may be damaging**—Moreover, the testimony taken to date could well be far more damaging than it may at first appear.

One by one the witnesses beginning with Deputy Defense Secretary Thomas Gates have sat in the crowded subcommittee room and stated that they know of no attempts by retired military officers to influence defense contract awards by the Pentagon.

As Gates told the subcommittee: "All these contracts are made in the interest of the department and are not awarded on any other basis—friendship, influence or anything else."

Gen. C. S. Irvine, former Air Force Deputy Chief of Staff for Material and now an **Avco** vice president, testified bluntly: "If I wanted to make sure my company didn't get a contract, I would go talk to my successor and ask him to do me a special favor."

But under questioning most witnesses also said other things.

For example, Irvine agreed that he might be more readily listened to by a former junior officer who over the years had come to respect his judgment.

Others agreed that it certainly might be easier for a retired military officer to gain the ear of a former associate still in the Pentagon.

And Gates, himself, said that the president of a company was its "No. 1 salesman" and agreed that the company's board chairman was its "No. 2."

The new Deputy Secretary attempted at this point to draw a distinction as to what is meant by the term "salesman."

"What is selling?" he asked rhetorically.

"That is what we are trying to find out," Hébert snapped.

Since then subcommittee members have repeatedly quoted Gates as in identifying defense contractors' "No. 1" and "No. 2" salesmen.

• **Not enough testimony**—In all, the subcommittee already has enough of such testimony to state in its report if it chooses that a number of the nation's top present and former military leaders concede that the subtle pressuring of military officers by their former military associates is possible.

What is still lacking, of course, any proof that this is what has be happening.

That is what the subcommitt staff is already digging for as it si more than 5,000 questionnaires ma out by ex-military officers and e Federal officials now employed by c fense contractors. That—or the lack it—is what will make up the seco phase of the hearings.

The subcommittee can be expect to attempt to show that the award Contract X was influenced by alleg influence brought to bear by retir Gen. or Adm. or Col. or Cmdr. Y.

Nor for the purposes of bringi about new legislation need such e dence be capable of standing up in court of law. It needs only to be stro enough to convince Congress and t public.

The writing of any legislation th might result from the hearings wou be an extremely complex problem. many astute lawmakers have found the past, it is most difficult to legisla honesty.

However, several proposals have ready come up a number of times the hearings.

One would put some kind of b —say two years—on the hiring of r tired military officers for anything b technical jobs. Of course, such a li is most difficult to draw.

A second proposal is that Pent gon officers involved in the contra ing process be required to submit li of all who talk to them about contrac to all interested parties.

Other proposals are far mc drastic.

Whether any of them will ever enacted into law will depend on hc explosive Chairman Hébert's ha grenades may prove to be.

QUOTABLE QUOTES ON RETIRED OFFICERS

General of the Army Omar Bradley, now chairman of the board of the **Bulova Watch Co.**—*"The greatest contribution we can make is because of our experience in administration and organization."*

Rep. Paul J. Kilday (D-Texas), high-ranking member of the House Armed Services Committee—*"I take the position that no officer should retire and soon thereafter enter the employment of a contractor in a position which would give him an opportunity to have that contractor favored or even give the appearance of so doing."*

Vice Adm. Hyman Rickover—*"I believe it is where you get up to captain and admiral and it is in positions such as Washington representative or where due to their personal contacts (they) can influence policy."*

Rep. Samuel Stratton (D-N.Y.)—*"It would be a grave mistake if this committee were to proceed in the assumption that there is something inherently wrong with a retired c ficer going to work for a defense contractor . . ."*

Rep. Alfred E. Santangelo (D-N.Y.)—*". . . I sense odorous aura created by the extensive hiring of retir military personnel. This practice . . . smells to the hi heavens and races with missiles and aircraft to outer space*

Gen. C. S. Irvine, (ret.), now vice president of Av Manufacturing Corp.—*"You just can't go back and say a guy who used to work for you: 'You know, give me a ha sandwich.' You got to have a little pride."*

Rep. Porter Hardy Jr. (D-Va.), Hébert Subcommitt member—*"No military man or nobody else . . . would into the office of a procurement officer and say: 'Do me favor and buy what I have here.' I don't think it would done that way. But there are a lot of other ways to sk a cat."*



TWO YEARS of development time shaved off *Titan*.

BMD's 'Radical Approach' To ICBM Pays Off

Concepts of concurrency & central-direction responsibility produce ahead-of-time weapon systems

by Erica Karr

WASHINGTON—Five years ago this ıth Brig. Gen. Bernard A. Schriever ı over command of ARDC's new ıtern Development Division, set up accelerate the Air Force's ICBM gram. In a short half-decade the anization, which became the Air ce Ballistic Missile Division, ıched and proved out a revolution- approach to development of a pon system. Using the concept of currency (simultaneous develop- ıt of components), and turning over responsibility for engineering and nnical direction to the **Ramo-Wool- lge Corp.**, the AF ICBM program lved ahead of schedule, with an mated two-year shaved off develop- ıt of the *Atlas, Titan* and *Thor*.

Growing at first slowly from a ıp of less than 50, Gen. Schriever's entific community" expanded to to- 's 1600, backed up by the 3000 em- ed of **Space Technology Labora- es** (offshoot of Ramo-Wooldridge). In the long record of achievements, e highlights stand out:

• Re-entry—Bucking general scien- opinion, BMD proved through its es of tests with the *X-17* ballistic vehicle that successful re-entry was ible at more than 12 times the d of sound (July, 1956).

• *Thor*—First fully successful flight of the *Thor* 105 (September, 1957).

• *Atlas—Atlas* takes off without a hitch for the first time. (December, 1957).

• Capsule Recovery—Data from space was recovered with the capsule sent up at 10,000 mph in a *Thor* re-entry vehicle (June, 1958).

• ICBM flight—The first successful ballistic flight, impacting successfully after re-entry at ICBM range was achieved after second launch of a *Thor Able* (July, 1958).

• *Pioneer*—Deepest probe into space by a man-made object was *Pioneer I's* 71,300 mile journey during which it picked up data confirming existence of the Van Allen radiation belts and confirming they would not be insurmountable obstacles for man in space (October, 1958).

• Full-range *Atlas—Atlas* capability was confirmed when it flew 6300 miles (November, 1958).

• Operational *Thor*—First SAC launch of operational-type *Thor* took place three years after it was given ok for development (December, 1958).

• Multi-stage ICBM — Completely successful first test flight of the *Titan* launched the free world's second type ICBM—a multi-stage heavier and "more sophisticated" vehicle.



JOB OF BMD now is preparing for operational status of Atlas ICBM. Here is t concept of proposed facility at Warren AFB, Wyoming.



"FOUNDING" father of BMD was Brig. Gen. Bernard A. Shriever, now heading ARDC.

• Polar-launched satellite—*Discoverer I*, man's first polar-orbiting satellite circled the earth over 10 days. Weight with orbiting 2nd stage—1300 pounds (February, 1959).

• Re-entry vehicle recovery—*Thor Able* carried aloft a test vehicle which radioed back evidence of its successful re-entry and then was retrieved from the Atlantic Ocean where it impacted (April, 1959).

• Space Pix—First pictures of on-the-scene rocket separation were made by motion picture camera carried by *Thor IRBM* re-entry vehicle to 300 miles altitude (May, 1959).

Looking to the future, BMD has set for itself an ambitious long-range goal: development of integrated space forces, since "space is our newest military medium." Meanwhile, BMD's sights in the near future are set on perfection of the missiles now in being; bringing to maturity such second generation missiles as the *Minuteman*, concentrating on greater mobility and protection at launch and greater accuracy; development of a reconnaisance satellite, a satellite-launched missile, and an anti-missile defense system satellite (MIDAS).



Convair *Redeye* is fired from tube.

REDEYE AND BULLPUP

Bazooka-type missile details released
Martin ASM becomes operational in Atlant

by James Baar

WASHINGTON—The Army and Navy have publicly unveiled two of their latest missiles—the **Convair** *Redeye* and the **Martin** *Bullpup*.

One carries death over the battlefield to straffing jets. The other carries death to ground installations and ships at sea.

Development of both arises directly from needs learned in battle.

Army foot soldiers have needed a light, mobile weapon to strike back at ever faster tactical aircraft. So have the Marines. They will get *Redeye*.

Navy pilots have needed a substitute for costly divebombing. So has the Air Force. They will get *Bullpup*.

Both missiles pack conventional warheads. However, the Navy is understood to be planning development of a *Bullpup* with a nuclear warhead.

The Navy also is planning development of a super Bullpup with a conventional warhead. This would pack the punch of a 1000-pound bomb. The present model contains a 250-pound bomb.

The Army unveiled its formerly-secret *Redeye* for the 1959 annual meeting of the Association of the U.S. Army.

• **Redeye specs**—The four-foot long, solid missile is designed to be fired by one or two men from a tube similar to the bazooka. Its diameter is about three inches. It has infra-red guidance and undoubtedly has a proximity fuse. The entire weapon weighs about 20 pounds —some 15 pounds lighter than a bazooka of approximately the same size.

The *Redeye* program—now in an advanced R & D stage—was started before the Korean War. More than 5 million has been spent on it.

The missile is one of the first o a series of new secret missiles being veloped for arming an Atomic Army. Among the others are *Claym* and the Martin *Davy Crockett*.

Davy Crockett, a nuclear-tip missile designed to be fired like a grenade, is of particular interest in development of a nuclear *Bullpup*. generally similar fractional yield head would be used for both missi

The Navy demonstrated the ca bilities of the newly-operational *B pup* as part of a fire power show on the end of July from the Car Saratoga.

The carrier, which lay about miles off the Florida coast, launc three Douglas A4D Skyhawks arm with one *Bullpup* each. The th



FOUR FOOT long *Redeye* **has a diameter of about three inches and carries infra-red guidance.**



ENTIRE WEAPON weighs about 20 pounds, some 15 po lighter than a bazooka and probably carries a proximity f



HESE A4D's can carry three *Bullpups* if extra fuel is not required. Aircraft belong to VA-34 of CAG-3, NAS Cecil Field, Fla.

hter-bombers fired their missiles at oke pot targets floating on a rela-ely calm sea. One missile overshot target. Two scored direct hits.

The Mach 1.8 *Bullpup* is 11 feet g. It has a one foot diameter. It ighs about 600 pounds including a 0-pound conventional warhead.

The simply-designed missile is di-ed into three sections: The rear sec-n contains a solid motor and tracking res; the center, the warhead; the se, the command guidance and con-l equipment.

The *Bullpup* can be launched at a get from 12,000 to 15,000 feet away. e launching plane then follows the ssile part of the way in while the ot guides it with a thumb switch. e launching plane is able to pull out its dive while it is still one to two es from the target.

The missile is designed to meet two cific problems:

• Cut the high loss of aircraft ced to fly through heavy ground fire.

• Improve the reduced accuracy of nbs dropped by supersonic aircraft.

• **Deployed in Pacific**—Operational *llpups* were deployed for the first e aboard the Carrier Lexington in Pacific.

An A4D can carry three *Bullpups* t does not carry extra fuel tanks. **North American** FJ Fury can carry .

So far Navy pilots generally have nd *Bullpup* a highly reliable and urate missile. However, the principal blem confronting them at this time btaining enough for training. Most *llpups* now being manufactured are ed in the national war stockpiles.

The Air Force originally sought de-opment of a much more advanced ion of *Bullpup* known as *White Lance*. This plan now appears to be dead. Instead, the Air Force will buy a *Bullpup* with a few special modifications.

At present, the *Bullpup,* because of its relatively small warhead, is designed for use against such targets as bridges, tanks, pillboxes and similar ground installations.

However, the nuclear-loaded *Bullpup* would be capable of sinking any ship afloat. The Air Force also would presumably be interested in such a weapon for tactical use.

A *Bullpup* with a nuclear warhead would not need the great accuracy of the conventional models. It could be fired from greater distances and the launching plane would not have to follow it as far toward a target.

The peak destructive overpressure from a shallow underwater nuclear explosion carries much farther than it does in an air burst.

For example, only an 8 kiloton warhead detonated nearly a half-mile from an enemy ship would smash its hull with an overpressure of about 3000 pounds psi.

An overpressure of 3000 to 4000 pounds psi is considered sufficient to sink any ship of substantial construction. But even much lower overpressures can sink a ship or completely disable it. And overpressures of less than 1000 are considered sufficient to badly damage internal equipment.

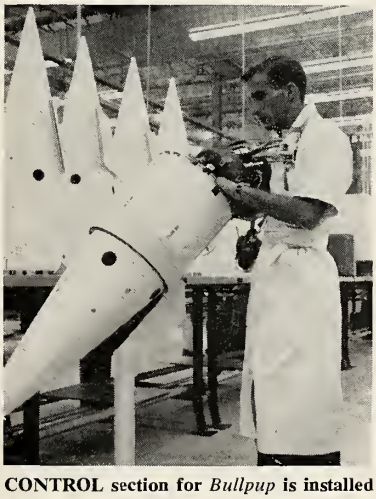
Finally, such underwater blasts even a considerable distance from a ship also result in damage to superstructures from both shock waves in the air and high waves.

• **Development of weapons**—Like *Bullpup, Redeye* and *Davy Crockett* are part of an overall attempt by both the Army and Navy to build up the nations limited war potential.

Such weapons are designed to enable a small force to mount sizeable firepower against an attack by much larger conventional forces.

Some observers have noted a trend in congressional thinking toward a greater buildup of such forces in the next few years. However, without a budget increase the billions that would be needed for such a buildup would have to come from funds that have been spent in the past for a buildup of U.S. strategic forces.

Moreover, there has been no indication that the cost of maintaining U.S. strategic power is about to decrease. Instead, with the coming of hardened missile sites and large-scale ICBM production, it is expected to increase.



CONTROL section for *Bullpup* is installed at Martin's Orlando, Fla. facility.

ARPA Obligating $18 Million for Solids Research

by Betty Oswald

WASHINGTON—The Advanced Research Projects Agency is spending a total of about $33 million for exploration in new high-energy solid propellants and supporting programs. Of this figure $18 million will be obligated in fiscal 1960.

The objective is to develop improved solid propellants with useful energy 10 to 20% above the solid propellants now being used. The net effect would be to double the warhead-carrying capacity potential of future intercontinental ballistic missiles.

Funding in 1959 amounted to $15 million spread over 54 contracts in seven broad research areas. As listed in a Pentagon Fact Sheet, they are:

• **Integrated programs:** $6,000,000—4 contracts. **Minnesota Mining and Manufacturing; American Cyanamid; Dow Chemical; Esso Research & Engineering.**

The integrated program concept involves thermochemistry, thermodynamics and performance estimates; chemical studies aimed at the synthesis of new ingredients; propellant formulation and compounding; and the study of the properties of the final propellant including ballistic and mechanical properties all in a single contract. The primary criterion for the selection of these contractors was the caliber and suitability of the scientific personnel available. The concept involves the definition of the research program in terms of the objective rather than in terms of ways and means of attaining the objective.

• **Propellant performance:** $1,720,000—11 contracts. National Bureau of Standards; University of California; Ohio State; **Arthur D. Little;** Bureau of Mines (Bartlesville); **Allegany Ballistics Laboratory; Aeronutronic Systems, Inc.; Rohm & Haas; Atlantic Research Corporation;** University of Chicago; University of Wisconsin.

A substantial program has been set up involving the selection and assembly of best thermodynamic values, performance calculations based upon these values, and kinetic studies aimed at the elucidation of processes which occur during expansion. These studies are providing a firm basis for the selection of those areas of chemistry which are most likely to contribute substantially to the desired goals.

• **Specialized synthesis:** $3,840,000—18 contracts. **Magna Products;** Penn State; Duke University; New York University; University of Florida; WADC, Materials Laboratory; Rohm & Haas; NOTS, NOL (Corona); **Olin-Mathieson; Allied Chemical; Callery Chemical; Monsanto Chemical; Pennsalt; Borden; Peninsular Chemresearch; Ethyl Corporation;** Atlantic Research Corporation; **National Research Corporation.**

The work under the integrated programs involves a large percentage of synthetic work. However, the necessity for new ingredients, if the objectives are to be achieved, recommends the placement of contracts concerned solely with synthetic work. This type of program will enable the DOD to obtain the services of laboratories especially highly qualified in certain branches of synthetic chemistry of special pertinence. The principal areas covered in the specialized contracts for synthesis already placed or planned include: new oxidizers, new light metal fuels, and research directed towards new chemical techniques.

• **Propellant research:** $750,000—3 contracts.

The new ingredients which are expected to become available as a result of the synthesis programs are likely to have properties quite different from those now used. This would recommend that new compounds be made available as quickly as possible to all major propellant research centers. However, it is also essential to preserve the Government's interest by seeing that compositions involving new ingredients do not become proprietary if the research is Government-sponsored. It has been decided that initial work on the use of new ingredients would be confined to certain laboratories which are free of proprietary restrictions. The designated laboratories are:

Ordnance Missile Laboratory; Naval Ordnance Test Station; Picatinny Arsenal; Naval Propellant Plant; Jet Propulsion Laboratory; Rohm and Haas, Redstone Division.

All propellant research on new ingredients coming out of ARPA synthesis contracts will be coordinated through the three Services.

• **High temperature research:** $900,000—8 contracts. Applied Phys Laboratory; Allegany Ballistics Labo tory; **Union Carbide Corporation; C nell Aeronautical Laboratory; Aton International; AVCO Manufacturi General Electric;** National Bureau Standards.

Present day high performance s propellants have flame temperatures the vicinity of 5000°F. Propella now under development may be s stantially hotter and accordingly, s ject the inert parts to extreme cor tions. It is necessary to have a resea program designed to solve this proble The research program planned invol the mechanism of ablation, proper of refractories, insulation studies, a a study of the pyrolysis of orga polymers. These programs are meant supply fundamental knowledge as the resistance of inert components high temperature.

• **Non-destructive testing:** This p gram is now being reviewed and de sions will be announced shortly. Due the fact that solid-fuel engines are coming successively larger every ye this has placed an ever increasing mand on the mechanical properties the propellant. Failures such as cra ing, separation from the liner and ar of porosity are likely to occur. Th faults can increase the burning surfa over that expected, leading to predictable and occasionally disaster pressure increases. Additionally, c tain faults may expose the wall surfa of the engine to high temperatures p maturely, leading to failures at oper ing pressures. Accordingly, an advanc solid propellant program should clude a substantial effort on techniq for non-destructive testing and insp tion. Failure criteria need to be veloped and instrumental methods the detection of faults require a gr deal of refinement. This program being reviewed for future funding.

• **Basic research:** $873,000—contracts. Bureau of Mines (Pittsburg Brooklyn Polytech; University of C fornia; Princeton University; **Aeroj General Corporation; Aerochemi Research Laboratory;** University Texas; **Stanford Research Institu Materials Research Corporation;** V derbilt University.

A variety of basic research progra involving many areas pertinent to t overall objective were set up throu the basic scientific offices of the th Services. These programs include study of detonation, the study of bu ing rate of solid propellants, meta able systems, ductile ceramics, ceran fiber-alloys, and various spectrosco studies of combustion products.

TV Watches Engine Case Tests

Newbrook Engine Corp. engineers learn how failure occurs by observing hydrostatic skin tests from safe vantage point

by Jay Holmes

SILVER CREEK, N.Y.—Closed-cir-uit television has been put to work sting rocket engine cases safely at a issile hardware plant here.

Engineers at the **Newbrook Ma-ine Corp.** have installed a TV camera side their hydrostatic test cell so ey can see just when, where, and what pressure a case begins to fail.

Newbrook, which manufactures ses for such large missiles as *Polaris*, *inuteman*, *Sergeant* and *Jupiter*, can st all of them in its cell. In most ses, observation by television makes possible to turn off the pressure be-re complete failure occurs. The otential failure is located precisely a small stream of water issuing om the spot. And the Newbrook en-neers know exactly how much pres-re causes the rupture.

Most hydrostatic testing of rockets is done in a closed chamber for safety. But without a TV viewer, cases are often tested to failure. And when they do fail, there sometimes is no way of knowing just where and when it happened.

Normally, the cases are tested for one minute at pressures up to 1235 pounds per square inch. However, additional pumps are available for pushing the pressure up to 10,000 psi.

The hydrostatic test is only one of several tests given rocket engine cases before they leave the Newbrook plant in this Lake Erie community. Hardness of the surface is checked with use of an instrument that measures magnetic and electric properties. This avoids damaging of the case in a diamond-point test. Other tests include tensile pulls, X-ray examination, bi-axial disc tests and hydrostatic tests of triaxial forces.



ELEVISION HELPS watch remote-control rocket-case test at Newbrook Machine.

A. J. Newman, Newbrook president, is confident that any metal can be welded to meet the exacting standards of the missile industry. As evidence, he showed a recent visitor dozens of cases tested to failure. In every case, the failure occurred away from the seam. "You have to do your welding properly," he said. "Close control is necessary. And you have to have welders who know their business."

Newbrook Machine is the second corporation started by Newman and Leroy Brooks, two engineers who set out on their own after World War II from the **Cornell Aeronautical Laboratory** in nearby Buffalo. They established **Excelco Developments Inc.** in 1946 and Newbrook in 1951.

They started small but have grown steadily. Employment now ranges from 200 to 250. Newbrook and Excelco say they have delivered more rocket engine cases for research and development than any other single vendor in the country to date.

Newbrook uses closed-circuit television for other uses besides watching what goes on in the test cell. A camera has been installed next to one bench where fine-tolerance machining is done. The worker can examine his piece of metal on an enlarged image in a television receiver above his head.

Another application is in maintaining plant security while showing customers the progress of their work. Often, work is being done on classified projects next to a civilian or unclassified job. In such a case, the customer may not be cleared to view the classified work. The solution is to point the camera at the unclassified job. Then the customer can view it on the office receiver.

Newbrook's facilities are sufficient for manufacturing the largest rocket cases that could be transported on a highway under a bridge. If he gets orders to build anything larger, Newman said, he will clear an area a half-mile away on the Lake Erie shore and fabricate at dockside.

No Action Soon on Industrial Security

Three bills introduced in Congress but vote not expected before next session even in light of Supreme Court decision

WASHINGTON—It's becoming increasingly apparent that industry will have to play the "industrial security program" by ear until the next session of Congress. This means that defense contractors will have to continue to follow the elaborate set of rules established by the Defense Department which are applicable both to military and National Aeronautics and Space Administration contractors.

Trouble will come only in those cases where a charge is made that an employee constitutes a security risk. A discharge of such an employee, even if ordered by the Pentagon, could cause trouble in view of the decision of the U.S. Supreme Court in the Greene case. There the high court held that the industrial security program was invalid since it was based neither on legislation nor an executive order of the Congress.

Seemingly this meant that the program could be revalidated by the simple act of issuing an executive order. However, there is language in the opinion of Chief Justice Warren which points to a new concern that those charged with being security risks must be given the right to confront their accusers. This language runs squarely counter to the basic security tenet that it is essential that informers and information gathered in so-called "raw" files be protected. Efforts to solve this problem have not been successful, and both the White House and the Justice Department continue "to study" the possible solutions.

• **Bills offered**—In the meantime, three bills have been introduced. Two (S2392, S2146) have been referred to the Senate Judiciary Committee but have not yet been assigned to a subcommittee for hearings. On the House side, one bill has been introduced. It's HR8121, introduced by Rep. Francis E. Walter (D-Pa), head of the House Un-American Activities Committee.

That Committee has asked for reports from the affected executive departments but has not yet received replies. Until those replies are received, hearings are not considered likely.

On the Senate side, one bill, S2392, has been labelled as "emergency" legislation by its sponsors, Senators Olin D. Johnston (D-S.C.) and James O. Eastland (D-Miss.). It would establish legal authority for the industrial security program as required by the Supreme Court decision. It would not, however, touch the tricky constitutional question of the right of the accused to confront his accusers. In introducing the bill, Sen. Johnston commented that industrial security could thus be kept alive while Congress sought to determine what, if anything, should be done to solve constitutional questions.

The other Senate Bill, S2146, seeks to meet the right of confrontation head-on. Introduced by Senators Thomas J. Dodd (D-Conn.) and Kenneth Keating (R-N.Y.), the bill, in the words of its sponsors, is designed "to eliminate unsupported charges by faceless informers in such cases by subjecting them to confrontation and cross-examination, and at the same time to protect regularly established confidential informants engaged in intelligence work for the government whose identity may not be disclosed without compromising the national security."

Under the terms of the Dodd-Keating bill, any person denied clearance for access to classified information or material or whose clearance has been suspended shall be given: (1) a written statement within 30 days showing the reasons, "stated as specifically and in detail as security considerations permit"; (2) an opportunity within 30 days to reply and submit affidavits in support of such reply; (3) a hearing, at his request, before a hearing officer designated for such purpose, who is required to prepare a recommended decision; (4) a review of the recommended decision by the head of the agency involved; and (5) a written statement of the decision of the agency head.

The bill spells out in detail how hearings shall be conducted to pro maximum opportunity for the acc to protect himself. It provides am other things that hearings shall be c ducted so as to assure "a full disclos of any evidence against the acc and confrontation of all adverse nesses."

• **Exception**—There is one imp ant exception spelled out. This w bar the right of the accused if a fin is made by the hearing officer agency head that the national secu public safety or public interest w be adversely affected. However, bill would bar reliance on "deroga information" as a basis for den clearance "unless the applicant has furnished a statement by the hea officer summarizing such informa in as much detail as is possible wit adversely affecting the national secu safety or public interest."

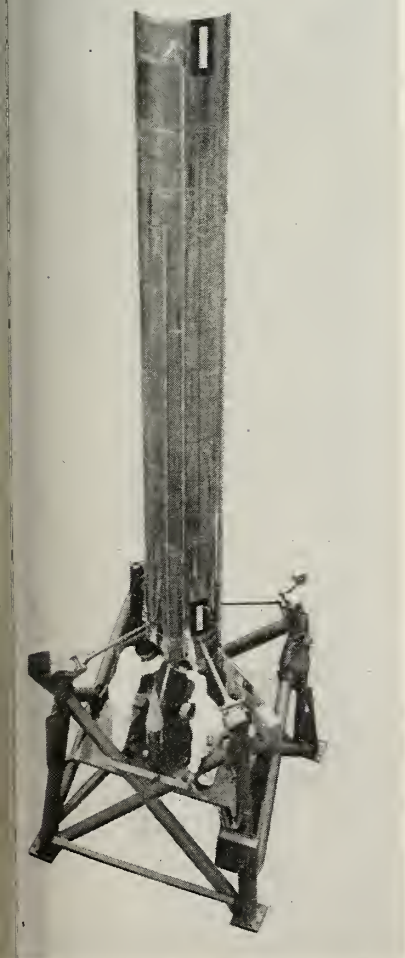
The bill also assures the right person who loses security clearance his job, as a result, to recover the ference between the pay he would earned if allowed to remain on the and his aggregate earnings during period in which his employment suspended or terminated. Obviou this right goes only to the man wins his case on review.

• **No action soon**—Despite fact that this bill comes close to m ing the goals set by the Supreme Co it is a virtual certainty that Cong sional action will be delayed until next session at the earliest. Infor sources say that lack of time a would dictate the delay. They add there is no particular urgency at time since defense contractors are erally playing along, and can alw pass on the bill to the Pentagon discharged employee successfully a fight for reinstatement.

Other tough problems include need for a definition of such term "derogatory" information, as well clear definition of the procedures u which adverse security decisions w be reviewed.



RESEARCH



BRISTOL SIDDELEY GAMMA ROCKET ENGINE POWER BLACK KNIGHT-BRITAINS HIGHLY SUCCESSFUL SPACE RESEARCH VEHICLE

On the 11th June, 19,000 lb. of thrust sent Black Knight to the threshold of outer space—500 miles above the Woomera rocket range in Australia.

This was the third successful firing *(there have been no failures)* and much of the credit for Black Knight's trouble-free performance must be given to the Gamma.

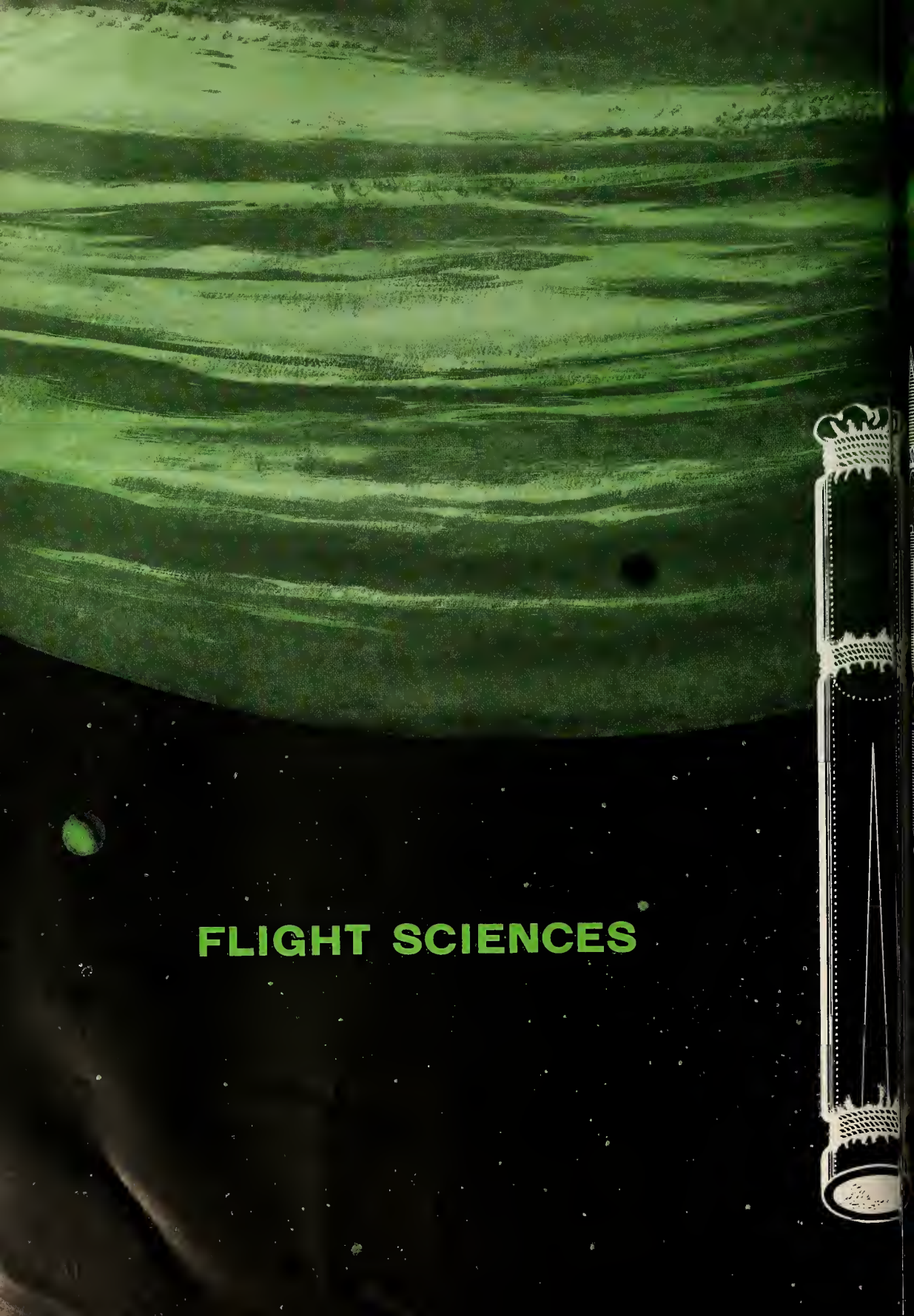
The Bristol Siddeley Gamma 201 is a liquid propellant rocket engine. Four trunnion-mounted chambers burn kerosene with HTP and each chamber is fed by its own turbopump unit. The complete weight of the engine compartment is less than 700 lb. (dry) and Gamma delivers 19,000 lb. at altitude—16,400 lb. at sea level.

Black Knight is a research vehicle and no military applications are planned. But the experience gained and lessons learned from this highly successful space probe will be invaluable in the development of Britain's IRBM—Blue Streak.

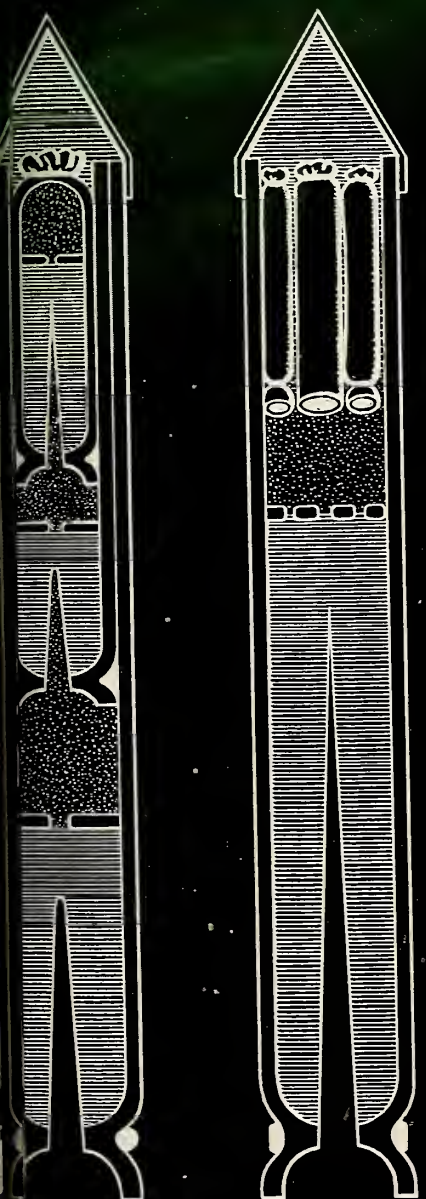
So impressive is Black Knight's performance with the Gamma powerplant that even more advanced applications are being actively developed. In fact, Black Knight coupled with Blue Streak is first choice to put Britain's projected space satellite into orbit.

Bristol Siddeley

ENGINES LIMITED


FLIGHT SCIENCES

FLIGHT SCIENCES: Principle of the step or multi-stage rocket, considered fundamental to the art of modern missiles and space flight, was set forth as long ago as 1650 by Kazimierz Siemienowicz, lieutenant-general of ordnance to the king of Poland. His design featured a 3-stage rocket with each step having its own gunpowder fuel, fuse, and nozzle.



EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Pioneering work at Lockheed is being conducted in free molecular flow in orbital flight; high altitude atmospheric properties; trajectory studies and missile flight dynamics; celestial mechanics with emphasis on orbital tracking predictions and de-orbiting.

Lockheed's capabilities in gas dynamics and thermodynamics are unsurpassed in private industry. Basic work is being performed in boundary layer flow and heat transfer; cooling and insulation; thermodynamic flight test; instrumentation; rocket motor controls and nozzle structures; reentry and materials; thin film thermometry; and measurements of dissociation and re-combination reactions.

Fundamental studies include hypersonic aerodynamics; environmental effects on satellite surfaces; magnetohydrodynamics; ultra-violet and infrared radiation from high temperature air flows; structure of hypersonic shock waves; new measurement methods; analysis of boundary layers near melting surfaces and study of lag or non-equilibrium in high speed flow through shock waves.

Equipment includes an electrically-driven wind tunnel—fastest in industry—which produces airflows to Mach 20-plus and stagnant temperatures approaching 16,000°F, with an instantaneous power output of 20 million kilowatts. A spark-heated, magnetically driven research shock tube produces velocities of over Mach 250 and temperatures of 500,000°F, and a specially designed, electric gun has accelerated projectiles to speeds approaching 20,000 ft/sec.

Major emphasis in structures concerns the design of reentry bodies, thrust termination and underwater launching devices. The Navy Polaris FBM required the solution of complex structural problems necessitated by the unique launching environment—water.

Other significant work has been accomplished in diversified aspects of aerodynamic and hydrodynamic load distribution, aeroelastic effects, studies of special dynamic problems arising from aerodynamic disturbances, cavitation, launching conditions and thermal problems relating to analysis of a complex structure taken through a complete time-temperature environment.

Lockheed Missiles and Space Division programs reach far into the future and deal with unknown environments. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. H-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed

MISSILES AND SPACE DIVISION

Weapons Systems Manager for the Navy POLARIS FBM; DISCOVERER SATELLITE; Army KINGFISHER; and Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

Centaur Engine Tests Begin

Scheduling calls for Pratt & Whitney to deliver first operational liquid hydrogen engine to Convair in 1960 for use in NASA's space vehicle Centaur, to be finished in 1961.

by Paul Means

WASHINGTON—The nation's first second generation space engine—**Pratt & Whitney**'s liquid hydrogen-liquid oxygen XLR 115 P-1—is scheduled for delivery to **Convair Astronautics** for integration into NASA's *Centaur* space vehicle in 1960.

Two years later, the high energy engine will be placed on top of ABMA-ARPA's million and a half pound thrust clustered *Saturn* booster for initial flight tests.

XLR 115 P-1, which will give the upper stage push to perform such missions as orbiting 24-hour communication satellites and sending man to the moon and back, is currently undergoing full scale developmental static run-up tests at Pratt & Whitney's Florida Research and Developmental Center at Palm Beach, Fla.



THRUST CHAMBER of XLR 115 is lifted onto test stand for static firing.

Its first use will be as the second stage of *Centaur,* which will have the Convair *Atlas* for its first stage, and optional use of JPL's 6 K, a 6,000 pound thrust storable propellant engine, for its third stage.

Upon receipt of the Pratt & Whitney engine, Convair has about one year, under present scheduling, to design and fabricate the second stage, and to integrate and test the complete *Centaur* vehicle before delivery to NASA.

• **Six vehicles slated**—The six *Centaur* vehicles NASA has contracted for are staged to come through in intervals of about two months during 1961 and 1962.

Project *Centaur* was funded for $22 million by ARPA in FY 1959 and for $42 million by NASA in FY 1960. Estimated individual cost of the first six *Centaur* vehicles is $7,500,000.

Early development of liquid hydrogen as a rocket fuel has been carried on for some years by NASA's Lewis Laboratories at Cleveland, and by the Air Force.

The low molecular weight fuel has a heating value of some 2.8 times that of kerosene. Its specific impulse when used with liquid oxygen is 391 compared to 300 for a LOX-kerosene combination, an improvement of about 40%. In spite of its low density and attendant large tank volumes, liquid hydrogen's better fuel economy allows for great increases in payload weights.

Before liquid hydrogen could considered seriously as a space vehi fuel, methods had to be devised whe by it could be produced with exacti standards of purity in great quanti and could be handled and transport safely.

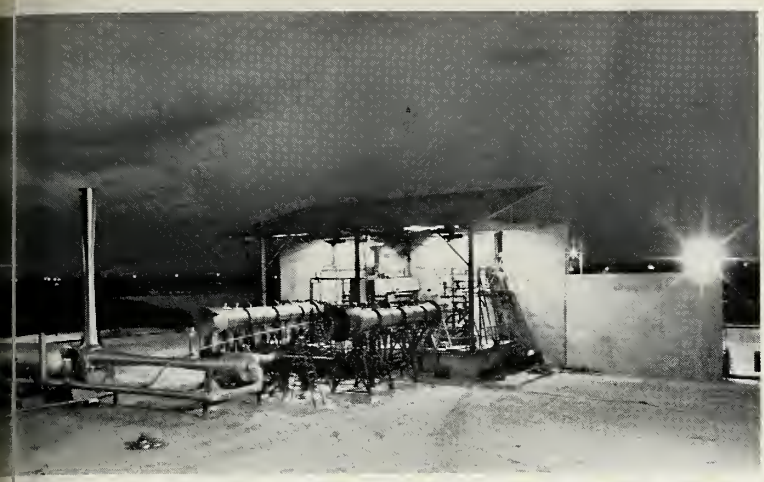
The U.S. Air Force, project sup visor of *Centaur* under ARPA, a retained in this role by NASA, beg large tonnage production of high pur hydrogen under contract to **Air Pro ucts Inc.,** at the U.S. Air Force Pla No. 74 in the Florida Everglades, r far from Pratt & Whitney's West Pa Beach facility. Other hydrogen pla initiated by the Air Force are an A Products, Inc. plant at Painesville, O and a **Stearns-Roger Manufacturing C** plant at Bakersfield, Calif.

AF Plant No. 74 combines cru oil, air and water to generate the g and then uses expansion turbines remove energy and liquefy it.

The liquefied gas is then shipp in Dewar tanks enveloped in nitrog to users. At the Pratt & Whitney W Palm Beach installation, the Air For currently is piping the fuel over distance of nearly half a mile in vacuum-jacketed pipe system.

The problems Pratt & Whitney fa in developing the first practical liqu hydrogen engine center around t fact that the cyrogenic material has boiling point of –422F°.

• **Quick disconnect necessary**—Since the Pratt & Whitney engine w be fired after the *Atlas* booster h carried it far into space, the fuel w have to be kept cold during the bas booster phase or the pressure in t tanks will rise to bursting point. Oth problems besides insulation inclu the necessity of keeping lines a



WILIGHT VIEW of Pratt & Whitney's double test stand for liquid hydrogen ocket engines showing the big tubes through which the engines fire.



PRATT & WHITNEY technicians prepare for an XLR 115 engine test.

umps from freezing, and the necessity making quick disconnects.

To counteract these problems, the ratt & Whitney test facilities simulate e space conditions under which the ngine will be fired by the use of yogenic plumbing, high-pressure gas rge systems, and a whole new techology of test instrumentation.

Rather than develop one 30,000 ound thrust engine for *Centaur*, P&W ngineers found it advantageous to uster two gimballed 15,000 lb. thrust ngines.

The XLR 115 P-1's components, nd full scale developmental models



HRUST CHAMBERS for *Centaur* ngine take shape in Pratt & Whitney's ssembly area.

are currently being tested on four large horizontal test stands constructed without government subsidy by Pratt & Whitney. The stands are designed to test engines up to 300,000 pounds of thrust.

A fifth and larger vertical test stand, jointly financed by the government and Pratt & Whitney, will have a capability of static testing a complete space vehicle, including engines and propellant tanks. This stand will be ready this fall—in time to begin the vertical testing of XLR 115-P-1.

The P&W engine will have a start-restart capability in flight, with sets of hydrogen peroxide rockets providing upper-stage altitude control during the coast period. The coast period, plus the high energy propellant, give the P&W engine a gain in payload weight of approximately 50% over *Vega* for similar missions.

Straightforward engineering progress should increase the thrust of XLR 115 in the near future from 15,000 lbs. of thrust to 20,000 lbs. of thrust.

• **Three more families**—Beyond the *Centaur* engine, P&W engineers are planning three families of upper stage liquid hydrogen eingines, one ranging from 10,000 to 30,000 lbs. of thrust, one from 30,000 to 100,000 lbs. of thrust, and one from 100,000 to 300,000 lbs. of thrust.

NASA has already indicated that engines from both the second and third families may be used on top of the 6 million pound clustered booster *Nova*.

And P&W engineers feel that progress in hydrogen engines will come with such rapidity that *Nova's* second and third stage hydrogen engines may be completed before the mammoth clustered booster is ready for them.

Though a liquid hydrogen-liquid fluorine rocket engine would be the ultimate chemical rocket engine, P&W engineers do not believe that the highly toxic oxidizer will ever replace liquid oxygen in liquid hydrogen engines.

They point out that liquid hydrogen's impulse is only slightly higher with fluorine than with oxygen, and there would be few missions which would require exploiting this advantage. On the other hand, hazards introduced by fluorine toxic and corrosive qualities should prevent its use as a propellant for manned missions.

DuPont Constructing Metals Research Plant

WILMINGTON, DEL.—**DuPont** will build a center for development research in niobium, niobium alloys and titanium at its Baltimore plant.

The installation, to be completed by the fall of 1960, will contain equipment to forge, extrude, roll, draw and heat treat all the refractory metals—such as tantalum, zirconium, tungsten and chromium. But it will concentrate on niobium and titanium at first.

F. H. Weismuller, general manager of DuPont's Pigment's Department, said basic research on other refractories will continue "while we engage in large-scale testing . . . of metals that are closer to commercialization."

The unit will be at a plant where DuPont has manufactured titanium dioxide white pigment for 28 years. The company has been interested in niobium, since known as columbium, since 1957, when it entered a joint development program with **Thompson Ramo Wooldridge Inc.** of Cleveland.

Inert-Gas Brazing Room Proposed

Aerospace Industries suggests manufacturers study joint establishment of 'space room' for high-temperature work on metals

LOS ANGELES—An industry group suggests it may be feasible to set up a jointly sponsored "space room" capable of providing a total inert-gas environment for welding and brazing metals.

The **Aerospace Industries Assn. of America** advanced the idea last week in its 1959 annual forecast of trends and requirements. The association proposed a study of the project's feasibility.

The report made no estimate of the cost. However, one engineer familiar with the association's thinking said such a facility could easily cost 10 or 15 million dollars. The engineer, who preferred to remain anonymous, said the idea is for a room on the order 40′ x 50′ x 6′ in size, where metals could be worked at temperatures up to 3500°F. The room would be used for both manufacturing and research.

Another idea being kicked around, the engineer added, is that equipment in the room should be entirely remotely controlled. This would have the obvious advantage that it would not be necessary to keep atmospheric temperatures down to those tolerable to human workers. Otherwise, they would have to be equipped with asbestos clothing and air helmets. The air in the room would be argon or some other inert gas.

No consideration has been given to how the cost might be apportioned. It may not be possible to finance it without government sponsorship, the engineer said. As yet, however, no approach has been made to any government agency.

The industry group's report also forecast requirements within five years for missile materials that will withstand brief exposures to temperatures of 3000°F and within 10 years to 5000°F.

In addition to these stern demands, Aerospace Industries called for development of new materials and methods in ever-shorter time spans. The report outlined the needs of the coming decade in assembly and joining, metal shaping, materials removal, plating and cladding, and heat treatment.

• **Combined processes**—Trends in assembly and joining are toward brazed and welded structures and indicate particular need for equipment development in this area, the report said. Combined processes will be necessary—for instance, welding and machining in a welding positioner.

The two chief problems will be achieving the very close tolerances required and brazing, welding and heat treating in a controlled atmosphere. To produce a stress-free, dimensionally accurate unit and locate details throu high-temperature processes, precisi sub-assembly tooling will be needed. A sembly tooling and manufacturing w be required for joining large sub-asse blies already in the hardened con tion. For welding and localized he treating during final assembly, portab equipment and techniques must be d veloped.

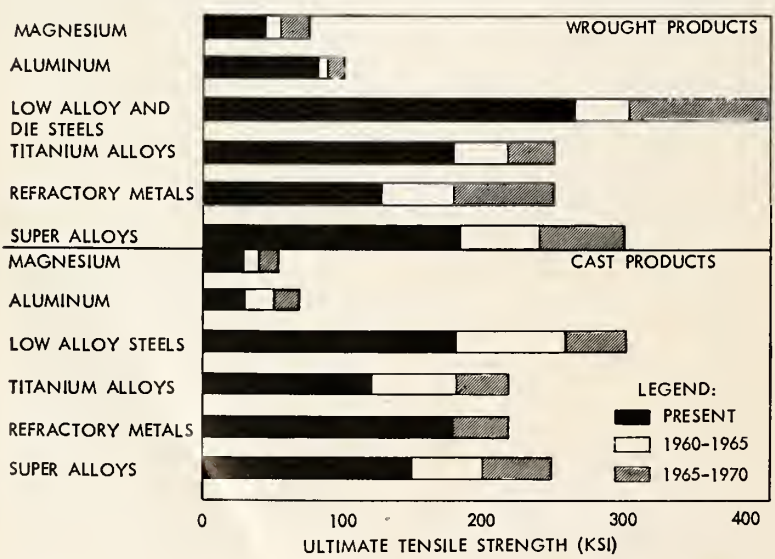
Aerospace Industries forecast ne for a method of joining metals witho heat. The group suggested an approa by use of metallic compounds plac in the joints, with fastening accor plished by a chemical reaction trigger by gas.

In metal shaping, the associatio predicted a demand for fabricatio techniques and equipment that w place the metal as close as possible its final configuration. This will con as more emphasis is placed on develo ing high-strength steels with yields 300,000 psi and titanium alloys wit yields of 200,000 psi.

• **Temperature barrier**—In materia removal, Aerospace Industries predicte that operations such as shearing, blan ing and machining, now performed room temperature, will have to be don with materials or tools heated or at sub zero temperatures. Since some meta and almost all ceramics and cerme cannot be machined with ordinar tools, these jobs will require cerami tools, ultrasonic machining or electric discharge machining.

Trends in plating and cladding in dicate the demand for automatic sys tems to control the processes, the asso ciation declared. The report called fo development of nondetrimental platin and cladding processes to withstan temperatures of 1200°F.

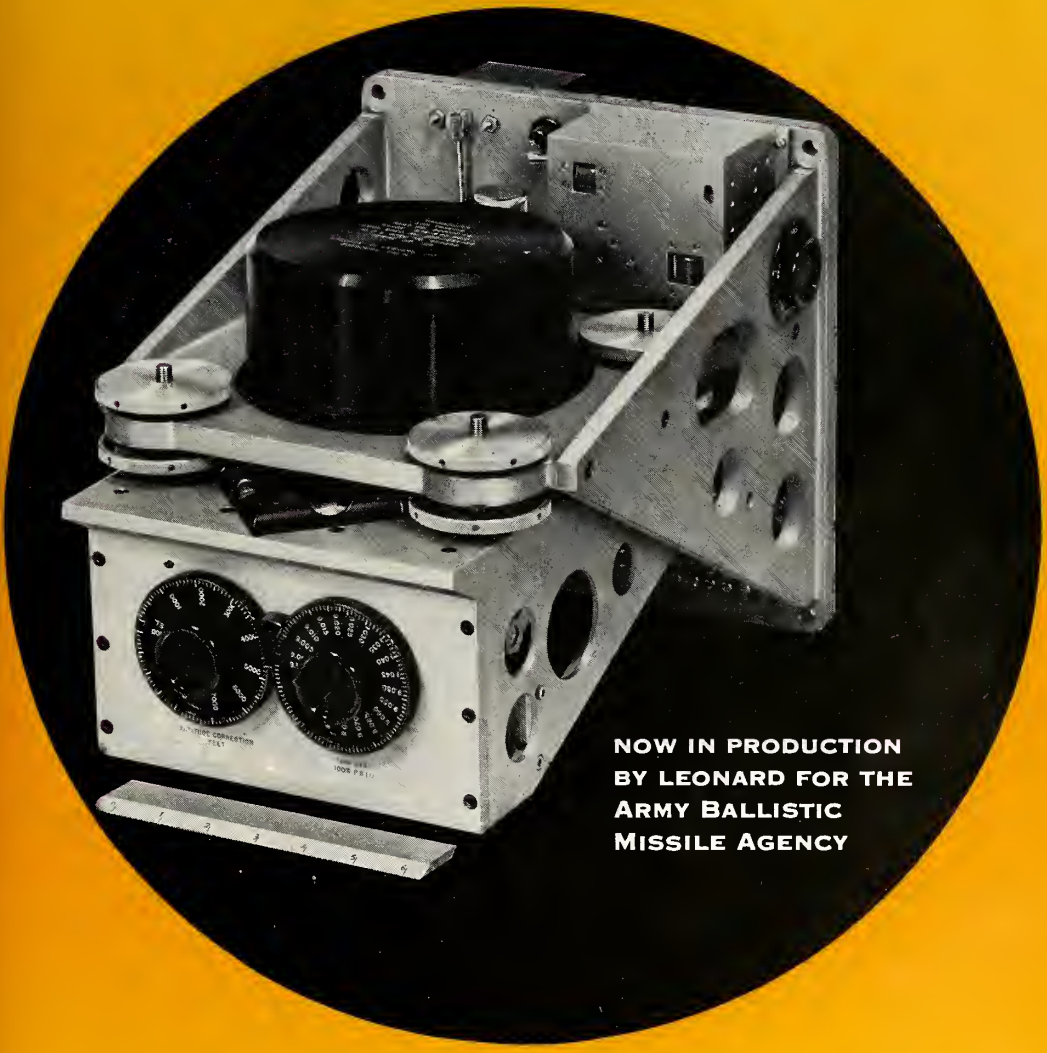
The industry association forecas demands in heat treatment for mini mum-mass materials for tempering an fixtures to control parts at treatin temperatures. Equipment for annealin or heat treating large component above 2000°F also will be required Sources using radiant heating or induc tion coils may be needed for treatin "localized" areas of assemblies to large for furnace treatment. The re port suggested resistance heating migh solve this problem.



ANTICIPATED increase in mechanical properties of wrought and cast alloys.

NEW LOX TANKING COMPUTER SYSTEM

WITH 1/10% OVERALL ACCURACY



NOW IN PRODUCTION BY LEONARD FOR THE ARMY BALLISTIC MISSILE AGENCY

OTHER RECENT CONTROL PROJECTS BY LEONARD INCLUDE:

- PROPELLANT UTILIZATION COMPUTER
- TANKING COMPUTER CALIBRATOR
- LOX TANK LEVEL TRANSDUCER
- MACH NUMBER DEVIATION COMPUTER
- INDICATED AIR SPEED TRANSDUCER
- DRAG-RISE DETERMINATION SYSTEM
- INDICATED ALTITUDE TRANSDUCER
- PRESSURE RATIO COMPUTER

Please discuss your system requirements with our engineers.

LEONARD PASADENA

Wallace O. Leonard, Inc.
373 SOUTH FAIR OAKS AVENUE
PASADENA, CALIFORNIA
TELEPHONE SYCAMORE 2-7131
TWX-PASA CAL 7321

What Can Withstand Re-entry Heat?

Bell Aircraft engineers find coated molybdenum, dense silicon carbide and coated graphite best for leading edge of boost-glide plane such as Dyna-Soar

LOS ANGELES—Coated molybdenum alloy, dense silicon carbide, and coated graphite are the most promising materials for the leading edge of the wings of a hypersonic global boost-glide plane such as *Dyna-Soar*.

Two **Bell Aircraft Corp.** engineers made this report at the recent national summer meeting of the Institute of the Aeronautical Sciences. The engineers, Frank M. Anthony and Harry A. Pearl, did not mention *Dyna-Soar* by name in their paper, "Selection of Materials for Hypersonic Leading Edge Applications." But their reference to a manned plane with range of 22,000 miles made it clear they were discussing that project.

In a "typical trajectory," they declared, such a craft would reach a peak altitude of 300,000 feet six minutes after launch, at which time the vehicle velocity is 25,400 fps and a range of 700 nautical miles has been traveled. During the ensuing descent, when vehicle weight is balanced by lift plus centrifugal force, a range of 21,900 miles is traveled in 105 minutes.

The end of the glide is assumed to come when altitude falls to 85,000 feet and velocity drops to 1200 fps. From this stage on, the flight is considered to be in the landing phase.

Dynamic pressures and temperatures each peak twice during such a flight, once during boost and once during descent.

• **Critical conditions**—These data show that three potentially critical flight conditions exist—high dynamic pressure combined with moderate temperature during boost, high temperature combined with low dynamic pressure during glide, and high dynamic pressure combined with low temperature during landing. However, Anthony and Pearl report, studies have shown that air load stresses are not a major consideration in selecting hypersonic leading edge materials. The real problem is high temperature.

In the typical *Dyna-Soar* flight, the Bell engineers estimate that maximum temperatures will range from 2600° to 2900°F, when the benefits of geometry and material characteristics are considered.

They screened materials for oxidation resistance, thermal conductivi thermal expansion, thermal emissivi tensile strength (metals) and modul of rupture (non-metals).

Molybdenum and its alloys w given a favorable report because high thermal conductivity, low coe cient of thermal expansion, high mod lus of elasticity and high mechani strength at elevated temperatures. T metal oxidizes rapidly, however, temperatures above about 1200°F form a corrosive oxide that is volat at about 1500°F. Some alloys poss higher mechanical strength and high crystallization temperatures but truly oxidation-resistant alloy has be developed.

Anthony and Pearl reported th an 0.5% titanium, 0.07% zirconiu alloy developed this year is appreciat stronger than other alloys and has recrystallization temperature of abo 2900°F—the upper limit of the te perature range for a *Dyna-Soar* lea ing edge. The short-time ultimate te sile strength of this alloy is 54,000 at 2400°F and 14,000 psi at 3000°F

• **Silicon coating**—A good coati

Fig. 1—Thermal Expansion vs. Temperature

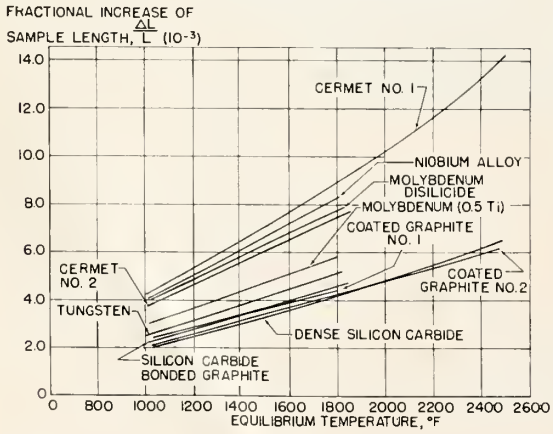


Fig. 2—Emissivity vs. Temperature

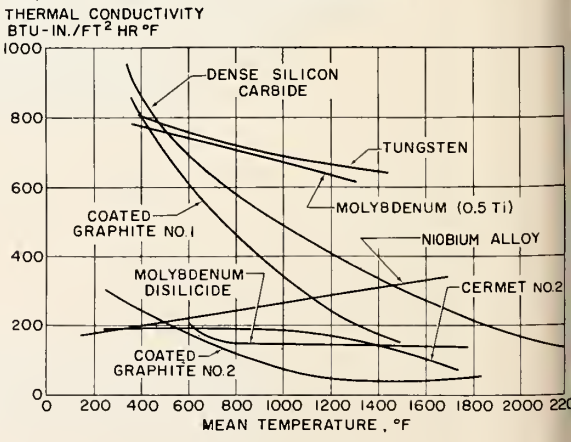


TABLE I COMPARISON OF TEMPERATURES AND THERMAL STRESSES FOR VARIOUS MATERIALS

1 INCH DIAMETER, 10° WEDGE ANGLE, 60° SWEEP.
$W/SC_L = 100 = 0.9$ 22,000 fps 241,000 Feet

Material	Temperature, °F Maximum	Minimum	Thermal Stresses, psi Tension	Max. Tension	Max. Compression	Tension (Bending) Ultimate Average	99%	Compression Ultimate
¼ Ti Alloy of Molybdenum	2,620	2,070	2,260	7,500	26,100	26,000	.....	17,000
obium Alloy	2,810	1,980	2,200	2,960	4,700	25,000	.....	..0
nse Silicon Carbide	3,060	1,840	2,100	10,350	25,000	18,000	6,920	52,000
ated Graphite, Type I	2,660	2,100	2,240	420	1,610	6,000	1,130	12,000
ated Graphite, Type II	3,290	1,770	2,100	1,620	15,900	4,350	800	.....
rmet, Type I	2,960	1,880	2,140	4,420	690+	46,500	34,400	0
rmet, Type II	2,960	1,880	2,140	5,200	9,650+	65,000	46,400	3,000
lybdenum Disilicide	3,040	1,850	2,120	4,930	2,780+	28,700	14,700	4,500

* For non-metallics measured bending strength on ¼" x ¼" x 5" specimens has been used for tension and compression stresses were taken equal to 3 times the bending values. For metals tension and compression allowables were assumed equal. Since scatter is small only average values for metals are used.

+ Values are low because modulus of elasticity becomes extremely low. In general this would indicate large plastic deformations. Therefore, stresses do not indicate a true picture.

r molybdenum, they said, is vapor-eposited silicon, which reacts with the etal to form molybdenum disilicide. he final coating is a graded mixture "alloy" composed of relatively pure olybdenum disilicide on the outer rface with greater concentrations of se material distributed through it as e proceeds below the surface, they plained. The bonding is chemical.

Silicon carbide is an exception nong carbides in that it is quite re-stant to oxidation. Like all carbides, licides and graphite, it has a high elting point. Anthony and Pearl re-rted that silicon carbide modified aterials, made experimentally by hot essing techniques, have modulus of pture of about 70,000 psi at 2500°F.

The **Carborundum Corp.** says it oduces a self-bonded form of this bstance (KT silicon carbide), which ins only 0.51 mg/sq cm in 5 hours oxidation when exposed to air at 92°F. Carborundum says the ther-al conductivity is 293 BTU/sq ft/-/hr at 1832°F, much higher than ost other ceramics and non-metals.

Graphite has high thermal conduc-ity and high thermal emissivity. hus, Anthony and Pearl reported, an ception is made to the general rule at it is undesirable to coat a ceramic aterial with another ceramic to pro-ct it against oxidation. Graphite also s desirably low modulus of elasticity d coefficient of thermal expansion. lthough its mechanical strength is ry low, it increases with tempera-re up to about 5000°F. Present rms of graphite do not approach eoretical density; thus it is expected at the mechanical strength will be creased in the future.

They said coated graphite is su-erior because of low weight, easy bricability and low modulus of elas-city. However, its strength is variable d the coatings are unreliable.

The investigators sought to obtain ata on material with the same process istory. Although it might seem that some information is available from technical literature and need not be obtained again, they pointed out that different processing can result in different properties. For example, they asserted that the effect on mechanical and chemical properties of applying a coating to a material may vary considerably from those of the bare metal.

• **Other materials tested**—In addition to the materials mentioned, the Bell engineers also tested a ternary niobium alloy, pure tungsten, silicon carbide bonded graphite, cermet type I (chromium, molybdenum, aluminum oxide), cermet type II (chromium, tungsten, aluminum oxide) and molybdenum disilicide. Tables I and II give the resulting thermal expansion data and comparison of temperatures and thermal stresses for the materials. Figs. 2 and 3 show thermal conductivity and thermal expansion plotted against temperature for each of the materials tested.

Below about 2400°F, Anthony and Pearl noted, niobium alloy appears to be advantageous because of lower density compared with molybdenum. For high emissivity, a coating would be necessary but the protective oxide formed would make it unnecessary to have oxidation protection of expendable components. However, protection of reusable components would be necessary to avoid embrittlement caused by subsurface contamination.

The two cermets have similar properties except that their thermal conductivity is lower than niobium. Thus, operating conditions would have to be less severe.

Molybdenum disilicide is also promising for temperatures up to 2400°F, they declared. This substance does not need a coating because it has a relatively high thermal emissivity, about .8, and its oxidation resistance also is excellent.

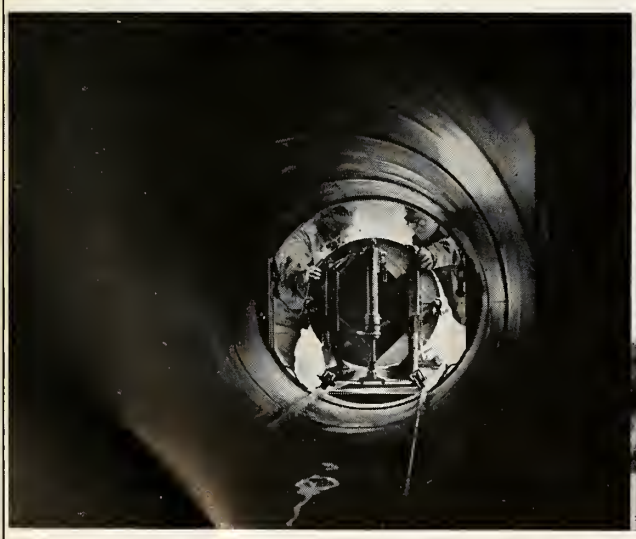
The Bell engineers said tungsten and coated graphite appear to be the most promising materials for use above 3100°F. But they added that much work is needed to advance the state of the art to the point where the materials can be used with confidence under such conditions. They noted, however, that for the leading edge of a boost-glide airplane of global range, temperatures ranged from 2600° to 3100°F for the materials considered.

Anthony and Pearl called for continued development in materials. Specifically, they urged more thorough definition of properties, improvement of processing techniques to reduce variability—particularly non-metal strengths, oxidation protection of coatings and extension of fabrication capabilities.

TABLE II THERMAL EXPANSION DATA

Material	Temperature Range (F)	Unit Expansion (in/in x 10^{-3})	Coefficient of Thermal Expansion (in/in°F x 10^{-6})
Dense Silicon Carbide	80-1040	2.1	2.2
	80-1800	4.2	2.5
	80-2485	6.6	2.7
Silicon Carbide Bonded Graphite	80-1000	2.2	2.4
	80-1840	4.7	2.7
Coated Graphite #1	80-1030	2.4	2.5
	80-1800	4.4	2.6
Coated Graphite #2	80-1020	2.1	2.2
	80-1820	4.3	2.5
	80-2482	6.2	2.6
Cermet #1	80-1000	4.2	4.6
	80-1830	9.1	5.2
	80-2496	14.1	5.9
Cermet #2	80-1000	3.7	4.1
	80-1850	7.7	4.4
Molybdenum Disilicide	80-1020	4.1	4.4
	80-1830	7.9	4.5
Columbium Alloy	80-1010	4.0	4.3
	80-1810	8.3	4.8
Molybdenum (0.5 Ti)	80-1010	3.8	3.2
	80-1810	5.8	3.3
Tungsten	80-1000	2.5	2.8
	80-1820	5.2	3.0

About the earthly side of the Corporal missile. The Army's Corporal mis sile is a surface-to-surface mobile artillery weapon. It's operational and it' in production. Tremendous quantities of materials fabricated into numerou pieces of ground support equipment operated by Army personnel are require to launch the Corporal with split-second timing and accuracy. And virtuall all of the steel material required can be purchased from one source — Unite States Steel. Whether we're talking about carbon steel, high-strengt low-alloy steel, alloy steel or Stainless Steel, steel fence, electrical cable



How thin and light can you make the shipping container for a rocket, and still have a strong, impact-resistant shell? The transportation industry specialists in strong, lightweight construction have overcome this same problem with the help of United States Steel.

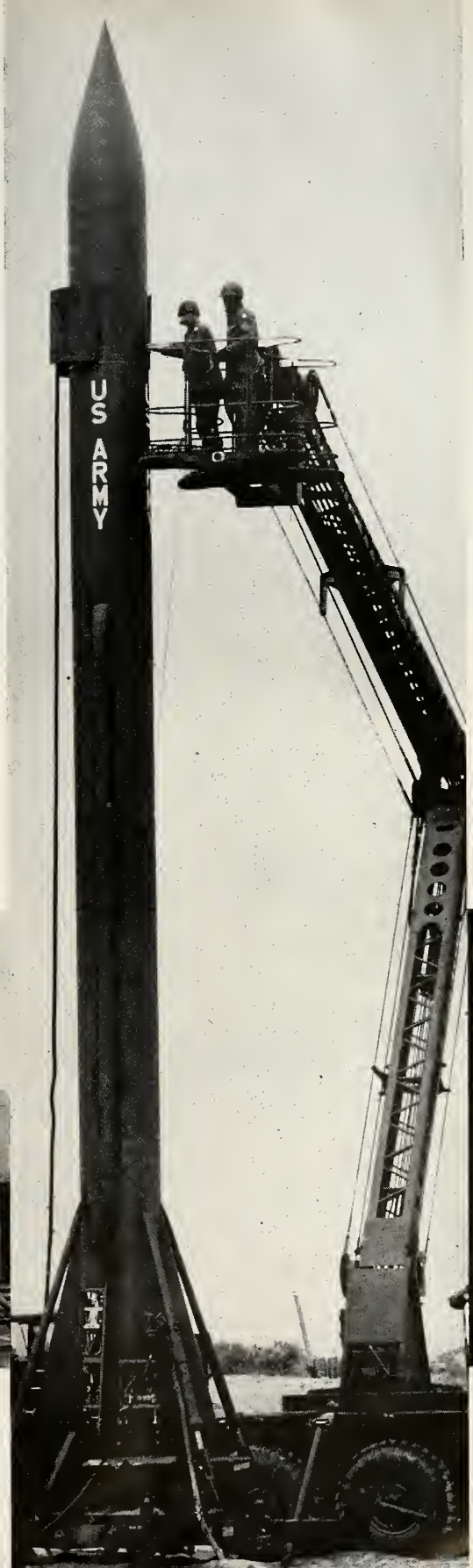


This Corporal transporter is made of steel. Why? Because this has to be a rugged piece of equipment to withstand the abuse of moving the missile over all types of rough terrain.

cement or wire rope, United States Steel maintains the technical services to provide the proper assistance to cope with any problem on these materials for ground support. When a ground support program is ready for the drawing board, consult **United States Steel**

USS is a registered trademark





Technicians are carried to the "brain" of the Corporal missile on a "cherry-picker." Its boom is similar to that of an industrial crane. United States Steel representatives are constantly working with the manufacturers of cranes and power shovels to develop more efficient strength-weight ratios and better rigging.

Where Are We Going in Fuel Handling?

The cryogenic engineer still must be a jack-of-all-trades with industry having to gear up for multi-million-pound thrust boosters

by S. David Pursglove

WASHINGTON—The past year has seen many developments in propellant handling. New equipment and new materials such as corrosion-proof alloys and plastics already have been discussed in "new product" sections of magazines, and they have been widely advertised.

The developments we want to discuss here, however, are not machines and materials as much as ideas and techniques. Much of the equipment announced recently probably will be replaced by newer products before too long. However, the recent thoughts of missilemen—some pointing to new trends in thinking—will stay with us and should be examined.

The missile industry has encountered new problems, too, during the past year. However, even these problems represent progress: they signify that engineers are discovering and describing their problems—a first step toward solving them.

Solutions still call for brute force engineering at many stages; there's no easy way out yet. The cryogenic engineer, for example, must be an intellectual jack-of-all-trades. He must understand heat transfer and liquid flow. He has to know all about pumps, instrumentation, and the properties of his materials. Engineers still are faced with the problem of accurately topping a tank of cryogenic oxidizer, although a fairly new device now makes the job a little easier.

The industry is still faced with the nightmarish task of gearing up for multi-million-pound-thrust boosters and their formidable handling problems. This has introduced a new type of handling problem. It's no longer a matter of getting a missile to a launch site and then worrying about fueling it. Soon, the problem of moving the missile to the site will be just as big as—possibly bigger than—the fueling problem. This applies to solid-propellant missiles as well.

Cryogenic engineers must be at home in these areas:

- **materials properties**
- **insulation techniques**
- **liquid flow**
- **pumps**
- **heat transfer**
- **instrumentation**

For that matter, we don't have to wait for the advent of super-size solids to see that the old argument that "solids don't have any problems like liquids do" is out of date and not true. In the past year there has been such a clamor for greater sophistication in solid-propellant missiles that a whole new area of handling-engineering is opening up.

High-energy fuels based on boron still offer problems, but these soon may be solved by the simple withdrawal of boron from the fuels picture. The same is true of free radicals. In the past year it has become obvious that free radical propulsion is on the way out.

• **Real breakthroughs**—On the positive side of the picture for the year past, things are very bright. Thinking has been penetrating and dynamic. Many of the developments to which newspaper writers have applied the term "breakthrough" really have been genuine breakthroughs.

One of the most important events recently is something that built up over a period of time, and without fanfare. It is the unspoken, but nevertheless definite, acknowledgement in missile circles that LOX will continue for a long time as our primary oxidizer. This allows the kind of advance planning that has not been possible while there has been so much talk about replacing liquid oxygen with various "exotic" oxidizers. Eventually, fluorine may take over in some missiles, bu this still is in the future—and probabl on a limited scale.

The National Bureau of Standard has made it possible for liquid hydro gen to be handled much like an other cryogenic. This gives new hop to scientists and engineers who war to use H_2 as the "ultimate fuel." Ne high insulation powders and vacuur insulating techniques further the caus of liquid hydrogen, as well as help th entire cryogenic propellant field.

As an example of some seriou thinking that has been devoted to pro pellant handling problems, engineer point to **Arthur D. Little's** announce ment of a large-scale cryogenics se vicing system. And, almost witho fanfare, the National Bureau of Stanc ards got its cryogenic data cente under way.

The cryogenic engineer still mu be at home in many fields, but abov all, he must be an engineer. He mu know approximately the same thing that are known by an engineer wh designs home refrigerators, but th emphasis has to be different.

Robert B. Jacobs, chief of the cry ogenic equipment section, Nation Bureau of Standards, has this to sa in the April ARS Journal:

• **Principles the same**—"Cryogeni problems can be solved through appl cation of the same basic principle which have been successfully employe for many years in mechanical, chemic and electrical engineering. Situations i which new principles (e.g. supercon ductivity) arise are very rare. No mally, the significant deviations cryogenic problems from the mor familiar ones are caused by chang in emphasis or differences in order magnitude; design difficulties are usu ally the result of insufficient knowled of properties of materials."

As an example, Jacobs suggests th the engineer who understands the bas phenomena occurring in a centrifug

ump can predict performance and avitation characteristics for a liquid ydrogen pump just as reliably as he an for a cold water pump.

Although the differences between old water engineering and cryogenic ngineering may be only differences in mphasis, they are very important. acobs points out that the engineer ho designs valves for operation at mbient temperatures is interested in ydraulic efficiency and leak tightness ross the seat and through the stem acking. When he takes on the design f a valve for handling a cryogenic ropellant, he has the same interests, ut some become more important: dif-erential contraction, freezing of pack-ng materials, impact strength, insula-on.

Jacobs points out six areas in hich the cryogenic engineer must be articularly well versed:

• Materials properties, not too ritical at room temperature, become ll-important at extremely low tem-eratures. In missile work, low tem-erature strength is needed and, with-the missile, material density be-omes important.

• Insulation techniques have to be familiar to the cryogenic engineer his own name. He must be on inti-ate terms with conventional, powder, nd vacuum techniques. In ground andling of propellants, he has to de-de between insulation and no insula-on—sometimes no insulation is pre-rred for the sake of economy and eed. It is up to the cryogenic engi-eer to make the decision.

• Flow of liquids is a function of any considerations, all of them ap-lying equally to ambient temperature nd cryogenic engineering. Cold flow resents additional problems involving ansient phenomona that take place uring cryogenic equipment cool down.

• Pumps, and what happens to em at low temperatures, must be nderstood thoroughly. The problems volved in pumping LOX are about e same as those involved in pump-g cold water, at least on paper. But acobs feels we need additional studies to cavitation characteristics.

• Heat transfer considerations are ll-important in cryogenic engineering, ut do not involve any new principles. owever, Jacobs warns of contradic-ons between much published heat ansfer data.

Instrumentation is an important ea for the cryogenic engineer con-rned with fueling a missile. His udies of instrumentation must be anted toward pressure, temperature, ow, liquid level, and static mass easurement. Cryogenic instruments, nd the materials of which they are made, have to take into account the effects of low temperature and high vacuum.

Jacobs makes it relatively easy for the cryogenic engineer to bring himself up-to-date in his field through a 56-entry bibliography of references in his survey of "Recent Advances in Cryogenic Engineering. Particularly valuable are these references: a new book published this year by D. Van Nostrand, "Cryogenic Engineering," by R. B. Scott; a series of articles by R. J. Corruccini, "Properties of Materials at Low Temperatures," in *Chemical Engineering Progress*, June, July, and August, 1957.

The Cryogenic Data Center is now in operation at the Cryogenic Engineering Laboratory, National Bureau of Standards, Boulder, Colo. Its purpose is to make information available to all persons concerned with cryogenics. Jacobs says it probably will not be completely up-to-date for about two more years, but it is currently rendering whatever services it can.

• **Fill 'er up?**—It may sound strange, but one of the biggest problems still faced by missilemen is that of filling a missile tank to the top with a liquefied gas. Assume all handling problems have been solved, then it's fairly easy to fill a tank part of the way. It's another thing to fill it all the way, or to top it.

Daniel A. Heald, senior design engineer at **Convair Astronautics,** described the problem recently to a meeting of the Society of Automotive Engineers. For example, he says, a missile's mission may call for rapid loading and firing. It seems like a small enough problem to get 0.5% accuracy on propellant weight at launch, or to fill the LOX tank to 98% of capacity to assure maximum range.

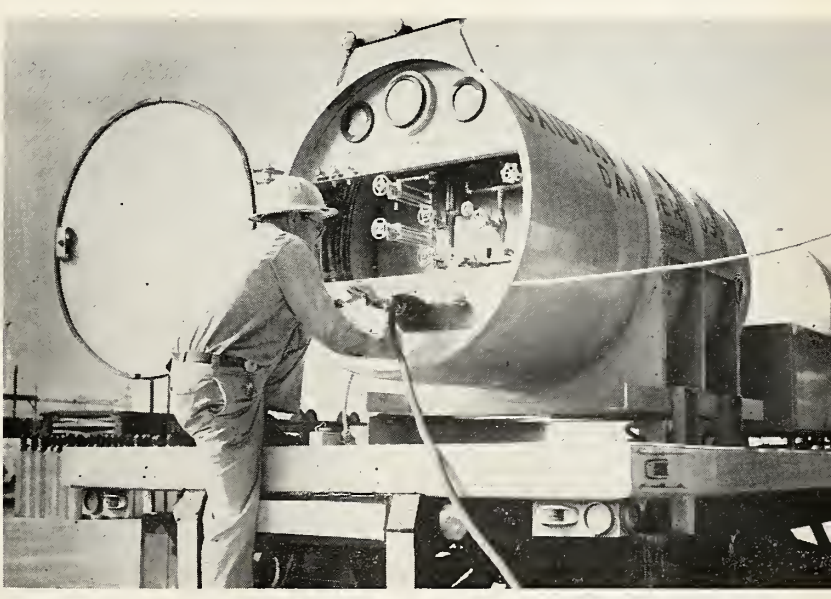
Just try to do it. Here is what Heald says we run into with a missile system with a large vertical airborne tank:

"The ground loading system, which must be considered an integral part of the whole, is a remote, high-capacity system with extensive automatic controls. Why not just weigh the filled missile on load cells, which have an advertised accuracy of 0.1%? This approach may have to be abandoned when one considers that the gross weight of the launcher system may nearly equal that of the missile, that misalignment of the missile and forces from cross winds introduce appreciable side loads which necessitate lateral load cells and complicate resolution of weighing systems, that calibration of such a complex system is difficult, and accurate load cells are expensive, and temperature sensitive, and that the propellant is rapidly boiling away."

Heald had developed a more practical technique:

"Calibrate the vessel so that the volume is known for a given liquid height; then knowing the density and level, the propellant load can be calculated."

This still leaves the problem of boil-off, but even that has been partly taken care of by a LOX tanking computer that **Servomechanisms, Inc.,** put into production around a year ago. SMI says the tanking computer meas-



SIGNIFICANT advancement in the transportation of fluorine both in liquid and bulk was made by General Chemical which designed this trailer transport.

Little tackles fueling time . . .

ures, controls, and indicates the level of LOX in tanks.

Loading is rapid and accurate, SMI says, due to a two-mode control system. The first mode permits high pumping rates until 98% of tank capacity is reached. Then the second mode takes over and controls a proportioning valve which adds the LOX necessary to fill the tank to within 0.1% accuracy. The second mode also provides continuous topping during standby to compensate for boil-off.

• **High-speed effort**—The problems involved in handling cryogenic liquids are at the bottom of most valid arguments against liquid-fueled ICBM's. Thanks to these problems, liquid fueling times are longer than we can afford in case we need to use missiles for retaliation.

In 1955, the Air Force asked **Arthur D. Little, Inc.,** to study fueling time problems and try to develop a reliable high-speed fueling system. A. D. Little's R. B. Hinckley and R. E. Kendall described the resulting system at the San Diego meeting of the American Rocket Society in June.

The system had to meet these requirements:

(1) Be capable of loading an *Atlas* within the available reaction time (interval between detection of a hostile ICBM in flight, and the time of its impact on target). This meant it would have to be capable of LOX transfer rates up to 5000 gpm, and fuel transfer rates up to 3500 gpm.

(2) Be fully automatic to eliminate human error and relieve control personnel of routine detail.

(3) Use only standard, off-the-shelf industrial components.

(4) Load the missile to an accuracy of 0.5% by volume.

A. D. Little discovered that the largest proven LOX pump available had a capacity of only 500 gpm—10 pumps in parallel would be required.

The research firm decided not to use pumps at all, but to use a pressure transfer system instead. Thus, the key to the system involves transferring the LOX under a pressure head of gaseous oxygen. Helium was ruled out because of the then national shortage which is being slowly alleviated. Nitrogen was ruled out at the time because of the unknown effect on LOX of nitrogen contamination due to nitrogen condensing in contact with the LOX. Subsequent studies at A. D. Little show the nitrogen contamination not to exceed 0.5%, Hinckley and Kendall report.

• **Good results**—Tests were run at Edwards AFB. A dummy missile LOX tank was used. Here are the results:

The system demonstrated fully automatic loading, topping and draining. LOX flow rates were greater than 5000 gpm, and transfer pressures were lower than expected. The system was controlled to an accuracy of 0.5%. The system could be cooled down in the time available—critical parts of the system were cooled sufficiently for transfer in less than three minutes. The topping system maintained the LOX level, and even changes in wind velocity resulted immediately in a new topping valve position. The system is fail safe as proved by deliberate malfunctions.

The system is applicable to fuels as well as LOX. It probably will be applicable to other oxidizers, too. However, it may be a decade or more before anybody has to start worrying about wide-spread operational transfer systems for other oxidizers. In the past year, whenever the matter has come up, industry leaders and top military officials have said, or strongly hinted, that LOX will be the operational oxidizer in our missile program for some years to come. It still is the safest, most economical, most readily available oxidizer for missile use. It is stable, non-toxic, non-corrosive and, in an emergency, it's easy to get rid of.

• **Future and fluorine**—However, surveys of this sort always end with a look at the future. That which has been said about LOX does not den that fluorine someday will find use a an oxidizer for some missions. Thi day is coming closer, thanks to **Be Aircraft's** continuing study of fluorin and thanks to **Allied Chemical's** ne developments in fluorine handling (se M/R May 11, p. 42).

Allied makes it possible to sh liquid fluorine almost as readily a LOX. However, it still is a dangero substance when it escapes, calls f special handling techniques at laun sites, and is corrosive. But NASA hard at work trying to develop ne materials that can take the punishme of liquid F_2—materials immune gaseous F_2 already are available.

Fluorine may someday be one-ha of a system already touted as the gre chemical propellant system we'll ev have—fluorine-hydrogen.

Just as the past year has seen r markable advances in fluorine handlir techniques, so have many of hydrogen problems been conquered. **Linde Con pany's** new super insulation techniqu make liquid H_2 storage easier. Hov ever, the real breakthrough has be discussed in M/R's Propulsion Eng neering many times. That is the ne National Bureau of Standards proce for converting unstable hydrogen stable hydrogen, thus eliminating bo off due to heat released in the natur transition from the unstable form the stable form.

Converted liquid hydrogen stor in Linde Company's new super ins lated tanks almost never boils away.

The theory is there. Now we ne hard-headed engineering and we'll ha an unbeatable propellant system. Har headed engineering, money and time



OUTSTANDING cryogenic research is being undertaken by the NBS-AEC Cryogen Engineering Laboratory in Colorado.

BRITISH ASTRONAUTICS

- **Pye Ltd. Develops Tank Missile**
- **Corporal Fired from New Missile Range**
- **Scorpion Engines Extending Aircraft Life**

by G. V. E. Thompson

LONDON—One of Britain's leading lectronics manufacturers, **Pye Ltd.** of ambridge, has developed a powerful hort-range guided missile intended to eplace the armour-destroying heavy un currently carried by tanks. The 0 lb. missile has a 5 ft. tailless body tted with cruciform wings, and is jet- eered. Simple and robust in construc- on, it is also easily stored and has a ng shelf life.

The size chosen is thought to be e best compromise possible between e requirements of ease of handling d high chance of kill per hit. The issiles can be transported in quantity a light vehicle, from which they can e fired. Alternatively, it can be car- ed by one or two men for short stances and ground-launched, firing d control needing only one man.

In either case, launching is from lightweight, zero-length launcher built om tube. Line-of-sight command con- ol is employed; the controller can use noculars or a periscopic monocular hich can be switched instantaneously om low to high power magnification ithout loss of target reference as the issile travels away from the launcher.

The control is a simple hand-held ystick. Its signals are shaped in a) lb. ground control unit and trans- itted to the missile by a wire link. he control unit can launch and con- ol several missiles consecutively. Op- ation of the joystick needs little skill; simulator is being developed as a aining aid, but one of the advantages the weapon system is that only a ort practice time is needed to achieve oficiency.

• **New missile range opened**—A w British guided weapons range has en opened. It is situated in South ist in the Outer Hebrides, a group islands off the West coast of Scot- nd. There was considerable contro- rsy when the establishment of the nge was first suggested, most of the jections being on account of the anges in the primitive way of life on e island that would follow. However, any of the crofters themselves seem to have welcomed the employment that the construction of the range has provided.

The first missile to be fired from the range was a *Corporal*, supplied in 1956 by the U.S.A. for use with the British Army. Apart from two civilians from the American manufacturers, all the personnel taking part in the firing were drawn from the Army: and had been trained at the School of Artillery, Larkhill.

The first *Corporal* carried an inert warhead and travelled for more than 50 miles over the Atlantic Ocean. In wartime, Britain's *Corporals* would be fitted with nuclear warheads supplied from America.

• **Napier's rocket engines**—The *Scorpion* series of rocket engines built by **D. Napier & Son Ltd.**, members of the **English Electric** group, are being used as powerplants for both missiles and aircraft. They work on the "thermal ignition" principle: high-test peroxide is catalytically decomposed into superheated steam and oxygen; this mixture enters the combustion chamber at high temperature and pressure, kerosene is injected and ignition occurs spontaneously.

Single, double and triple-chamber engines are in production; all have the advantages of compactness and low weight. Routine testing of pre-production engines at altitudes of up to 70,000 ft. and temperatures of −70° to +40°C has been done in a Canberra jet bomber fitted up as a flying test bed.

The flexibility and precise control overthrust possible with *Scorpion* makes it ideal for powering target missiles. It is also suitable for air-launched short to intermediate-range missiles, such as the "stand-off" bomb.

Single *Scorpion* engines are installed as boosters in present-generation interceptor fighter aircraft, the HTP being carried in nitrogen-pressurized underwing tanks. For the "last-generation" all-weather fighters (such as English Electric's Lightning), Napier's have designed a rocket power pack that is interchangeable with the standard long-range kerosene tank carried by the aircraft.

The pack attaches to the aircraft at two points, is of skin and stringer construction and incorporates a Double *Scorpion* engine. HTP is carried in an integral tank forming the front part of the shell of the pack, and kerosene is drawn from the tanks of the aircraft. On the top of the pack is a kerosene inlet, a nitrogen-charging connection and the electrical connections to the control panel in the cockpit.

In combination with the advanced air-to-air missiles now being developed, this power pack is expected to give the semi-obsolescent fighters a new lease of life.

• **Short** *Seacat*—For many years the standard close-range weapon of the Royal Navy has been the 40mm gun. This is now to be replaced by the surface-to-air missile *Seacat*, now being developed by **Short Brothers & Harland Ltd.**, of Belfast, Northern Ireland.

News that Short had been awarded a development contract for *Seacat* was first released in April, 1958. Two months later, speaking in the House of Lords, the First Lord of the Admiralty described *Seacat* as a most ingenious weapon with a novel type of direction which gave very high promise. In Dec. 1958, the Parliamentary Secretary to the Admiralty indicated to the House of Commons that there would be a considerable number of these missiles in service by the early 1960's.

Security on *Seacat* is still strict, but a full-scale model of the missile and a film of a test firing were shown for the first time at the recent Paris Air Display.

Powered by a solid propellant motor, *Seacat* is designed to be instantly ready to repel attack and is highly maneuverable. Apart from its use by the Navy, it will also provide an anti-aircraft armament for small ships.

A variant of the missile is being developed for use by land forces as a replacement for light field artillery. This is to be known as *Tigercat*. Several Commonwealth and N.A.T.O. countries have expressed interest in both missiles.

Detection of Nuclear Explosions in Space Possible by Optical Means

Two spectroscopes mounted in satellite proposed as method of surveillance

by Savo Ćorić

KOBLENTZ, GERMANY—Were it not for the existence of Van Allen radiation belts and solar flares, detection of nuclear explosions in space by means of orbiting satellites equipped with radiation-measuring instruments would be relatively simple. For space is a near-void in which radiation and fission products from such an explosion expand freely without any hindrance—unlike the earth's atmosphere, where they remain confined to a limited area.

In the radiation belts, however, any man-made radiation may pass unnoticed because of the very high level of radiation of the belts themselves. For this reason, an existing project, designed to supervise space with orbiting satellites in case an agreement on a nuclear test ban is reached among the nuclear powers (U.S.A., Great Britain and U.S.S.R.), would not attempt to send satellites into the radiation belts.

It plans instead to orbit six satellites below radiation belts (under 600 miles) and six others above the belts—in a 40,000-mile orbit. Each satellite should be equipped with Geiger-Mueller and scintillation counters to pick up gamma and neutron radiation produced in a nuclear blast. The satellites' radio transmitters would then broadcast the findings to an international network.

But a nuclear explosion produces many other phenomena which might possibly be used for more reliable and efficient detection. If, for example, the radiation-counting instruments of the aforementioned and similar projects were replaced or supplemented with optical instruments using spectral analysis to analyze the optical phenomena particular to a nuclear blast, the detection of such blasts would be by no means hampered by radiation belts.

• **Advantages**—The proposed optical detection would have following advantages over radiation-counting methods:

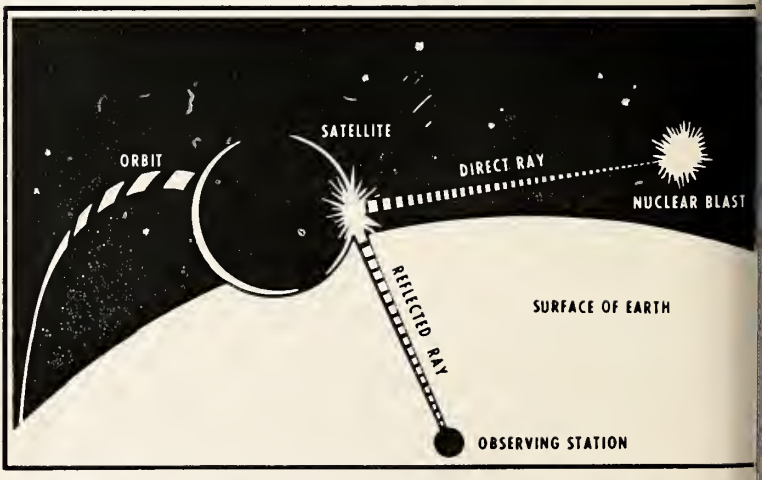
1. Blast-monitoring satellites could be launched into much lower orbits, that is with much less fuel and by much smaller rockets;

2. Reliability. Radiation-measuring instruments would be swamped, even above the radiation belts and at auroral latitudes up to any altitude, by charged particles hurled into space by solar flares. So it would be easy for a would-be violator to carry out undetectable nuclear-weapons tests one or two days after such a solar flare has been observed on the sun—when the oncoming solar gases reach the vicinity of earth. The proposed optical detectors would, of course, not be affected by such radiation; neither would they be optically fooled by such flares or any other light flashes unrelated to a nuclear blast;

3. Aided by favorable atmospheric conditions (i.e., a good visibility) th optical detectors would also detec nuclear blasts taking place in the atmos phere and even on the ground.

• **Details**—T h e optical-detectio equipment would be mounted in spinning satellite. It would consist o two spectroscopes viewing the spac through the same slit. Each spectro scope would be followed by a scree and a photoelectric sensor (a photocel or a solar battery).

One screen would be pervious onl to such Fraunhofer lines of the sola spectrum which would be identical wit the lines of the emission spectra of th most abundant chemical elements o the nuclear bomb or its fission prod ucts (uranium, plutonium, barium, etc.) the other screen would let pass to it sensor only those Fraunhofer line identical with spectral lines of som chemical elements not to be foun either in a nuclear bomb or among it



EXPLOSIONS far off under the horizon could be detected by receiving the flash reflected by the outer surface of the satellite.

ission products in appreciable quantities (the Fraunhofer lines are not dark, hey only appear so in relation to much righter continuous solar spectrum).

Furthermore, the Fraunhofer lines eaching both sensors must be selected o prevent detection equipment from he influence of either atmospheric or errestrial light sources, natural or rtificial, which emit line spectra aurorae, lightnings, ionized vapors of lisintegrated meteors, extended fires, as-discharge lamps). Thus these Fraunofer lines will not be identical—at sual temperatures of the light sources —either with the spectral lines of the onstituents of the atmosphere or with he lines of the chemical elements to e found in meteors, in organic compounds or in the plasma of a glow amp in appreciable quantities.

This means that both sensors will e sensitized by solar spectrum and he spectra of terrestrial and atmospheric light sources which emit a continuous spectrum (incandescent lamps, ncandescent solid meteors), while only ne sensor will respond to the line pectra of the nuclear bomb components and its fission products.

The outputs of two sensors are mplified and connected to a differential ircuit where the pulses provoked by he solar spectrum—as well as those enerated by the continuous spectra of errestrial and atmospheric light sources —cancel and only such pulses which re produced by the spectrum of a uclear explosion pass to the transitter. They are either transmitted imediately to earth or stored on a magetic tape for later transmission.

The differential circuit could consist of a simple transformer with two rimary windings connected in phase pposition. Each sensor would feed one primary winding and all pulses which are common to both sensors, that is those produced by the solar spectrum, cancel while only the pulses generated by the nuclear explosion would be transmitted to the secondary winding of the transformer.

By this means, changes in the luminosity of the received sunlight, caused both by the changing attitude of the spinning satellite and the optical phenomena on the sun itself (i.e., sunspots and solar flares), would not influence this detection equipment for their effects would always cancel in the differential circuit, and only the pulses produced by the spectrum of a nuclear explosion would be recorded.

This detector will be influenced not only by the emission but also by the absorption spectra of the nuclear-bomb components. The emission spectra will be provided by the flare of the explosion itself and by the subsequent glow of the ionized vapors of the nuclear-bomb components and its decay products. The absorption spectra will appear when the detector is receiving the sunlight which passed through a "cooled-off," non-glowing cloud of such vapors.

This cloud will absorb only the light of the Fraunhofer lines of the solar spectrum which are particular to the elements to be found in the cloud. These lines will, therefore, appear darker in the detector than the other Fraunhofer lines which are not affected by the vapor cloud. As the former lines are received by one sensor and the latter lines by the other sensor an unbalance will appear in the differential circuit and this unbalance will produce a signal which will be transmitted by the transmitter.

The absorption spectra will thus make it possible to detect later the nuclear explosions which took place while the satellite was out of sight, far off under the horizon. When the satellite is orbiting in the shadow of the Earth this type of detection will be, however, ineffective.

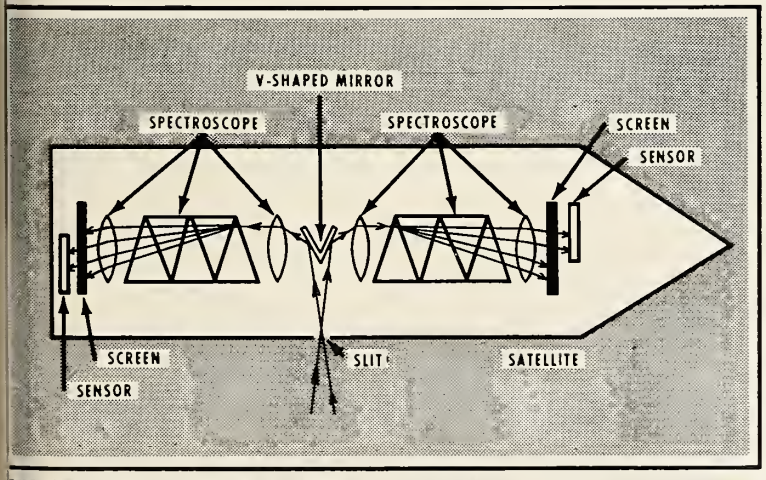
• **Looking around corner**—The same equipment—plus a telescope and a spectrograph—could be used in a ground installation to observe orbiting satellites in quest of nuclear-explosion flashes reflected from the surface of the satellites.

In this case the resulting signal, produced by a nuclear blast in the differential circuit, would trigger the photographic camera of the spectrograph so that the entire spectrum of a nuclear-bomb explosion would be photographed. This would make it possible not only to detect a nuclear explosion but to identify the nuclear device itself—A-bomb or H-bomb. The same spectrogram would also reveal the construction of the nose cone as well as its constituents.

In favorable weather conditions, this method could detect all nuclear blasts in space above and below the satellite itself as well as above the tangent drawn from the satellite to the earth's surface away from the observing station. When visibility was bad, the equipment could be taken up by planes.

All big satellites can be used advantageously for this type of detection and especially the big balloon-satellites (they have the largest surface to weight ratio). The moon itself might be included.

Finally, both types of detection could be used for spotting big forest and prairie fires in remote areas. All that would be necessary would be to replace the screen pervious to the spectral lines of the nuclear blast with a screen transparent for the spectral lines of an element which is found in any organic compound. This is the element carbon.



WO SPECTROSCOPES with associated screens, sensors and circuits would suppress unlight signals and transmit only nuclear blast signals.

Lockheed's X-7 Missile Enshrined at AFMDC

ALAMOGORDO N.M.—The **Lockheed** *X-7* ramjet-powered test missile has been enshrined at the Air Force Missile Development Center in New Mexico where it set the Free World's speed and altitude records for air-breathing vehicles.

It was over the New Mexico desert test range of the AFMDC that members of the Lockheed-designed and developed *X-7* family flew in excess of four times the speed of sound—in the neighborhood of 3000 miles per hour —and reached a record (still classified) altitude at the edge of the upper atmosphere.

Magnetic Tape Recording Sales Booming

This year should see 700,000 units sold but most promising future application will be in astronautics for photo-reconnaissance

by Robinette E. McCabe*

REDWOOD CITY, CALIF.—One of the fastest growing industries in the United States is the magnetic tape recording industry. Since the appearance of the first tape recorder on the American market just twelve years ago, few devices have spread so far so fast.

Its success is attested by today's status of the industry, which has mushroomed into a multimillion-dollar business, with gross sales for 1958 exceeding $72,000,000 for 410,000 units, according to the **Electronic Industries Association.** Although future estimates vary, it has been predicted that between 650,000 to 700,000 recorders will be marketed in 1959, boosting overall sales to $140,000,000.

First adopted for radio and home entertainment purposes, the tape recorder has spread in all directions until now it is a basic tool for advanced scientific activities, contributing heavily to research and military programs in missile development, satellite tracking, and related laboratory instrumentation procedures. Less known than for its brilliant entertainment contributions, this complex area holds great promise for the future of magnetic tape recording.

Tape equipment manufacturers refer to this area as the "instrumentation" field. These applications have been a major factor behind the recent burgeoning of the industry, and current trends indicate that the next few years will bring even more extensive progress in this direction.

The fertility of this field can be shown from the growth of the **Ampex Corporation** whose concentration in this area accounted for 50% of the total instrumentation sales in the United States in 1958. Less than ten years ago, the company was doing a gross annual volume of $350,000 a year. In 1958, the company's volume was $44 million.

• **Forces behind use**—Like any major development, the application of the magnetic tape recorder in such a spectacular manner has been the result of a practical as well as theoretical expediency. By the end of World War II, a storing element—a "gadget with a memory"—was badly needed: scientific, industrial, and defense agencies were swamped with data vital for emergencies and the solution of immediate problems.

The technical advantage of magnetic tape as a recording medium is attributable to:

1) Its capacity to record any phenomena which can be converted to an electrical impulse, over a wide frequency range with minimum distortion.

2) It will store more information per unit length than any other medium.

3) It requires no processing (no chemicals are required to *develop* it), and thus immediate reproduction is possible.

4) The time base can be altered—which is something no other medium provides. This permits events to be recreated on playback either faster or slower than they actually occurred (using a 10:1 contraction rate, for example, an hour of missile test recording can be reproduced in 6 minutes).

In many cases, these four characteristics of the tape recording process permit the attainment of results which cannot be achieved in any other way.

• **From wire to tape**—The first magnetic-recording device was demonstrated experimentally at the Paris Exposition in 1897 by Valdemar Poulsen, a Danish scientist. Acclaimed the electrical marvel of the age, it nevertheless remained relatively obscure and undeveloped until World War II.

During the war, both U.S. a German scientists attempted to repr duce magnetic recorders suitable f military use in recording sound a coded messages. The Americans co centrated on developing a wire corder, but the Germans concentrat on magnetic tape. When Germany s rendered, Allied technical teams d covered magnetic tape recorders many of the enemy's military and gc ernment broadcast installations.

Several units were shipped to t United States where it was demc strated that magnetic tape had greater versatility than wire. For o thing, tape can be edited. This is r feasible with wire since it cannot spliced without distorting the magne signal. And, where ease of manipu tion is a major factor, the reason tape's popularity is obvious.

The first practical recorders audio use were introduced in t United States in 1948. The units we immediately successful and thousar of machines were installed in broadc and sound studios.

• **Instrumentation next**—Almo simultaneously, missilemen recogniz the potential of magnetic tape. In l 1948, the Naval Air Missile Test Ce ter at Point Mugu, California, had audio-type recorder modified for te metering and used as a "back-u or check, for strip-chart recorders. soon became the primary method recording the missile flight test data acceleration, fin flutter, rate of f consumption, flight curves, tempe tures, and a dozen other vital elemen

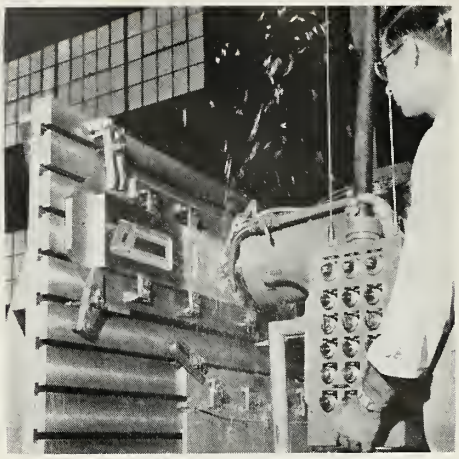
The problem in the missile fi was clearly defined: more and mc information in less and less time. T manufacture of tape and other reco ing components was sufficiently a vanced to meet the need. Magne tape's pre-eminence for this testi rests in its ability to capture millic

* Ampex Corporation.



← **AMPEX MR-100 tape survived *Thor* flight and nine days exposure in Atlantic.**

→ **RECORDERS are being used extensively for machine control. Here's close up of Giddings & Lewis Profiling Machine.**



f separate measurements in relatively hort periods of time. Receiving the utput of dozens of transducers on and ithin the system, it can be used to easure almost any variable at any oint.

• **Development**—To accommodate issile requirements, an intensive delopment program (which is still goig on today) was undertaken. Because he amount of information that can be tored per unit length of tape depends n the width of the tape and the numer of tracks on which the data is nscribed, bandwidths were increased rom the normal 15 kc, which is satisactory for audio use, to 100 kc and eyond.

Tape widths were increased from 4 to 1 inch, which is the width of ost computer tapes. (For most instruentation purposes, 100 kc and 1″ pe is satisfactory, although in teleision recording bandwidths as high as megacycles can be recorded successully, and 2″ wide tape is used.)

The upward trend in channels of nformation increased from a single hannel, to 7 channels, to 14 channels, o 16 channels, and to 32 channels per nch of tape.

The tape speed was increased for wo reasons. First, because the amount f data that can be inscribed per unit f time depends upon the speed of the ape and, secondly, because high ransfer rates for computer and telemery applications demand higher speeds. Although the speed at which tape noves past the recording head in home achines is generally 7½ or 3¾ inches er second, tape handler speeds are as igh as 150 ips for computer and elemetry use.

The result of the improvements is n evidence at missile testing installaions. In a typical use, a single facility or handling test data transmitted from *Atlas* and *Thor* ballistic missiles, utilizes 23 laboratory-type instrumentation recorders and is capable of correlating as many as four million measurements in three days' time.

Additionally, it has proven to be an instrument of immense scope in the missile field for it is used in several ways.

• To guide the missile. It activates electronic devices which control the path of the missile.

• To recover information from space. Miniature missile recorders ride in the missile nose cone and radio outer-space information back to receiving stations.

• For data reduction. The recorder is used with computers and other automatic data-handling devices to reduce the data to usable form.

Sizes and weights of these recorders vary according to their specialized purposes, but all of them are rugged. One sturdy little missile recorder recently survived a U.S. Air Force missile flight and 9 days in the Atlantic Ocean, yet was able to perform perfectly when retrieved from the water and tested. Used on a *Thor-Able* missile flight that carried a **General Electric**-developed plastic sphere, the recorder was imbedded in the nose cone. Before the cone struck the water, the recording unit was thrown free to fall independently.

Surviving the tremendous vibrations and shock of the launching and re-entry periods, as well as exposure to the water, it performed to specifications as soon as a new tape reel had been installed.

• **Flight testing**—Magnetic tape nearly revolutionized data acquisition for aircraft flight testing programs. In the early days of flight tests, the pilot would read the instruments on his control panel and note his observations on a pad strapped to his knee.

As design techniques were refined, test engineers required more extensive data and introduced more automatic methods of data acquisition to free the pilot from his primary mission of flying the plane. Measurements were brought to dials mounted on a panel which was photographed by a motion-picture camera. Pen-and-ink graphic recorders and other devices permitted continuous recording of high-frequency information, such as vibrations and flutter.

Many of these techniques are still in use today and serve a purpose. But, as in the missile industry, the demand for more and more measurements and a more rapid reduction of these measurements to usable physical quantities upon completion of the flight, required the use of more modern techniques.

Tape's ability to store over 8 million measurements during a 2-hour test flight on one standard 10½″ reel of tape proved so appealing that tape recorders are now used in all major aircraft laboratory and test facilities, both commercial and military. **The Boeing Aircraft Company,** in employing it in the KC-135 jet tanker flight testing, samples each of 420 separate measurement points at the rate of 2.5 times/sec.

If these measurements were to be recorded on photo panels, or on oscillographs, several weeks of concentrated effort, involving large numbers of persons, would be required to reduce the data by manual means before the design engineer would have the significant numbers to either correct or improve the design. In accelerated aircraft programs, time lags of this magnitude are too costly to be tolerated.

• **Machine control**—Also, recorders are being used extensively in the aircraft and missile industries in quite another way. This is for machine control. Because you can electronically record motion on tape, many milling machines

no manual control required . . .

and profilers now take their cues from recording systems.

If you were to walk into a spacious bay at **Convair Division** of **General Dynamics Corporation's** big San Diego Plant 2, you could see a massive skin miller gnawing methodically at a 10′ by 30′ plate, removing 25 pounds of metal in 15 minutes flat. Down the road a few miles at **Rohr Aircraft Company's Chula Vista works,** a horizontal profiler makes metallic mincemeat of a rough aluminum forging.

There is no manual control at either machine, but there is nothing haphazard about the paths followed by the cutting tools. It is instead precision machine tooling, called "numerical control"—or machining by numbers. Like the roll that controls a player piano, magnetic tape provides an accurate system of guidance. Through digital recording, information can be transferred at rates up to 90,000 characters per second, permitting machining techniques far beyond the capability of human hands.

• **Video tape**—But the refined and accurate recording of sound was but the first step. An event almost as great as development of the tape recorder itself occurred in 1956 with the addition of a picture to tape.

The first machine was demonstrated in Chicago at the National Association of Broadcaster's Convention. Despite the fact that the machine was priced at $50,000, it received an immediate welcome in the television industry and now stations equipped with these units are able to reach 95% of the television sets in America.

The addition of a picture to tape was pioneered by the Ampex Corporation which, as of now, is still the only company to deliver production units of television recorders to the television industry.

But even more interesting is the fact that even before the machine was in production for commercial television purposes, the prototypes were sold for instrumentation purposes. One of the first three prototypes went to the White Sands Proving Ground where the Army Signal Corps is using it to track missiles. A highly classified project when it was first proposed, the U.S. Army recently announced its successful use on hundreds of missile firings.

The radar signals are picked up at five stations strung out over the 4000-square-mile range. Because radar signals are in a frequency range still too high to be recorded by any known means without conversion, a radio receiver converts them to a lower frequency. Yet the amount of conversion that can accurately be accomplished is limited, and this leaves the high-frequency radar signals still out of range of most recorders. A Videotape (TM Ampex Corp.) recorder, with a frequency response up to 4 mc, does the job. In the period since this first prototype was pressed into use, many other Videotape recorders have been sold for instrumentation purposes.

Taking a cue from colleges and universities across the country, rocket and missile installations are using them for educational purposes, too. At the Redstone Arsenal in Huntsville, Alabama, for instance, twice each month by means of closed-circuit television, senior Army officers are taught the complicated business of rocketry—a teaching program produced for the Army by the **TelePrompTer Corporation.** One end of the classroom is in Huntsville, and the other end is 278 miles away at Fort Knox, Kentucky.

• **Its future**—Applications involving telemetry (the transmission of measurements), static testing of rockets and missiles, laboratory research, medical recording, and machine tool control form the foundation of today's instrumentation business. For the future, it is expected that it will continue to serve in all of the categories where it is presently being used. Also, it is envisioned that it will radically expand in some of the areas as the government moves toward more missile and space projects, with vast research and development programs geared to these activities.

One of its most exciting future applications will be in space. And the new tape method—magnetic photography—is certain to be used. Even now, plans are being considered for a space recorder for a proposed flight involving photo-reconnaissance of Mars. This test envisions the launching of a rocket from the earth that will take a little over two years before its return. During this time, it will circle Mars, with the recorder photographing the surface as the space vehicle passes by. The photographic information will be radioed back to earth as the space vehicle returns near the earth's atmosphere.

However, the airborne picture recorder will not have to wait for a trip to Mars to prove useful. Equipment is now being built that will permit tape's use for operational missions which include intelligence reconnaissance, weather reconnaissance, and infrared photo-mapping. Since these wi be airborne recorders, with recordin ability only, there will be a correspond ing increase in ground reproductio and data processing equipment fo these missions. Even conservativ studies indicate that this field ma dwarf all previous applications.

It is assured that the testing o military and commercial aircraft—witl its attendant use of the recorder—wil continue over the coming years. It addition, the arrival of the commercia jets for public transportation, brough more business for the recorder. Th Federal Aviation Authority has aske for a jet performance and crash re corder, designed to withstand the intens heat and shock of an accident, for al jet airliners. Also, the FAA may us tape to activate electronic devices use in new air traffic control systems.

• **Problems**—Future space record ing will require surmounting hundred of problems, but today two of th biggest appear to be improved syste fidelity (accuracy of performance), an miniaturization of equipment.

Fidelity limitations of the record ing system are primarily centere around the tape. The mechanical fea tures and electronic component relia bility of the tape recorder can als limit the system, but by far the big gest drive for improvement is centere on the tape, and on the record, re produce, and erase heads which com in contact with the tape. For it is fel that the steady improvement of th magnetic heads may help to overcom some of the inherent characteristics o the tape.

To discuss the problem require some elaboration on the structure o magnetic tape and the recording proc ess. All tape consists of a non-mag netic base which supplies mechanica strength. Since the thickness of th base material varies from 0.0005″ t 0.0015″, it must be of considerable strength or it would support no stress at all.

Favorite base material for instru mentation uses is Mylar, a **Du Pont** manufactured plastic. Chemically, it is polyethylene terephthalate, formed by the condensation reaction between ethy lene glycol and terephthalic acid. A polymer with an oriented molecular pat tern, it exhibits a smooth surface, uni form thickness, and a resistance to high temperatures and humidity. To this Mylar base is added the magnetic iron oxide particles, ground to a micro scopic size. They are combined with a binder and applied to the base with pre cision equipment.

The tiny magnetic heads in a re cording system perform three vital functions. The record head converts in formation—in the form of encoded

electrical signals—into a pattern of magnetization upon the tape. The reproduce head reconverts this magnetization pattern into electrical signals again, to be decoded and put to an array of practical uses. The erase head obliterates old information, leaving the tape clean for further use.

It is an extremely sensitive technique, and herein hides the problem. For, in spite of all reasonable precautions, the surface of the tape does not end up entirely smooth and homogenous. Small defects manifest themselves by instantaneous lapses or reduction in signal level, which are referred to as "drop-outs."

The most serious of these are "nodules" or clusters of oxide particles which form along the surface of tape. As these nodules pass across the head, they cause the tape to be lifted away from the head and result in defective recording. A similar difficulty will occur if a foreign particle of dust is permitted to find its way onto the surface of an otherwise perfect tape.

Illustrative of the reliability problem are the difficulties experienced with Videotape. The extreme fidelity demanded of Videotape, which must accept ten times more information per unit area than audio tape, produced an inordinately high rejection rate when the tape was first introduced.

In addition to achieving a reliable, flawless surface, positive steps will have to be taken to extend tape's environmental limits. The physical properties of Mylar are relatively unaffected throughout the temperature range of −20° to +80°C. It remains flexible without signs of embrittlement at temperatures as low as −60°C.

But as the temperature is increased above 80°C, it behaves like an elastimer, finally melting at about 250°C. Several new resins that appear to be potentially useful have appeared recently. For example, polyurethane, an isocyanate derivative, can be produced in forms not unlike conventional plastic products, and some manufacturers claim its useful range to be as low as −60°C and as high as +200°C (the magnetic iron-oxide material presents a problem only at about +400°C when it reverts to nonmagnetic form).

As might be expected, the size and weight of mobile recorders for missiles and aircraft has been ever downward. Completely transistorized systems, lightweight metals, and miniature mechanical components have been used. These techniques have helped, but equipment will have to be shrunk much further.

There no longer appears to be a question of whether the magnetic tape recorder can serve as a useful tool in rocket and missile applications, but rather how it can serve the best.

Engineering and management opportunities in...

RCA SYSTEMS SUPPORT PROJECTS

RCA offers expanding opportunities in Weapon Systems Support projects. This work involves program planning, advanced operations analysis, systems analysis, equipment development and design, and systems integration. Experience is desired in the many areas of systems support—checkout and test equipment, logistics, and training.

Exceptionally fine professional and management positions are available to EE's, ME's, Mathematicians, and Physicists with at least five years of experience.

Salaries are excellent; opportunities for advancement, unlimited. Benefits are among the best in the industry. Several current Systems Support Project areas are:

Aircraft electronics systems

Military and civil digital communications systems

Missile systems

Space vehicles and space stations

FOR INTERVIEW WITH ENGINEERING MANAGEMENT:

Please send complete résumé to:

Mr. C. B. Gordon
RCA, Box Z-22H
Professional Employment
Building 10-1
Camden 2, N.J.

EQUAL JOB For All Qualified Applicants OPPORTUNITY

RADIO CORPORATION OF AMERICA
Defense Electronic Products

New Techniques Aid Electronics Cooling

Basic methods of heat dissipation in components are the same but the applications can vary. Here are the principal cooling methods.

by Hal Gettings and Charles D. LaFond

WASHINGTON—Electronic components cooling is a part of equipment overall cooling design that must complement the system or it might just as well be eliminated. Where system cooling transfers heat to the ultimate sink, components cooling transfers unwanted heat in such a manner that it can be picked up by the greater heat exchange mechanism.

Basic methods of heat dissipation are the same—only the applications vary:

- Cold plate mounting (air, liquid or evaporative)
- Direct forced air convection
- Free convection to ambient air
- Radiation heat transfer

Other methods, such as direct liquid cooling, could be used but these are the most commonly encountered.

• **Cold plate cooling**—A common and often quite satisfactory method of cooling electronic equipment is by conduction or cold plate cooling. In a recent paper by Mr. J. R. Baum, a senior staff member of the **Motorola, Inc.**, Mechanical Engineering Laboratory at Phoenix, Ariz., the application of cold plate cooling to an airborne radar receiver/transmitter was described. It was emphasized, however, that the design method provided the same general approach employed in all cold plate cooling of electronic equipment.

The method was chosen in this instance for several reasons. Pressurization of the unit for electrical reasons was a requirement. The most severe temperature—altitude requirement established for the equipment was 131°F at 10,000 feet. The equipment had a total power dissipation of 430 watts and was designed for operation in ambient temperatures up to 131°F for continuous operation and 160°F for short periods of time.

It was estimated that if no cooling provisions were made in the equipment design the unit would have at least a 100°F rise over the ambient temperature in the external surface. In addition, the maximum electronic component temperature rating was 185°F. Because of pressurization, direct forced-air cooling through the equipment could not be used.

To support the cold plate conduction cooling, forced air was to be employed for cooling the component mounting structure. This was accomplished by employing a split casing mounting bulkhead. This was installed horizontally and separated to provide the space through which ambient air could be forced by means of small external blowers. To better utilize available space and for better air distribution two small blowers were employed rather than one large unit. To increase the efficiency, a series of fins parallel to the air flow were used to provide maximum heat transfer.

• **Forced air convection**—The term "forced air convection," usually refers to the use of blowers or externally supplied cooling air for circulation within the electronic equipment. Thus a source of moving air is available for cooling, but without the refinements of cold-plate construction.

Air velocity over a dissipator can be increased by the use of baffles or ducting to direct and increase the local velocity of the available air over the desired area. A short dimension in the flow direction is desirable and this may dictate the baffle orientation.

Where no central forced air circulation exists, it may still be necessary to provide for high rates of local heat dissipation by use of small blowers. A number of miniature blowers are available to meet a variety of situations. The choice would be based on the required velocity, space, and other requirements.

• **Free convection**—Probably the most common method of getting rid of heat in electronic equipment is by free convection. Where components are mounted on metal chassis of larg area, in room ambients, usually no ser ous problem exists. With higher am bients and denser packaging, the prob lem can become acute.

One common decision to be mad in orientation of the dissipator i whether it should be mounted hor zontally or vertically.

In general, Motorola has foun that vertical surfaces with the shor dimension vertical are the most de sirable. A series of short vertical fin very close to the component i effective. This configuration also min mizes the distance from the componen to the dissipator and reduces th accompanying internal thermal resist ance of the dissipator. Because of th extremely low value of convection hea transfer, there is a need for providin maximum dissipating area and mini mizing thermal resistance up to the dis sipating area.

• **Radiation heat transfer**—Radia tion heat transfer is important with fre convection, since it can be of the sam order of magnitude as the convectio term. In considering radiation hea transfer, emissivity and shape factor are the only terms capable of being in creased.

The shape factor is fixed by th overall orientation of the dissipato with respect to its surroundings. Thi is a function of the particular con figuration and cannot be easily altered

The emissivity factor is a direc function of the finish, or radiatin "color," of the dissipator and the re ceiving surfaces. A highly emissive finish such as flat black is desirable Surface finish is one factor often over looked where the heat transfer can b increased with practically no effort. T attain the best possible surface fo radiation, a high emissivity surfac should be provided on both the dissi pator and receiving surfaces.

• **Electron tube cooling**—Majo cause of failure with miniature electron tubes, revealed by exhaustive investiga

ions by many manufacturers and the government, is excessive operating temperatures. To reduce this failure cause, a number of cooling methods have been utilized.

Where component density is not a problem, an airflow directly over the tubes has been successful.

In high-density packages adequate cooling is a great problem. In addition, the metal tube shield used for electrical shielding tends to add to the problem.

Motorola has determined after extensive testing that the use of heat dissipating shields and inserts can help to minimize this difficulty. A substantial improvement in thermal performance results. Also, the investigation showed that horizontal types were considerably more efficient than vertical types.

The most common method of utilizing these tube heat dissipators is to employ some form of clip, shield, or mount to grip the tube envelope. This provides a means of conducting heat to the chassis, cold plate, etc.

• **Power transistor cooling**—Generated at the collector, heat in a power transistor must be transferred to the ultimate sink through a thermal path between the sink and junction. Thus it behooves the design engineer to understand the limits of various mounting methods.

The design of most power transistors provides for the best possible internal thermal path between junction and base. Also, the base is provided with sufficient area for proper heat transfer to the dissipating device.

Of the various methods of heat transfer, cold plate cooling offers the fewest problems in transistor mounting. If the transistor is mounted without an electrical insulator, only the bare surface contact resistance is present. Addition of an electrical insulator such as mica or Mylar will further increase the resistance to heat transfer.

For various insulators, the contact resistance is the governing factor rather than the insulator thickness. In general, the mating surfaces should be as smooth as possible with maximum contact pressure. Minimum insulator thickness should be used, consistent with electrical requirements. If possible, a conductive grease should be applied in the joint. The use of a surface-treated thin metal washer, such as anodized aluminum, appears to have some merit.

The use of a highly thermal-conductive material is the best method of assuring efficient dissipator performance. Consistent with weight and space requirements, a large enough cross-sectional area should be used to increase conductance. When weight limitations are involved, thermal conductivity and material density must be considered together. On this basis, it has been found that for the same weight the conductivity of magnesium and aluminum are superior, in that order, to copper. This is true in spite of the fact that magnesium and aluminum have a lower thermal conductivity than copper. Where space alone is a consideration, then thermal conductivity will govern.

The distance between the transistor base and the midpoint, or average temperature point, of the dissipator should be kept to a minimum consistent with the thermal conductivity and thickness. This particular point must be considered, together with the necessity for having sufficient dissipator surface area. For example, if an increase in horizontal dissipator area is required in a particular case, then the thickness or material conductivity must be increased proportionally. Failure to do this can increase the resistance to heat transfer in the dissipator at the same rate that heat transfer from it is being increased —with no net gain.

One approach to this problem is to provide a dissipator configuration (such as vertical finning) so that the distance between base and average temperature point may be kept short with no loss in area.

In some cases the designer can choose the method of dissipating the heat to the ultimate sink. If this is the situation, the selection of dissipator and cooling methods go hand in hand. It is assumed that the dissipator provides the conductive link to the final method of dissipation to a sink. So-called conduction cooling still requires final dissipation to the ambient air or to a coolant fluid at some point.

• **Miniaturized IR cooler—Arthur D. Little, Inc.,** of Cambridge, Mass., has developed a tiny cooling device which super-chills infrared detection equipment to 60° Kelvin (−350°F). It employs a new refrigerating technique which may prove to be a significant scientific achievement.

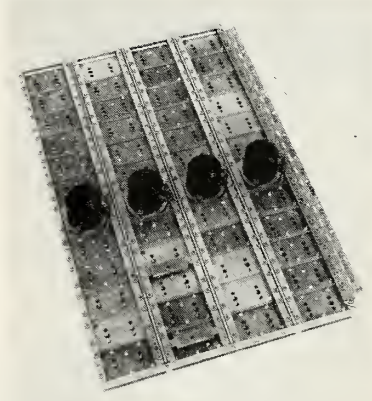
The eight-ounce min-IR cooler resulted from a two-year research project into extreme low temperature equipment conducted by Dr. Howard O. McMahon and William E. Gifford at Arthur D. Little, Inc. Cambridge research and engineering company. It was unveiled at the 1959 National Missile Industry Conference in Washington, D.C.

Development of the system for infrared applications is being conducted by ADL and **Hamilton Standard, Division of United Aircraft Corp.,** Windsor Locks, Conn.

The heart of the system is the cooling head which is inserted into or preferably made integral with the IR cell dewar. System operation is based on regenerative precooling of



THIS Arthur D. Little-developed min-IR-cooler is a low-pressure, closed-cycle refrigeration device developed for use with IR detection equipment.



THIS environmental conditioning system by AiResearch utilizes a series of modules to serve as a cold plate.



WEIGHING two pounds, this Dunham-Bush ethylene glycol-to-air heat exchanger has capacity of 5460 BTU/hr (1600 watts).

wider range response . . .

relatively low pressure gas and performance of work by the gas during expansion.

The closed system consists only of a compressor and the cooling head. The cooling head contains inlet and exhaust valves, expansion piston, regenerator, and cylinder.

In operation, helium gas expands from 300 psi in a ¼" diameter cylinder, 2" long. A tiny plastic piston is the only moving part of the unit below room temperature. The cold end of the tube refrigerates an infrared cell to 60° Kelvin. (Cooling infrared detectors to extremely low temperatures increases their sensitivity and makes them responsive to a wider range of IR wave lengths.)

Since gas cooling is achieved through an expansion work cycle and not through the Joule-Thomson effect, porous plug clogging difficulties are eliminated and maximum system pressure (and thus component size and weight) is greatly reduced. Hamilton has stated that the closed system presents no limitations on stand-by or service operative periods and is logistically simple.

This device is considered to be the first satisfactory miniature refrigerator for extremely low temperatures.

The same principles used in the min-IR-cooler are being applied by ADL to other areas of low temperature.

• **Peltier cooling**—The practicality of applying Peltier cooling to a telemetry package has been shown by Ray Marlow of **Texas Instruments, Inc.,** in a paper presented at the American Rocket Society's Semi-Annual Meeting in San Diego in June.

To optimize performance in a missile-borne telemetry system, components must be protected against extreme or sudden temperature variance. The operating characteristics of transistors and diodes are particularly influenced by operating temperatures.

If the package is provided with thermal insulation, heat build-up resulting within the system must be controlled by some means of disposal. This is particularly true in a satellite having a long flight time. Also, during long pre-flight checkout operation of missiles, this problem is manifest.

Marlow suggests that here Peltie cooling and heating appears to offer solution in airborne or missile elec tronic equipment.

The Peltier effect is achieve through the direct conversion of elec trical energy to thermal energy by pass ing an electrical current through tw semiconductors in series. One junctio of the thermoelectric element become cold and the other hot, depending o the direction of the current. The col or hot junction will provide an environ ment in which the electrical compo nents will operate with increased reli ability in a telemetry package.

The great advances in semiconduc tor materials in the past years hav permitted improved performance o the Peltier effect. The use of thi method of component cooling coul provide a thermal environment tha would lengthen component life expec tancy. Reliability is inherently hig since there are no moving parts in volved.

Marlow indicated that the limitin factor of Peltier cooling is the materia itself used to make the thermoelectri thermo-elements. But, he believes th use of Peltier cooling and heating wil increase with the advance of the state-of-the-art in semiconductor materia fabrication.

Look...

Trevarno

HIGH STRENGTH—HIGH TEMPERATURE PHENOLIC MOLDING COMPOUNDS solve many missile problems for Aerojet-General where high temperature insulation with good strength-to-weight ratio is required.

For information about how Trevarno Resin Pre-Impregnated Glass Fabric can help you solve your problems, write or call District Office nearest you:

Los Angeles:
635 S. Kenmore Street—DU 8-5260
Dallas, Texas:
4924 Greenville Ave. — EM 8-7871
In the Midwest:
115 N. Main St., South Bend, Ind.
CE 3-1821 . . . or write directly to
Coast Manufacturing & Supply Co.
P.O. Box 71, Livermore, California

Trevarno
GLASS FABRICS



Ease of fabricotion, both in time ond lobor required, lower cost of tooling, high gloss content, give these parts their strength-to-weight rotio.



Trevorno high strength, high temperoture phenolic gloss molding compounds ore used extensively where housing for electricol components ore required becouse of its excellent insulating properties.



missiles and rockets

2nd ANNUAL MISSILE SUPPORT ISSUE

SEPTEMBER 21, 1959

From the magazine which is first and best in Missile Support—the most accurate picture available of the tremendous Missile Support field, which takes a big slice of every missile dollar. Penetrating articles and reports by recognized experts and experienced M/R staff members help you reach the heart of this multi-billion dollar market . . . through the pages of the technical/news weekly of the missile/space industry. Contact your *missiles and rockets* representative today, and find out how you can put your sales message before the men who make the important decisions concerning Support System equipment and capability.

NEW YORK CITY: 20 East 46th Street YUkon 6-3900 • DETROIT: 201 Stephenson Bldg. TRinity 5-2555 • CHICAGO: 139 N. Clark Street CEntral 6-5804 • LOS ANGELES: 8929 Wilshire Blvd. OLeander 5-9161 • MIAMI: 208 Almeria Avenue HIghland 4-8326 • TORONTO: 12 Richmond Street E. EMpire 4-2001 • LONDON: 28 Bruton Street GRosvenor 8356 • PARIS: 11 Rue Condorcet Tru 15-39 • GENEVA: 10 Rue Grenus 34 66 73

ADVERTISING FORMS CLOSE SEPTEMBER 1, 1959

M/R

missiles and rockets

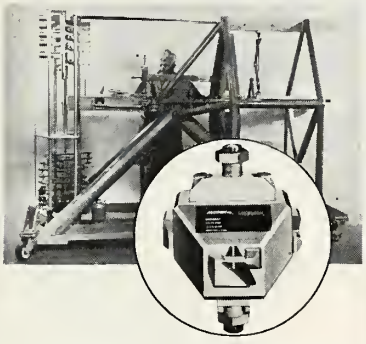
AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

major breakthrough in flexure technology

— a *completely* universal pivot

— ranges to 1,500,000 pounds



This unique flexure permits true universal motion in any direction about a point. Unit is frictionless, and stable. It provides maximum axial stiffness with minimum rotational restraint. The design eliminates looseness, slop, and wear, permitting exceptional precision and reliability in small space.

applications:

MISSILE STATIC and DYNAMIC TEST FIXTURES

PRECISION WEIGHING SYSTEMS

FATIGUE MACHINES and/or SUPPORT OF TEST SPECIMENS

HELICOPTER DRIVE SHAFTS

Complete data on request. Bulletin 200.

Aeroscience inc.

3155 N. Rosemead Blvd., Rosemead, Calif.
ATlantic 0-2112

propulsion engineering

By M/R STAFF

Solar sail propulsion. . .
will be a reality "fairly soon." T. C. Tsu, advisory engineer, mechanics department, **Westinghouse Research Laboratories,** believes that a solar sailing project can be "realized fairly soon without extensive research and development." He discusses the characteristics and advantages of "Interplanetary Travel by Solar Sail" in the American Rocket Society Journal, June. Tsu presents solutions to the equations of motion and optimization of sail tilt angle. He also computes travel time and general performance compared with chemical and ionic propulsion.

Think of a solar sail vehicle . . .
as a rocket with unit mass ratio and an infinite propellant reserve, says Tsu. He refers to R. L. Garwin's paper, "Solar Sailing—a Practical Method of Propulsion within the Solar System," Jet Propulsion (ARS Journal), March 1958, for figures on cost and feasibility. "The solar sail is of negligible cost," Tsu summarizes, "and is perhaps more powerful and less difficult than many often-cited and competing schemes." A solar sail operates by the pressure of sunlight falling on a sail made of ultra-thin aluminum foil or aluminized or silvered plastic sheet. This is the radiation pressure principle, known to physicists and parlor trick fans for many years.

Advantages of solar sails are numerous . . .
The ship's mass remains constant; sail force is available for the ship's entire journey; neither fuel nor other propellant is needed; no powerplant is needed, and consequently there are no waste heat disposal problems. Although the force is very small compared with that available from chemical rockets, Tsu points out that the force is available for as long as it is needed.

"A trip to Mars or Venus can be made . . .
in less time by solar sail than by chemical rocket," says the Westinghouse engineer. A solar sail can return to earth or make in-flight navigational corrections whenever necessary. Since it moves at a non-uniform speed under a non-central force system, the sail's contents are not entirely weightless. However, the weight of a load would be much less than on earth.

New oxidizer data handbooks . . .
are available from a leading manufacturer of rocket propellant oxidizers, **Allied Chemical's** General Chemical Division (40 Rector St., N.Y.C. 6). Allied offers a 29-page bulletin on fuming nitric acid, both white and red, properties, corrosion data, storage and handling directions. The company also offers a bulletin on both gaseous and liquid fluorine, and a work on chlorine trifluoride, which also includes data on the other halogen fluorides. These data booklets supplement the existing Allied library on oxidizers: Handling elemental fluorine gas in the laboratory, liquid fluorine unloading procedure, chlorine trifluoride vapor pressures.

USSR is bragging about chemical progress . . .
made since the Communist Party central committee meeting a year ago last May. That was the meeting at which Russia decided to accelerate chemical industry development, especially production of synthetics. The Soviet Embassy (Washington) says the industry has "overfulfilled the 1958 plan for gross output." Production was 13% over 1957 production, and the first five months of 1959 show production up 11% over 1958, the embassy statement says. Included among the items cited, are jet engine compressor blades.

Alcohol from crude oil . . .
is up, the Russians say. Last year, the USSR produced 26 million decaliters of alcohol from crude oil. Although the Embassy release does not spell it out, there is a strong hint that the majority of Russia's alcohol in the past had been produced by the fermentation process.

(Continued from page 9)

ffort to make space . . .

ehicles invisible to radar and other racking techniques is picking up steam. epublic Aviation has placed contracts ith General Applied Science Laboraories, Flight Support Inc., ANTALAB c., Fluidyne Engineering Corp. and ynametrics Corp. as part of its proram to develop design techniques. Proram almost certainly involves use of lastics, since no metals are transparent electro-magnetic radiation.

• • •

lavy will spend $12 million . . .

1960 FY to develop special ASW etection system—believed to be kind f a "wet DEW line" for submarine etection.

SPACE MEDICINE

apsule "K rations" . . .

hich would be propelled into astroaut's mouth while in space by a slot achine device is suggested by **Southest Research Institute** scientists as alrnative to squeeze bottles. Shell as ell as filler of the pills would have utritive value.

MANUFACTURING

Army Engineer R&D Laboratories, ort Belvoir, has new AC-DC inert gas c welder for working on very thin auge metals such as those used in *edstone* . . . Successful flight of **Temp Aircraft Corp's** prepackaged liquid opellant *Corvus* came only after hardon victory over troubles with spun etal propellant tanks . . . **Beech Aircraft Corp.** has received $1.5 million ntract for KDB-1 Army drones . . . 54,000 cubic foot seamless nylon raom capable of standing winds up to 0 mph and temperatures –65°F to 5°F has been developed by **Aviation roducts Division, Goodyear Tire and ubber Co.** . . . **Bowmar Instrument orp.** has $65,000 contract to produce *ershing* transmission unit . . . Twory missile assembly building containg 40,000 square feet of space and om for test and checkout of two *tlases* is now being built at Vandenrg AFB. A&E is by **Welton Becket & ssociates** . . .

Satellite clock and time programmer being developed by **Waltham Precion Instrument Co.** under **McDonnell ircraft Corp.** contract for *Mercury* psule. Device will set into motion lit-second schedule of 13 important activities, including re-entry . . . New entry in liquid missile and rocket fuel business is **Frontier Refining Co.,** Denver . . . Upcoming soon: Army contract award for *Mauler*, self-propelled missile system capable of providing allweather air defense to forward troops . . . **Aerojet-General Corp.** has Army Engineers contract for design of 6 million pound thrust rocket test stand at Edwards AFB . . . $3.5 million production contract for *Guardian II* pre-packaged rocket engines has been awarded **Reaction Motors Division of Thiokol Chemical** . . . **Stromberg Carlson Division of General Dynamics Corp.** is holder of Rome Air Development Center contract for design and development of 15 antenna assemblies for the Air Force's highly classified Ground Passive Electronic Reconnaissance Facility.

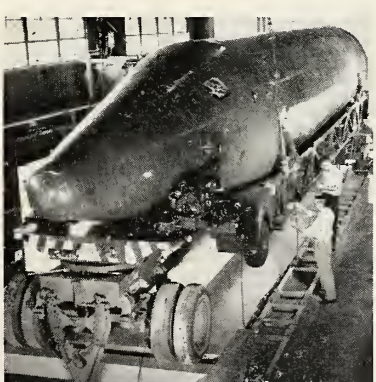
Sonic Burning Control Sought for Solids

Resonance burning, a phenomenon that has bothered rocket engineers for years, may be put to good use. **Acoustica Associates Inc.** of Plainview, N.Y., says it has received a $85,188 contract from NASA to study the possibility of controlling the burning rate of solid rockets through high-intensity, ultra-high-pitch sounds.

David Gross, an Acoustica engineer, said a threshold effect indicates that the control might become operative at a pitch upwards of 10,000 cycles a second. This is a just barely audible note than can be produced on a violin but is about 1½ octaves above the highest note on a piano. The human car is sensitive to pitch up to about 15,000 cycles.

Gross said research by the Russian T. M. Kurbansky and Americans at Georgia Tech seems to show that the burning rate of typical solid propellants can be increased 3 to 10 times by such sonic mixing. At present, the only control available for solid rockets is the on-off type.

Acoustica is a developer of ultrasonic sound equipment used for industrial cleaning and liquid gauging.



ABMA technicians have come up with their own version of "rock and roll." This shake table can put 30,000 pounds through a rotary action providing up to 90,000 pounds gross vibrating force. The facility is about 10 ft. in width and can accommodate vehicles with wheel bases up to 50 ft.

New Regulations Up On Operational Status

New regulations now in the process of coordination by Air Force headquarters will give major weapon system management responsibility to the Deputy Chief of Staff (Operations). Under the new rules, "general operational requirements" will be abandoned in favor of "required operational capability documents" which will be the responsibility of Deputy Chief of Staff (operations).

Since there is still a necessity to evaluate the technical requirements of proposed weapon systems, Deputy Chief of Staff (Development) will issue "system development requirement (SDR)" and subsystem development requirement.

After that it will be up to the Deputy Chief of Staff (Operations) to determine the feasibility of producing a new weapon system, after first determining that the proposal meets both the required operational capability and the system development requirement. At this point, he will order a new system into production by issuing a new "Specific Operational Requirement" and "Operational Support Requirement" document.

By this new method, AF hopes to establish tighter AF management control over new weapon systems. However, official statement indicates that there will be no change in procurement practices.

E-B Gets Contract

Electric Boat Division of General Dynamics Corp. has been given a contract to build the aiming system for the nation's largest radio telescope being constructed by the National Radio Astronomy Observatory in Greenbank, W.Va.

Aerojet-Stauffer Make Alloys

Development of a "new family" of metals for solid rocket casings has been achieved by **Aerojet-General Corp.** and **Stauffer-Temescal Co.** of Richmond, Calif., M/R has learned. The new alloys, of tantalum and tungsten, can be produced cheaply, machined normally, and still withstand the tremendous heat of solid rocket motors.

Aside for the rare metal rhenium, the two components of the new alloys have the highest melting points of any known metal. The joint-effort program carried out by Aerojet and Stauffer-Temescal has produced ingots measuring 5" in diameter and 42" long, from the electron-beam furnaces at Stauffer-Temescal.

The alloys have a melting point which falls between 5430 and 6150 degrees F. The melting points of pure tantalum and tungsten. The tensile strength of the worked 90% tantalum, 10% tungsten alloy at room temperature is 150,000 psi, and at 4500° F. the strength is still about 15,000 psi.

The tantalum/tungsten alloys are very resistant to chemical attacks because of the extreme purity imparted to the alloys during electronic-beam melting. The ingots are worked and fabricated using conventional steel-mill equipment and methods, and are machined by Standard Machine Tools.

Direct re-cycling of scrap has reduced costs of the finished shapes of the alloys. The development program was headed by J. A. Griswold and C. L. D'ooge, project engineers in Aerojet's program of developing solid-fueled propulsion for *Polaris* FBM. Stauffer-Temescal Company is owned by Stauffer Chemical Co. and Temescal Metallurgical Corp.

Centaur Guidance To Be Pure Inertial

Minneapolis-Honeywell has won a $5.4 million contract from **Convair** to develop and produce a pure inertial guidance system for NASA's *Centaur* space vehicle. System will incorporate a variation of Honeywell's "mig" (miniature integrating gyro) that must be capable of putting either 9000 pound payload in 300-mile orbit or "soft" land 1000 pounds on the moon.

One of the companies now engaged in DOD's GLIPAR (Guide Line Identification program for Anti-Missile Research) program is **Technical Operations Inc.**, which has $127,000 contract to develop any "unorthodox" long-term anti-missile approaches. Program is studying everything from "death rays" to anti-gravity devices.

New milling technique utilizing chemicals—but different from conventional chemical milling processes—is disclosed by United States **Chemical Milling Corp.** The company says tolerances of sheet metal can be improved through its "Chem-Tol" method so that the variation of metal thickness is less than ±0.001 inches.

15 *Delta* Engines

Multi-million dollar contract for 15 liquid powered engines for NASA's *Delta* deep space mission rocket has been awarded **Aerojet-General Corp.** by **Douglas Aircraft Co.** Deliveries of the second-stage engines will extend over a two-year period and will be similar to those used in *Vanguard* and *Thor-Able* program. Aerojet says while associated with these programs this particular engine has had a perfect record of nine for nine to date.

NASA is buying 20 modified Navy pressurized flight suits for $75,000 from **B. F. Goodrich Co.** for its *Mercury* astronauts. Evaluation team members wore the suits for as long as 24 hours before the selection was made.

Standard Tests Methods For Relays Proposed

The American Standards Association has virtually completed a proposed industry-wide code establishing standard test methods for relays. The code, first ever to be drafted by industry, will be circulated for comment and approval following a review meeting in New York in September.

Hazeltine Acquires Wheeler Laboratories

Hazeltine Corp. of Little Neck, N.Y. has acquired **Wheeler Laboratories, Inc.**, in a move to double its engineering department. The Laboratories now are wholly-owned subsidiary of Hazeltine.

Wheeler Laboratories' experience has been in microwave, antenna and related fields in the *Nike-Ajax, Nike-Hercules, Titan, Thor, Nike-Zeus* and *Terrier-Tartar* projects.

Hazeltine recently established a test and engineering center in Indianapolis and started construction of an engineering laboratory in Greenlawn, N.Y.

contracts

MISCELLANEOUS

$324,000—Consolidated Systems Corp., Subsidiary of Consolidated Electro-dynamics Corp., Monrovia, Calif., for an automatic data recording and monitoring system to be installed at Thermo Structures Laboratory at Sunnyvale, Calif. (Subcontract from **Lockheed Aircraft Corp.**).

NASA

Aerojet-General Corp., has received "multi-million" dollar contract for the production of 15 liquid powered engines similar to those used in *Vanguard* and *Thor-Able* programs for use in varied NASA space experiments.

$100,000—Applied Science Corp., Princeton N.J., for airborne statistical telemetering equipment for project *Mercury* capsules. (Subcontract from **McDonnell Aircraft Corp.**).

NAVY

$3,500,000—Reaction Motors Div. of Thiokol Chemical Corp., Bristol, Pa., for production of the *Guardian II* pre-packaged rocket engine.

$2,000,000—Pratt & Whitney Aircraft Div. of United Aircraft Corp., East Hartford, Conn., for development of nuclear aircraft engine hardware.

$1,921,672—Convair Div. of General Dynamics Corp., Pomona, Calif., for *Terrier-Tartar* shipping containers and handling bands.

$100,332—Aerojet-General Corp., Sacramento, Calif., for 5KS-4500 X112A rocket engines (reloads) and 5KS-4500 X112A3 rocket engines (new).

AIR FORCE

Scaife Company, Oakmont, Pa., has received a contract for additional *Falcon* missile motor cases, bringing the current orders on this item to almost $400,000. (Subcontract from **Thiokol Chemical Corp.**).

$3,596,026—Gas Industries, Inc., Allentown, Pa., for oxygen, nitrogen. (three contracts).

$875,000—Summers Gyroscope Co., Santa Monica, Calif., for spare parts on the Phase II Vertical Gyro Indicator.

$740,250—Lewyt Mfg. Corp., L.I. City, N.Y. for coordinate data monitor.

$299,906—Melpar, Inc., Falls Church, Va. for weather data record viewer, spare parts, and special test equipment and applicable data (ground support equipment).

$234,646—Stanford Research Institute, Menlo Park, Calif., for design and construction of parabolic antennas.

$117,208—Union Carbide Corp., Linde Co. Indianapolis, for liquid oxygen converters and engineering and maintenance data.

$105,169—Thompson Ramo Wooldridge, Inc., Cleveland, for nuclear regenerative fuel cells.

$97,350—Plasmadyne Corp., Santa Ana, Calif., for investigation of the production of millimeter and sub-millimeter electro-magnetic waves.

$95,985—Convair Div. of General Dynamics Corp., San Diego, for spare parts for center missile bay door equipment assembly.

$88,823—Barnes Engineering Co., Stamford, Conn., for radiation measurements from major missiles.

$88,748—American Institute for Research, Pittsburgh, for development of optimum methods of organizing and presenting SAGE operator job information in semi-training equipment.

$74,739—Schulz Tool & Mfg. Co., San Gabriel, Calif., for operational development of nozzles and adapters for pressure serving advanced missiles and aircraft.

$73,677—Parker Aircraft Co., Los Angeles, for operational development of missile propellant servicing couplings for use on advanced missiles and aircraft.

$68,326—Stanford Research Institute, Menlo Park, Calif., for research directed toward the use of satellite radiation observations in numerical weather prediction techniques.

$56,414—General Communication Co., Boston, Mass., for radar beacons.

$51,948—Elkton Div., Thiokol Chemical Corp., Elkton, Md., for *Cajun* rockets.

$49,626—Aerolab Development Co., Pasadena, Calif., for component parts of the *Nike-Cajun* rocket system.

$39,935—Lowell Observatory, Flagstaff, Ariz., for research directed toward the study of the property of the planets.

$34,982—North American Aviation, Missile Div., Downy, Calif., for research directed toward study of geophysics of the moon.

$34,531—Regents of the New Mexico College of Agriculture and Mechanic Arts State College, N. Mex., for rocket instrumentation engineering services.

ARMY

Aerojet-General Corp., Azusa, Calif., has been named the prime contractor for the design of a six-million-pound-thrust rocket test stand to be constructed at Edwards AFB, Calif. (Amount not disclosed.)

$14,320,690—Sperry Rand Corp., Sperry Utah Eng. Lab., Salt Lake City, for *Sergeant* missiles.

$5,347,428—Convair, Div. of General Dynamics Corp., Pomona, Calif., for feasibility study. (Two contracts).

$3,569,388—Douglas Aircraft Co., Santa Monica, Calif., for repair parts, launching equipment and missile technical representative services. (Three contracts).

$2,000,000—Aerojet-General Corp., Downey, Calif., for further flight testing of two SD-2 Drone systems including design improvements and manufacture of AN/USD-2 surveillance drones.

$1,973,000—California Institute of Technology, Pasadena, Calif., for research and development. (Two contracts).

$1,504,250—Western Electric Co., Inc., N.Y., for development of production equipment for the mechanized production of semi-conductor devices for the *Nike-Zeus* program.

$924,717—Cubic Corporation, San Diego, Calif., for electronic measuring system.

$390,582—General Electric Co., Cincinnati, for fabrication, static and wind tunnel testing of tip turbine, liftfan propulsion system and design and fabrication of wind tunnel model.

$373,269—North American Aviation, Inc., Canoga Park, Calif., for design and development.

$356,265—Paul Smith Construction Co., Orlando, Fla., for construction of G/M launch facilities.

$306,775—Consolidated Systems Corp., Monrovia, Calif., for digital acquisition system.

$274,015—Radioplane Co., Div. of Northrop Corp., Van Nuys, Calif., for supplies and services re missile targets.

$234,614—Aerojet-General Corp., Azusa, Calif., for warhead.

$221,858—Biltmore Construction Co., Clearwater, Fla., for construction of FPS-26 radar tower and facilities at MacDill AFB, Tampa, Fla.

$215,816—Domestic Film Products Corp., Millersburg, Ohio, for air supported tents for *Nike-Hercules*.

$195,114—RCA, Moorestown, N.J., for research and experimental work in connection with radar parameter measurement and improved operation of instrumentation radar sets.

$190,391—U.S. Amalgamated Constructors, Inc., Tampa, Fla., for construction of flight simulator training building at MacDill AFB.

$189,000—Electro Plastic Fabrics, Pulaski, Va., for air supported tents for *Nike-Hercules*.

$187,900—Irving Air Chute Co., Inc., Lexington, Ky., for air supported tents for *Nike-Hercules*.

$179,529—The Berger Bros. Co., New Haven, Conn., for air supported tents for *Nike-Hercules*.

$154,927—Motorola, Inc., Scottsdale, Ariz., for telemetry sets.

$110,250—Bomac Laboratories, Inc., Beverly, Mass., for electron tubes.

$99,431—Aeronutronic Systems, Inc., Glendale, Calif., for study ground effects air-cushion vehicle.

$99,428—General Electric Co., Syracuse, for research and development work to perform modes of failure and reliability prediction studies of pulse cables.

$86,050—Radio Corp. of America, Harrison, N. J., for electron tubes.

$82,583—Raytheon Co., Waltham, Mass., for electron tubes.

$80,635—Tung-Sol Electric, Inc., Newark, N.J., for electron tubes.

$68,598—Aerojet-General Corp., Azusa, Calif., for analysis of fuel developments and rocket engine designs.

$66,776—Minneapolis Honeywell Regulator Co., N. Hopkins, Minn., for *Honest John* adaption kit components.

$60,000—Unit Research, Inc., Cambridge, Mass., for study of wind shear measurements.

$48,103—Bridgeport Brass Co., Hunter-Douglas Div., Riverside, Calif., for redesign of rocket and launcher.

$45,750—Wallace O. Leonard, Inc., Pasadena, Calif., for transducers.

$44,990—North American Aviation, Inc., Missile Div., Downey, Calif., for study of satellite rendezvous.

$44,800—Firestone Tire and Rubber Co., Los Angeles, for guided missile.

$30,800—Firestone Tire and Rubber Co., Los Angeles, for guided missile.

BIDS

Purchasing and Contracting Div., White Sands Missile Range, N. Mex., ORDBS-P&C-A: Mounts for camera, single precision axis, capable of supporting cameras up to 300 lbs. Contractor shall furnish all labor and material in construction of the mount—9 ea.—IFB-ORD-29-040-60-34—Bid opening 16 Aug. 1959. Bid sets available through 16 Aug. '59.

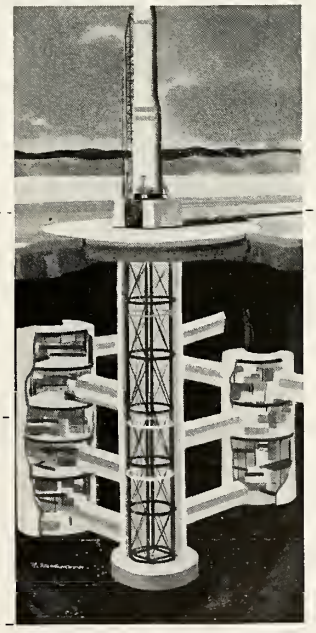
Dayton Air Force Depot, Gentile Air Force Station, Dayton, Ohio. Att: Directorate of Procurement and Production:
Tube electron Klystron type 6BM6A in A/W Spec MIL-E-1D, dated 31 Mar. 58 and ISS MIL-E-1/746C dated 30 Nov 56 S/N 5960-355-7269—3000 ea.—IFB 33-604-60-131B—Bid opening 7 Sept. 59.
Capacitors fixed and variable identified by manufacturers part numbers, 24 items—various quantities—IFB 33-604-60-121B—Bid opening 7 Sept. 59.
Tube electron transmitting RETMA type 673 S/N 5960-669-6864, 275 ea. Tube electron planar triode type 6280/416B in A/W MIL-E1/366A (Navy) Except that qualification approval is not required S/N 5960-NSL, 3400 ea.—IFB 33-604-60-8B—Bid opening 12 Aug. 59.

U.S. Army Engineer District, Norfolk, Ft. of Front St., Norfolk, Va. Construction of Langley *Bomarc* facilities, flight "B" Langley AFB, (A) Twenty-eight launcher storage buildings on piling: Buildings are about 62'x23' with structural steel framing and combination of metal and precast concrete panel siding. These buildings have a sliding roof and required mechanism to open them in a short time. (B) Composite building: Metal building about 160'x160' on piling; (C) Electrical distribution and communication systems; (D) Distribution systems for hot water, low pressure compressed air; (E) Water distribution system; (F) Roads and hardstands; (G) Chain link fencing (2150' plus or minus); (H) Site prep. grading and seeding; (I) storm drainage system.—IFB ENG-44-110-60-1—Bid opening 28 Aug. 59.

1939
Ets-Hokin and Galvan installed "Mousetrap" rocket launchers on U.S. Navy sub-chasers.

1956
EHG pioneered in the installation of electronic systems of test and launching complexes for Intercontinental Ballistic Missiles.

1959
EHG has now installed or serviced the electrical and electronic phases on most of the ICBM complexes in the United States.



Installation Specialists to the Space Age

I INSTRUMENTATION WIRING
C COMPLETE INSTALLATION
B BASE COMMUNICATION SYSTEMS
M MISSILE GROUND SUPPORT SYSTEMS

EHG

ETS-HOKIN & GALVAN
551 Mission Street, San Francisco, California
Wilmington, San Diego, Stockton, Monterey, Oakland, Sacramento, Vandenberg AFB, San Mateo and Downey, California; Cape Canaveral, Florida; Denver, Colorado; Phoenix, Arizona; Cheyenne, Wyoming; Las Vegas, Nevada.

Burt Ramsay, chief engineer, technical, has been named director of Engineering, Amelco, Inc. with **Roger R. Boy de la Tour,** assistant chief engineer, technical, succeeding Ramsay at the electronics firm. Ramsay joined Amelco two years ago after leaving the Canoga Corp. where he worked on development of various missile support systems, solid state amplifiers and power supplies. Boy de la Tour came to Amelco in December 1958 from Lear, Inc.

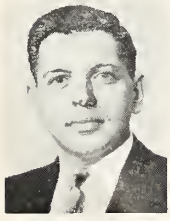
David A. Young, who was Aerojet-General's first employee when the company was founded in 1942, and recently chief of ARPA's space technology program, has been named director of Corporate Long Range Planning Division by Aerojet. Young, a graduate of CalTech, served in various positions at Aerojet, including chief of the Rocket Physics Department of the Research Division and assistant chief engineer of the Liquid Engine Division in charge of nuclear projects.



Charles C. Goodrich, as Douglas Aircraft Co.'s representative at the Army's Redstone Arsenal, will operate from a new Douglas office to be established in Huntsville, Ala. He will maintain technical liaison with the Army Ordnance Missile Command and the Army Guided Missile Agency. Goodrich has been at White Sands Missile Range for the past five years and, since last fall, has been project engineer for the *Nike* series at that location.



Dr. Leonard S. Sheingold of Sylvania Electronic Systems, division of Sylvania Electric Products Inc., has been named a member of the U.S. Air Force Scientific Advisory Board. Dr. Sheingold, who is manager of Sylvania Electronics' Applied Research Laboratory, has held many active and advisory appointments to governmental scientific groups including DOD's Weapons Systems Evaluation Group, the Operations Research Office of Johns Hopkins University and the Office of Naval Research.



Russell A. Kimes, director of American Machine & Foundry Co.'s General Engineering Laboratories, has been appointed a divisional vice president of AMF's Government Products group. He will also continue as director of engineering, responsible for the operation of AMF's Alexandria division in Alexandria, Va., the Greenwich Engineering division, and the Mechanics Research division in Chicago. He will work out of G.E.L. headquarters at Greenwich, Conn. Kimes came to AMF in 1946 as assistant works manager of the Buffalo plant.



Fred Rauschenbach, former sales manager of Martin-Baltimore, has joined United Electro Dynamics, Inc. as manager of Development Planning in charge of company expansion and market development. Rauschenbach, whose 16 years in the Marine Corps includes work in guided missile development, was later assistant project engineer on the *Lacrosse* missile for Martin-Baltimore and also spent a year with ACF Industries, Avion Division, directing the weapons systems department.



Dr. John M. Salzer has joined the technical staff of the vice president, Engineering, Ramo-Wooldridge Division of Thompson Ramo Wooldridge Inc. Formerly director of systems at the Magnavox Research Laboratory, Dr. Salzer worked in systems investigations, promotion of military products, supervision of projects in missile guidance, control computers, data processing, communications systems, and special studies. Prior to that he was with Hughes Aircraft Co.



David I. Margolis, former assistant treasurer of the Raytheon Manufacturing Co., has been named assistant to the president of International Telephone and Telegraph Corp. From 1952 to 1956 he was security analyst for Josephthal & Co. of New York City. Three engineers have been promoted to senior scientists at ITT Laboratories, Nutley, N.J.: **Richard E. Gray,** former senior project engineer c the Radio Communication Laboratory and **Henry F. Herbig** and **Malcolm C Vosburgh,** former executive engineers c the Wire Communication and the Avioni Systems Laboratories. They will work o development and application of ne scientific theories and laws.

Dr. Ray P. Dinsmore, authority o natural and syn thetic rubber an vice president c research and deve opment for th Goodyear Tire Rubber Co., ol served his 45th yea with the firm re cently. Dr. Din more's colorful ca reer in research ha been highlighted by award of the Colwy Gold Metal for 1947, awarded by the In stitution of the Rubber Industry for h work in synthetic rubber research and i development and application to product and the Charles Goodyear Medal for 195 by the Rubber Division of the America Chemical Society.



Appointment of **Julian J. Kliolz,** vic president, to serv on the board of d rectors, was an nounced by Asso ciated Gaskets, In Other appointmen by the firm: **Josep J. Locastra,** pla superintendent an **Paul Gordon Am brose,** productio manager. Kliolz b came a vice president in 1948 when h came to the firm from the H. O. Canfie Rubber Co., where he was assistant pr duction manager. Locastra also came fro Canfield, starting there in 1923 and worl ing in almost every department of th organization. Ambrose has been assista production manager at Associated Gaske since 1957.



Robert E. Lehman has been appointe manufacturing ma ager of Pulse E gineering, Inc., ele tronics firm, aft 12 years at Lenku Electric, where h was variously tran former productio foreman, transfor er design enginee manager of th transformer desi group, and manager of the transform standards group.



letters

Quality Important

To the Editor:

We have read with interest the excellent article, "Notch Sensitivity Will Crack," which appeared in the June 2 issue, page 15. The article, however, makes little mention of the importance of the quality of the basic materials used in rocket cases.

While **Allegheny Ludlum's** role has been as a basic supplier of special cleanness air melt and more importantly, consutrode vacuum melt plate, sheet, and forging billets, and we have not entered into the fabrication or testing of completed casings, it is our understanding that there is increasing verification that the cleanliness and freedom from even minute internal flaws is extremely important in insuring maximum bursting strengths. We are also informed by our customers that the high-strength, low-alloy grades melted to extreme cleanliness standards and consutrode vacuum melted to very low inclusion counts offer considerable advantage in the ability to form such materials in the severe spinning operations involved in certain designs.

J. B. Henry
Manager, High Temperature
Alloys & Valve Steels
Allegheny Ludlum Steel Corp.

We will deal with this in future articles.

Overindulged?

To the Editor:

Your editorial, "Wake Up and Live," in the June 22 issue was a superb summary of what has happend in the aircraft industry to cause the current rash of symptoms. It's like the man who has eaten the best rich food for years—and now has the gout.

Keep up the good work. It takes guts to tramp on people's toes, but it is necessary and good at times.

Larry L. Booda
CDR, U.S.N.R.
Navy Department
Washington 25, D.C.

Clarification Pleases

To the Editor:

"New England's Missile Boom," by William E. Howard, in the July 6 issue of M/R, was another fine article that helps clarify this thing called the "missile industry . . ."

W. E. Green
Metal Fabricators Corporation
73 Pond Street
Waltham 54, Mass.

New Missile 'Bible'

To the Editor:

Your superb July 20 issue—the Third Annual Engineering Progress Issue and World Guided Missile Encyclopedia . . . will forthwith become our "bible" as we continue to work with manufacturers of missile and rocket components . . . You and your staff are to be congratulated on a major contribution to the dissemination of knowledge in this field.

D. J. Duffin
Duffin-Hughes Associates
Public Relations
1518 Walnut Street
Philadelphia 2, Pa.

Congrats on Editorial

To the Editor:

May I be permitted to compliment you on your outstanding editorial in the July 13 issue of MISSILES AND ROCKETS, of which I am a subscriber, headed "Components Reliability: What's Needed?"

Perhaps I am so keenly enthusiastic about your editorial for the reason that I have sung the same song for many, many years—frankly, without too much in the way of results. Your editorial provides much needed ammunition for designers in the missile field, to say nothing of highspeed supersonic aircraft.

As a designer of switches and thermal controls, mostly in the aircraft and missile fields, for the past 30 years, I feel that today we know how to make our respective components right, but there never seems enough time to do the job; and if it is approached, our companies who are naturally commercially minded are appalled at the cost of such devices. Generally speaking, they listen politely and agree in principle but very little is done towards authorizing the research and engineering necessary to do the job with a component that simply will not fail.

It is my feeling that if it is necessary to use a three karat diamond to do the job, we certainly should use the diamond for it is most assuredly impossible to compromise on materials or engineering structure where the minute components necessary are all the more needful of the type of work that goes in an ultra-precision timepiece.

I am trying to get together as many articles on this subject as I possibly can to provide a scrapbook of information and I hope influence on others. Therefore, if possible, I would like to receive as many reprints of this marvelous editorial as you could possibly send me. Also if you have any data along these lines; that is, other reprints of a similar nature, I would very much appreciate receiving it.

L. W. Burch
Consulting Engineer
Metals & Controls
34 Forest Street
Attleboro, Mass.

Omission

To the Editor:

The article, "Boston—'Hub' of space research" by William E. Howard in the July 13 issue fails to note that the "Golden Semicircle" of missile/space manufacturing becomes nearly a full circle when you consider the contribution of General Electric's plant in Lynn, Massachusetts, eight miles northeast of Boston.

Surely, the men who build the accessory power system for the *X-15*, the turbopumps for the *Vanguard* first-stage engine and who are now at work on equipment for future space vehicles, deserve a place on the wheel of the Boston area's space industry.

Paul Schratter
Manager, Product Information
Aircraft Accessory Turbine Dept.
General Electric, West Lynn, Mass.

We regret the omission.



THE MOST!

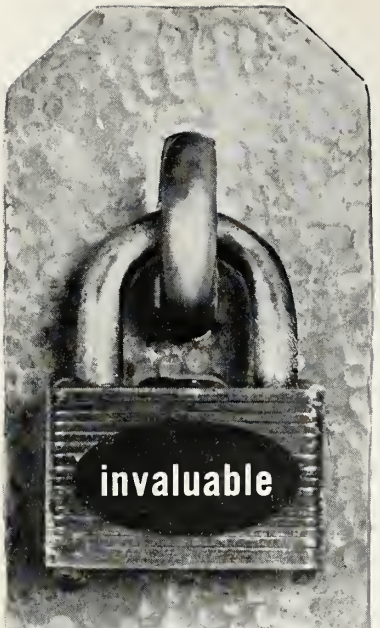
TO SAY THE LEAST . . .

for high-performance slip rings, brushes,

commutators and switching devices

POLY-SCIENTIFIC CORPORATION

BLACKSBURG, VIRGINIA



No one understands the extreme importance and value of vital test film better than CFI. For this very reason, our security system, devised to handle classified film, is the model for the industry.

CFI CAPABILITIES also include the knowledgeable handling of all of your film requirements with the utmost care... for sales and test data films, training films, and visual aids, 16 or 35mm.

CFI's EXPERIENCE with many major aircraft and missile companies and related organizations enable us to recognize the need for uncompromising quality and fast action.

CFI FACILITIES are the finest... complete and modern. Improved processing techniques are constantly being developed at CFI, advancing the state of the art.

CFI KNOW-HOW has been accumulated in its 40 years as the nation's largest and most progressive organization with complete lab facilities in both Hollywood and New York.

COMPLETE INFORMATION is available. Write or call for a representative.

cfi

CONSOLIDATED FILM INDUSTRIES
959 Seward St., Hollywood 38, Calif. • HO 9-1441
521 West 57th St., New York 19, N.Y. • CI 6-0210

missile business . . .

By WILLIAM E. HOWARD

Very quietly the Small Business Administration is casting a hard look at the "fee" end of DOD cost-plus-fixed-fee research and development contracts. Some strong complaints have been voiced by small firms over DOD policy on fees. They claim the profit margin is too little—in some cases non-existent. The SBA wants to know the extent of the problem; how many small firms are being squeezed out of military R&D competition simply because they can't afford to risk going into the red.

Some small outfits get caught in a jam . . .

They take on R&D projects knowing that they are potential money losers. But they also know that if they don't take them, they will be cutting off their source of work and in the end will have to shut up shop. There is always a chance that a losing proposition may turn into a more lucrative follow-on contract or a bigger related research project. When a company hits a string of losers, however, merger with a big corporation with a strong cash position sometimes becomes the only way out.

The SBA is against the merger trend . . .

now prevalent in the missile industry. The main purpose of this Federal agency is to play mother hen to a brood of small businesses. It wants to see small business thrive—to help little ones grow into big ones.

SBA now is wondering whether DOD is thwarting its mission. M/R has learned that SBA has hired some outside consultants to look into the situation. One problem investigators are up against from the start is finding out precisely what DOD's policy is on fees; who fixes them and why they vary.

Recent Congressional testimony by Perkins McGuire . . .

assistant secretary of defense for supply and logistics, indicates that fees fluctuate rather widely from a token fee of $1 to 10%. A DOD survey shows that the average for all the armed services is somewhere between 6% and 7%. For a small firm working on a $100,000 contract, the fee would run to $6000 or $7000. This doesn't yield much of a profit after taxes and operating overhead are deducted.

Where the SBA inquiry will lead, and what it will turn up, is still a matter of conjecture. But it is a safe bet that any pertinent findings will wind up in the hands of the small business lobby to press for action by either the Administration or Congress.

Historically, Congress has always regarded . . .

anyone who does business with the Government with suspicion. The idea seems to be prevalent that any industry's pockets are automatically lined with gold as soon as the ink dries on a contract. The SBA is going to run into this fixation if it tries to bring about any revision in present policy toward fees.

Why it is perfectly legitimate for a manufacturer to make 15% or all he can in the consumer market, yet practically criminal if he nets more than 2% on a military contract is difficult to understand. Congress has never explored this "double standard" from the viewpoint of how it may affect our research effort and technological progress. And it will be interesting if someone can convince lawmakers that this might be a fruitful field of investigation.

SBA might do well to build a case on the importance . . .

of small company R&D in the missile/defense effort. Contributions from this segment of industry are truely impressive. And there is plenty of evidence to support the thesis that some of the country's best brains function most efficiently when they are in a small company—and when the profit motive is strong.

—when and where—

AUGUST

Association of the U.S. Army, Annual Meeting, Sheraton-Park Hotel, Washington, D.C., Aug. 3-5.

American Astronautical Society, Second Annual Western Regional Meeting, Ambassador Hotel, Los Angeles, Aug. 4-5.

William Frederick Durand Centennial Conference, The Problems of Hypersonic and Space Flight, Stanford University, Stanford, Calif., Aug. 5-7.

American Society of Mechanical Engineers, American Institute of Chemical Engineers, Third National Heat Transfer Conference & Exhibit, University of Connecticut, Storrs, Aug. 9-12.

Metallurgy Division, Denver Research Institute, Eighth Annual Conference on Applications of X-Ray Analysis, Stanley Hotel, Estes Park, Colo., Aug. 12-14.

Institute of Radio Engineer's Professional Group on Ultrasonics Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

Institute of Radio Engineers, Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 18-21.

AFOSR/Propulsion Research Division, Directorate of Aeronautical Sciences Office of Naval Research, Office of Ordnance Research & National Aeronautics and Space Administration, Symposium on "The Dynamics of Ionized Cases," Northwestern University, Evanston, Ill., Aug. 24-25.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare, (classified), San Diego, Calif., Aug. 24-26.

International Commonwealth Spaceflight Symposium, Church House, Westminster, London, England, Aug. 27-29.

Army-Navy Instrumentation Program, Annual Meeting, Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Texas, Aug. 31-Sept. 2.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkeley, Calif., Sept. 2-4.

Air Force Association and Panorama: Send Reservations to AFA Housing Bureau, P.O. Box 1511, Miami Beach, Sept. 3-6.

AFOSR/Directorate of Aeronautical Sciences, Office of Naval Research, National Science Foundation, Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Sept. 9-11.

New York University's College of Engineering, Titanium Metallurgy Conference, For information: Dr. Harold Margolin, New York University, University Heights 53, New York, Sept. 14-15.

Institute of the Aeronautical Sciences, Western Regional Meeting on Frontiers on Science and Engineering, Los Angeles, Sept. 16-17.

Standards Engineering Society, Boston Section Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Instrument Society of America, 14th Annual Conference and Exhibit, Chicago, Amphitheatre, Chicago, Sept. 21-25.

Industrial Nuclear Technology Conference, Sponsored by Armour Research Foundation of Illinois Institute of Technology and Nucleonics Magazine and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

Institute of Radio Engineers, 1959 National Symposium on Telemetering, Civil Auditorium, San Francisco, Sept. 28-30.

Institute of Radio Engineers, American Institute of Electrical Engineers, Eighth Annual Industrial Electronic Symposium, Mellon Institute, Pittsburgh, Sept. 30-Oct. 1.

OCTOBER

Anglo-American Aeronautical Conference, Institute of the Aeronautical Sciences, Hotel Astor, New York, Oct. 5-7.

Society of Automotive Engineers, National Aeronautics Meeting, Aircraft Manufacturers Forum and Aircraft, Engineering Display, The Ambassador Hotel, Los Angeles, Oct. 5-10.

Radio Interference Reduction and Electronic Compatibility Conference, Sponsored by the U.S. Army Signal Research and Development Laboratories, Conducted by Armour Research Foundation of Illinois Institute of Technology and Institute of Radio Engineers Professional Group on Radio Frequency Interference, Museum of Science and Industry, Chicago, Oct. 6-8.

Electronics Industries Association Conference, University of Pennsylvania, Philadelphia, Oct. 6-7.

Aeronautical/Astronautical Problems of High Speed Flight Meeting, Sponsors: AFOSR/Aero Sciences Directorate, ONR, OOR, NSF, and Stanford University, Stanford University, Stanford, Calif., Oct. 6-8.

Stanford Research Institute, First High Temperature Symposium, Asilomar Conference Grounds, Monterey Peninsula, Calif., Oct. 6-9.

AFOSR/Propulsion Research Division, Aeronautical Sciences Directorate and Avco, Second Advanced Propulsion Symposium (classified), New England Mutual Hall (tentative), Boston, Oct. 7-8.

National Electronics Conference, Sponsored by American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University and University of Illinois, Hotel Sherman, Chicago, Oct. 12-14.

Armour Research Foundation, 15th Annual National Conference, Hotel Sherman, Chicago, Oct. 26-30.

Institute of Radio Engineers, Professional Group on Electron Devices, Shoreham Hotel, Washington, D.C., Oct. 29-30.

NOVEMBER

Institute of the Aeronautical Sciences, Annual National Midwestern Meeting, Wichita, Kansas, Nov. 2-4.

41st National Metal Exposition and Congress, International Amphitheatre, Chicago, Ill., Nov. 2-6.

Mid-American Electronics Conference, 11th Annual Meeting, Kansas City Municipal Auditorium and Hotel Muehlebach, Kansas City, Nov. 3-5.

Fifth International Automation Exposition and Congress, New York City, Nov. 16-20.

Advertisers' Index

Aeroscience, Inc. 42
Agency—Balsam Adv., Inc.
Bristol Siddeley Engines, Ltd. 17
Agency—Young & Rubicam, Ltd.
Coast Mfg. & Supply Co. 40
Agency—Long Adv., Inc.
Consolidated Film Industries 48
Agency—Gaynor & Ducas, Inc.
Dow Chemical Co., The 6
Agency—MacManus, John & Adams, Inc.
DuKane Corp. 3
Agency—The John Marshall Ziv Co.
Ets-Hokin & Galvan 45
Excelco Developments 8
Agency—Melvin F. Hall Adv. Agency, Inc.
Grove Valve & Regulator Co. 2
Agency—L. C. Cole Co.
Leonard, Inc., Wallace O. 23
Agency—MacManus, John & Adams, Inc.
Lockheed Aircraft Corp., Missile System Div. 18, 19
Agency—Hal Stebbins, Inc.
Minneapolis-Honeywell Regulator Co., Honeywell Div. 4
Agency—Commerce Adv.
National Co. 52
Agency—Burton Browne Adv.
Poly-Scientific Corp. 47
Agency—Houck & Co., Inc.
Radio Corp. of America 37
Agency—Al Paul Lefton Co., Inc.
United Air Lines 51
Agency—N. W. Ayer & Son, Inc.
United States Steel Corp. 26, 27
Agency—Batten, Barton, Durstine & Osborn, Inc.

CLASSIFIED

For approved storage and transportation of high explosives and propellants in Los Angeles area contact:

W. A. Murphy, Inc.
436 North Arden Drive
El Monte, California
CUmberland 3-8048

WASH. REPRESENTATION Govt. sales liaison, Public Relations, cover all fields, J. V. Hurson Assoc., 412 Albee Bldg., D.C., RE 7-4122.

NASA Budget Cut is Dangerous Economy

If some pollster were to query the 436 members of the House of Representatives with a question which would read like this:

"Do you want the United States to have a space program commensurate to her place in the world of nations and second to no other country on earth?"

The replies undoubtedly would add up to virtually a unanimous "yes."

Why then did the House cut $68 million from the budget of the National Aeronautics and Space Administration early this month before sending it to the Senate? In the words of NASA Administrator T. Keith Glennan:

"During the hearings on our fiscal 1959 budget request, some members of Congress raised serious questions about our not having requested far greater sums than we felt, after careful study, that we needed to organize NASA and initiate the (space) program.

"What has happened since then to give anyone a sense of complacency? For I can only interpret the action of the House as an indication of a lessening in the sense of urgency which has been expressed so often on the floor and in Committee.

"Have we—who started serious work in the space field six or seven years *after* the Soviets were pouring unlimited funds and their best brains into the drive to dominance in space—suddenly achieved some enormous advantage?

"If so, I would like to know about it. I would sleep better at night."

NASA is requesting a fiscal 1960 budget of $485,300,000. In addition NASA has requested $45,000,000 in supplementary funds for 1959.

The House Committee on Appropriations cut the combined requests by $45.5 million.

The House itself, on points of order, further reduced both requests by $22,725,000—a reduction of $68,225,000 in all.

What could these cuts mean to NASA? In the words of the administrator and his qualified associates:

Vega—drastically cut back. *Vega* is a modified three-stage *Atlas* capable of putting a 5800-pound satellite in orbit to make television surveys of the moon, among other things. It is an essential preliminary for moon flight. Budget funding: $42.5 million.

Centaur—retarded. *Centaur* is similar but more powerful than *Vega*, designed to put 8000 pounds in orbit or to soft-land a 730-pound scientific load on the moon. Budget funding: $41 million.

Nova—eliminate or drastically reduce. *Nova* is the 1½-million-pound-thrust, single-chamber engine, producing in time a 6 million-pound-thrust cluster necessary to carry manned expeditions to the moon. Budget funding: $30.2 million.

Rover—reduce. *Rover* is the nuclear rocket for space travel.

Mercury—probably slowdown. *Mercury* is the manned satellite project.

Tracking and data acquisition networks—delayed. As necessary to space probes as precinct support to a Congressman.

New personnel—reduced by 15%. People are skills and training and competence. Without them no project can be accomplished.

What is likely to happen in the Senate or in Senate and House compromise?

The $22,725,000 lost on the points of order technicality will probably be restored. But the $45.5 million cut by the House Appropriations Committee will probably be lost entirely or at best partially restored. And, in the words of one high NASA official, the loss of even $20 million would affect the projects listed above.

The NASA budget request seems to us more than ordinarily reasonable. Some $100 million of it goes to support NASA research centers. Less than $375 million is new money for the space field. Compare this to a $40-plus *billion* defense budget in these days of a cold war where Russia uses her space exploits as an instrument of power politics; when she has convinced much of world opinion that success—or failure—in the space field is a measure of a nation's scientific progress.

At the risk of stepping on Pentagon toes, we would say—and earnestly—that the value of the United States of placing a man in space first, or of making a landing on the moon first—that either of these things is of more value to this nation in the cold war than a squadron of intercontinental missiles —which costs just about $100 million.

We believe that Administrator Glennan and his associates at NASA are doing a good and conscientious job. They don't pretend to have a magic formula for space exploration. If someone has such a formula they would like to see it.

Furthermore, we believe the NASA budget is honestly and tightly prepared. If for no other reason —and there are other reasons—the budget is too small to be otherwise.

CLARKE NEWLON



AIR FREIGHT EXCLUSIVE

Radar keeps deliveries on time—another United Air Lines "extra" at no extra cost

United, as the only coast-to-coast airline with all-fleet radar, can promise you unmatched delivery performance and a smoother ride for fragile shipments. Whether your shipment goes by DC-6A Cargoliner or one of the 900-plus daily passenger flights, on-time schedule dependability is improved by radar, a feature customers appreciate.

AND MORE "EXTRAS"

Reserved Air Freight guarantees you space aboard any United flight on as little as three hours' notice.

Personalized service—a follow-through feature, monitors your shipment from origin to destination.

Door-to-Door service—a convenient United feature for minimum handling, maximum speed.

Centralized cargo control insures that there'll be space on the flight you want when you want it.

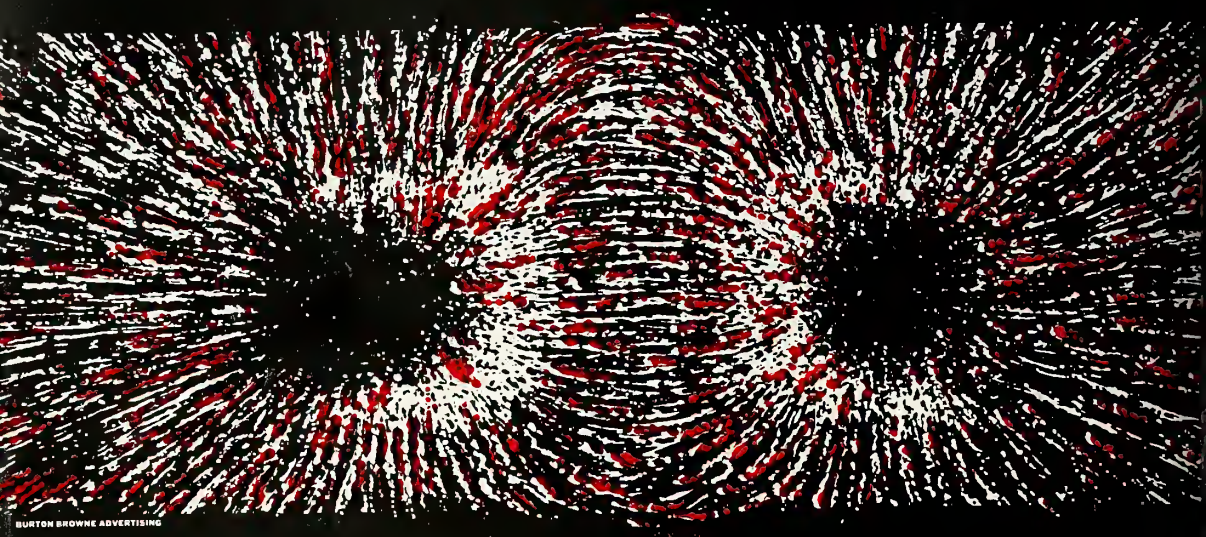
FREE BOOKLET

Tells how United Air Lines saves shippers money, provides better service. How about you? Just write to Cargo Sales Division, United Air Lines, 36 So. Wabash Avenue, Chicago 3, Illinois.



YOU PAY NO MORE FOR EXTRA CARE WHEN YOU SHIP UNITED AIR LINES

FARADAY the FIELD and FREQUENCY RESONANCE



BURTON BROWNE ADVERTISING

Creative Imagination took Michael Faraday from the experimental discovery of the induction of electricity to the theory of "the field"—foundation of all the new physics including relativity.

Creative imagination at National Co. has taken the known unvarying resonance of the Cesium atom and translated it into a frequency producing instrument with a stability of frequency of 1 part in 10^{11}—this is man's most accurate measurement of time.

The applications and adaptations are many-fold and still largely unexplored.

National Co. is a community of minds and talents that enjoys the challenge and the prestige of success in such advanced fields as multipath transmission, noise reduction, correlation techniques for signal processing, Tropospheric scatter systems, Ionospheric scatter systems, molecular beam techniques, long range microwave transmission, and missile check-out equipment using microwave and digital techniques.

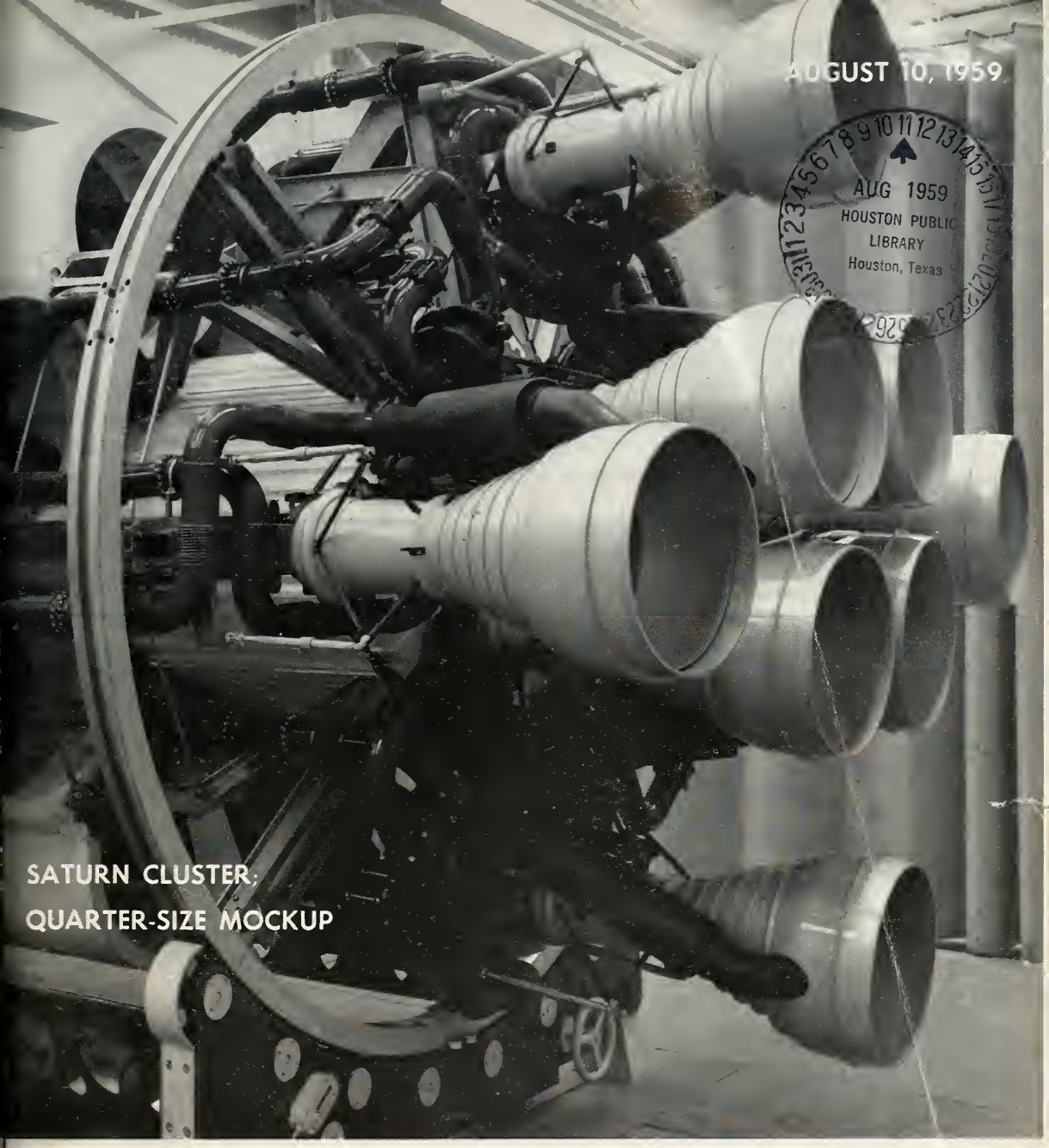
National Co. has grown with the Tradition of New England electronics. Your needs and problems receive exceptional attention at National Co. because, here, *creativity is required, recognized and rewarded.*

Write or phone

tuned to tomorrow **National** NC®

National Company, Inc., Malden, Mass.

MANUFACTURERS OF MATERIEL AND EQUIPMENT FOR U.S. DEFENSE



AUG 1959
HOUSTON PUBLIC
LIBRARY
Houston, Texas

AUGUST 10, 1959

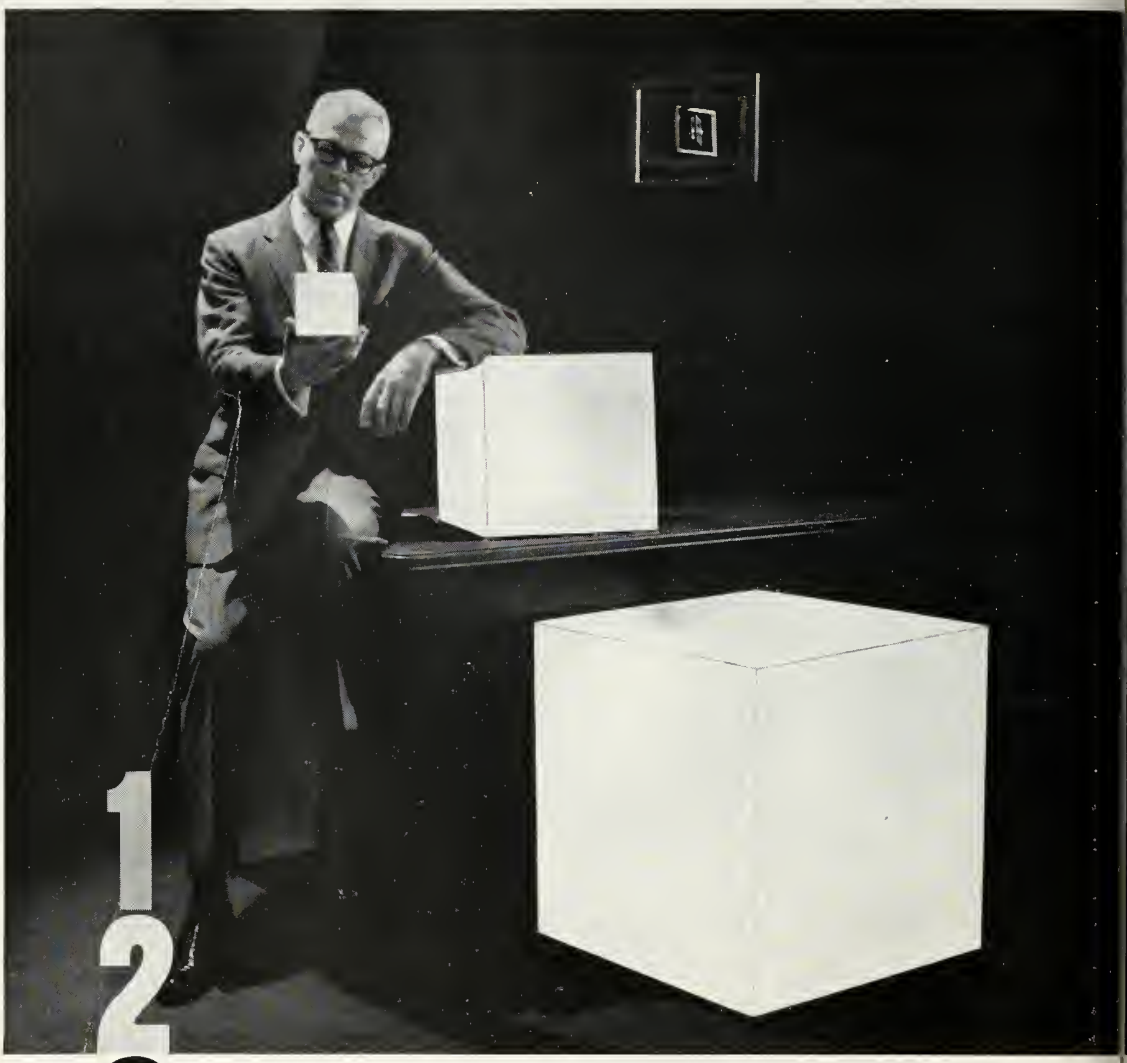
SATURN CLUSTER:
QUARTER-SIZE MOCKUP

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

ecial Market Report:
UNDER-SEAS WARFARE (USW) . . 24

AN AMERICAN AVIATION PUBLICATION



3 generations of airborne digital computers (but we can't show you their configurations)

In the photo above, the three ARMA computers have been intentionally deleted. But the cut-outs accurately represent the relative size of the three generations of ARMA airborne digital computers.

The larger size has been *in production* since 1957. The middle-sized one (a quarter the size of today's) will be in production in 1960. And the micro-miniaturized version in the engineer's hand will be operational in 1962—only .3 cubic feet in volume.

A production line unit of ARMA's curren model has operated in excess of 4000 hour without a component replacement. And th 1960 and 1962 versions will have reliabilit factors at least equal to this.

With this program of miniaturization ARMA has made the digital computer truly airborne. ARMA . . . Garden City, Nev York. A division of American Bosch Arma Corporation.

693

We invite you to visit our booth at the Wescon Show, San Francisco.

AMERICAN BOSCH ARMA CORPORATIO



• GUIDANCE
• NAVIGATION
• BOMBING

So Flexible, *it can be adapted to various type missiles, manned or unmanned aircraft — use star-field pattern for matching interplanetary guidance —*

So Uncanny, *it can be launched from barren areas where there are no fixed ground reference points and strike a precise target thousands of miles away —*

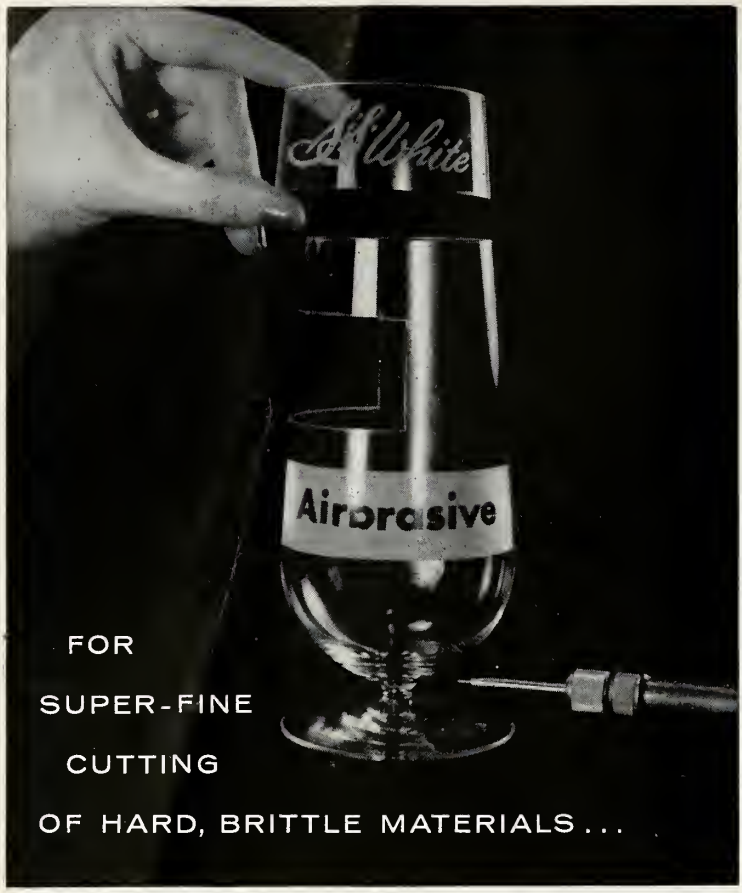
So Pinpoint Accurate, *it can hit its objective with a single missile — rather than needing a salvo.*

Pinpoint

PRIME CAPABILITY OF

GOODYEAR AIRCRAFT

Plants in Akron, Ohio, and Litchfield Park, Arizona



THE S. S. White Industrial Airbrasive® Unit

Not that we advise doing this to your fine crystal glassware, but it seemed to us a dramatic way to show you the versatility and the cool, shockless cutting and frosting action of our Industrial Airbrasive Unit.

Cuts as fine as .008" or large frosted areas are equally easy to make with this amazing industrial tool. A gas-propelled stream of abrasive particles quickly slices or abrades, as needed, almost any hard, brittle material, such as fragile crystals, glass, oxides, metal, minerals, ceramics.

Applications range from printed circuits, wire-stripping potentiometer coils, and cleaning off oxides... to shaping or drilling germanium. Every day new uses for the Airbrasive Unit are being discovered.



Send us your most difficult samples and we will test them for you.

SEND FOR BULLETIN 5705A . . . Complete information.

1064

New dual Model D!



S. S. White®

S. S. White Industrial Division
Dept. 20A, 10 East 40th Street, New York 16, N. Y.
Western Office: 1839 West Pico Boulevard, Los Angeles 6, California

Circle No. 10 on Subscriber Service Card.

Executive Editor .....CLARKE NEWL
Managing Editor ....DONALD E. PEF

NEWS STAFF
News Editor .....REED BU
Defense and Legislative .....BETTY OSW
JAMES I
West Coast .....RICHARD VAN OS
Copy Editor .....ERICA K
Editorial Assistant .....DAVID NEWI

ASTRIONICS
Guidance and Control ....CHARLES D. LAF
Support Equipment .....HAL GETTI

ASTRONAUTICS ENGINEERING
Chemistry & Propulsion .....JAY HOL
Astrodynamics .....PAUL ME

MISSILE SUPPORT
Installations and Equipment
East Coast .....WILLIAM E. HOV
West Coast .....FRANK McG

BUREAUS
Los Angeles .....FRED HU
Paris .....JEAN-MARIE R
Geneva .....ANTHONY VAN

CONTRIBUTORS
British Astronautics .....G. V. E. THOME
Propulsion .....MICHAEL LOE
Industry .....JAMES J. HAGGERTY,
Soviet Affairs .....DR. ALBERT P.
Space Medicine .....DR. HUBERTUS STRUG
Astrophysics .....DR. I. M. LI
Research .....HEYWARD CANNEY,

ADVISORY BOARD
DR. WERNHER VON BRAUN . ROBERT P. HAVE
DR. PETER CASTRUCCIO DR. ARTHUR KANTRO
CONRAD H. HOEPPNER DR. EUGEN SAE
R. F. GOMPERTZ ALEXANDER S

PRODUCTION AND ART
Art Director .....WILLIAM MA
Assistant Art Director .....BACIL GU
Production Manager .....J. F. W
Ass't Production Manager .....ELSIE C

BUSINESS STAFF
Publisher ..... E. D. MUHL
Advertising Sales Manager .....W. E. BR
Eastern Advtg. Manager ..... P. B. KI
Circulation Director .....L. L. BRE
Promotion Manager .....J. E. MU
Advtg. Service Manager ..MRS. GLADYS BU

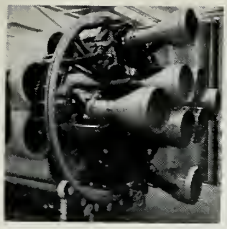
ADVERTISING OFFICES
New York .. (20 East 46th St.) P. N. ANDE
A. B. SCHE
Detroit ...(201 Stephenson Bldg.) K. J. W
Chicago .....(139 N. Clark St.) G. E. Y
Los Angeles .(8929 Wilshire Blvd.) J. W. C
C. R. MARTI
Miami .....(208 Almeria Avenue) R. D. I
Toronto (12 Richmond St. E.) ALLIN ASSOC
London .....(28 Bruton St.) NORALL &
Paris .....11 Rue Cond
Geneva .....10 Rue G

Missiles and Rockets Volume 5 Number

Published each Monday by American Avi
Publications, Inc., 1001 Vermont Ave.,
Washington 5, D.C. Wayne W. Parrish, P
dent; Leonard A. Eiserer, *Executive Vice P
dent & General Manager;* A. H. Stackpole,
S. Hunter, Eric Bramley, Robert R. Pa
Vice Presidents.

Printed at the Telegraph Press, Harrisburg
Second class postage paid at Washington,
and at additional mailing offices. Copy
1959, American Aviation Publications, Inc

Subscription rates: U.S., Canada and Po
Union Nations—1 year, $8.00; 2 years, $12
3 years, $14.00. Foreign—1 year, $10.00
years, $18.00; 3 years, $26.00. Single c
rate—$.75. Subscriptions are solicited
from persons with identifiable commer
or professional interests in missiles
rockets. Subscription orders and change
address should be referred to Circula
Fulfillment Mgr., M/R, 1001 Vermont A
Washington 5, D.C. Please allow 4 w
for change to become effective and enc
recent address label if possible.



COVER: Quarter-size mockup of ABMA's *Saturn* cluster. For report on clusters technology on this vehicle and plans for the *Nova*, see story on page 24.



SOMETHING more than just size is required in antennas technology. There are still close tolerance manufacturing criteria and maintenance problems under environmental conditions. See report on page 18.



DESTINED to be as big in money expenditures as missiles and space is the challenging field of Under Sea Warfare. Read the special 10-page staff report beginning on page 24.



ASW is a big part of the USW picture and the Red missile submarine threat is bigger than their ICBM's. See story on page 32.

missiles and rockets ®

MAGAZINE OF WORLD ASTRONAUTICS

AUGUST 10 HEADLINES

Pick Your War—Then Plan for It
Pentagon's new instruction on industrial readiness planning leaves it up to individual services to choose type of war and make industry gear to match decision 16

ASTRIONICS

Antennas: There's a Limit in Size
What's needed is the ability to manufacture dishes and maintain them in an exposed environment to the close tolerances required 18

WESCON Trying New Method for Technical Papers ... 20

ASTRONAUTICS ENGINEERING U. S. Reg. Pdg.

Clustering: Big Payloads Quickly
Engines such as *Saturn* and *Nova* will add a greater degree of safety and reliability to manned space flight than the comparable single engine boosters 21

M/R SPECIAL REPORT ON UNDER SEA WARFARE

USW: A $4-Billion Yearly Market
Many missile companies are realizing that this great technological challenge is as important as space flight and in the next few years will be just as expensive. Included is a list of market needs 24

$$$—Biggest Barrier to Effective ASW
But industry hits other factors: Lack of single ASW group in Navy; lack of consistency in requirements; and difficulty in getting state-of-the-art information 28

Torpedoes—Neglected Factor in ASW
Between wars we forget about them but they'll have to be vastly more sophisticated and reliable if they are to be equal to their mission in coping with missile submarine threat 30

Soviet Subs Bigger Threat than ICBM's
Intelligence reports assume Reds converting to nuclear and deep diving boats armed with *Komet III* IRBM. Red China now third biggest submarine builder 32

MISSILE SUPPORT U. S. Reg. Pdg.

Servovalves Need Fresh Approach on Temperature
Moog Valve believes 1000°F reachable by using acceleration switching servos 34

Air-Support Space Platform Advocated 36

THE MISSILE WEEK U. S. Reg. Pdg.

Washington Countdown 9
Industry Countdown 13
More About the Missile Week 44

DEPARTMENTS:

New Products	37	West Coast Industry	47
Propulsion Engineering ...	41	Contracts	48
People	46	When and Where	49
Editorial	50		

NEXT WEEK:

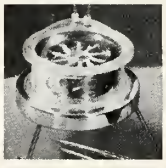
Propulsion Control Systems—New Art Needed
APU and Batteries—What's the Market?
Part I, Special Survey of Middle Atlantic States Missile Industry

Materials Memo

3M reports on SNAP III . . . heat reflective tape . . . adhesive welding

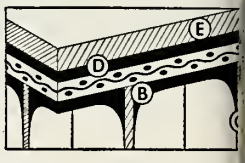
Many of the 27,000 different products manufactured by Minnesota Mining and Manufacturing—the 3M Company—have proved valuable in missile manufacturing and space research. Here is information on newer products . . . and up-to-date ideas and applications for some established products:

■ **SEEBECK & PELTIER, 1959:** Over 100 years ago, in 1829, the German physicist, Thomas Seebeck, discovered that heat applied to one junction of two dissimilar metals in a circuit would produce an electrical potential. The reverse of Seebeck's effect was discovered in 1834 by Jean Peltier when he found that a current passed through the junction of two dissimilar conductors caused heat to be absorbed or given off. Because of the poor conversion efficiencies of available materials, applications of these principles have, until recently, been limited to temperature measurements. But about 10 years ago, a major breakthrough led to the development of new and more efficient conductor materials. Now the Seebeck Effect is headline news: The 1959 development of the first working thermoelectric generator, SNAP III, designed and built by 3M for the Martin Company and the AEC. This unit directly converts heat of radioactive material into electrical energy. Depending on the isotopes used, a 5-lb. generator could provide 5 watts of electricity for one to many years. For comparison, 1,500 lbs. of batteries would be needed to supply 5 watts for one year. Peltier's principle, on the other hand, has led to development of a new 3M Heat Pump. Because of the wide-spread interest in these materials, we now offer a test kit that will let you experiment with heat pumps yourself. Kit contains an assembled Model E-8 heat pump; four extra "P" type elements; four extra "N" type elements; complete instructions—is available for $75. Send your purchase order to Electrical Products Division, 207-1, Dept. 1442, 3M Co., 900 Bush Ave., St. Paul 6, Minn.



■ **HOT TEMPERED TAPE:** One of the latest of the more than 370 pressure-sensitive "SCOTCH" Brand Tapes has unusually good heat-reflective properties. No. Y-9014 can protect plumbing and other hardware from high intensity radiant heat; protect thermally sensitive materials from 5000° F. radiation for short periods. Basic construction is glass cloth laminated to highly-reflective aluminum foil, with a specially compounded pressure-sensitive silicone adhesive. It stands up well under continuous duty at 500°. (Under development: Tape that will withstand 800-850° F.!) You can find this tape liberally applied in engine compartments of some of our big-birds. And wouldn't it be useful in and around high-temp air-breathing jet airplane engines? For complete information on this, or any of the other "SCOTCH" Brand Tapes, call yo 3M Industrial Tape salesman, or write: Missile Indust Liaison at the address below.

■ **SPACE AGE ADHESIVES:** The last 10 years ha seen adhesive technology move a long way from anim glue and gooey surgical tapes. Today adhesives are i creasingly regarded for structural joining. As example Today most helicopter blades are fabricated with structur adhesives. Intricate castings are now being made in sever simple parts which are then bonded together to form t whole. Advanced aircraft and Missiles are built with a hesive bonded honeycombs. And 3M research has led t way in these new advances in adhesive technology. Yo 3M AC&S salesman will be glad to give you the comple story. "AC&S", incidentally, means "Adhesives, Coatin and Sealers." There's more to the operation than just sticking things together!



GREATER BOND AREA: One side of "3M" Composite Adhesive Film (a) is coated with dry filleting epoxy (b). Under heat, this epoxy turns liquid, wets deep into t honeycomb (c), then cures chemically to a high-streng solid fillet. Elastomeric adhesive (d) on the opposite si of film, bonds firmly to skin material (e). Sandwich bo has controlled thickness; is tougher and far less mes than previous sandwich construction adhesives.

■ **ABOUT "MIL":** 3M's Missile Industry Liaison is service staffed by technical personnel experienced in rocl propulsion and other phases of space technology. Th job is to translate problems of the aerospace industry those 3M specialists best qualified to solve them. If y have questions on any of the items mentioned here, would like to know what else 3M makes—or **could** ma —for your needs, write: 3M Company, Missile Indus Liaison, St. Paul 6, Minn., Dept. VAA-89.



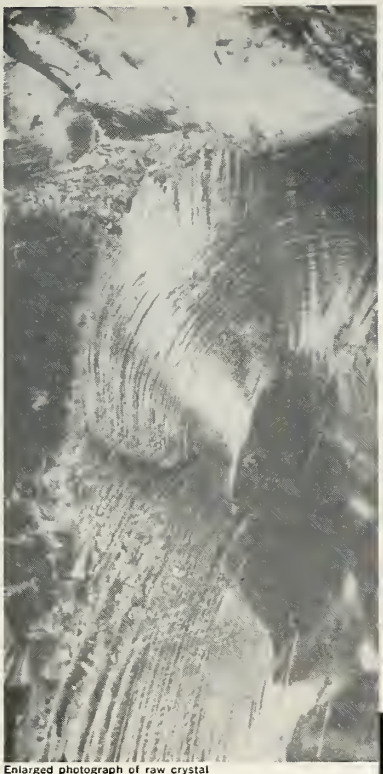
DESCRIPTIVE BROCHURE shows cro sample of 3M Products for missile a space uses. For free copy, write: 3M C Missile Industry Liaison, St. Paul 6, Min Dept. VAB-89.

"SCOTCH", AND "3M" ARE REGISTERED TRADEMARKS OF 3M CO., ST. PAUL 6, MINN.—EXPORT: 99 PARK AVE., NEW YORK 16. CANADA: LONDON, ONTARIO.

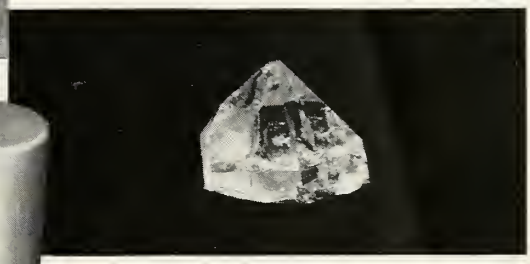
MINNESOTA MINING AND MANUFACTURING COMPANY
. . . WHERE RESEARCH IS THE KEY TO TOMORROW

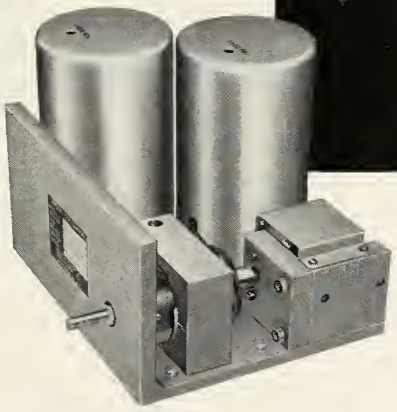
3M COMPANY

MISSILE INDUSTRY LIAISON



Enlarged photograph of raw crystal





BULOVA CRYSTAL CONTROLLED ULTRA-STABLE SHIFT OSCILLATORS

Bulova shift oscillators are all that any electronics engineer could ask for in miniature crystal controlled packages!

Consider this new Bulova custom designed 18.5mc shift oscillator. Here's an assembly of two oscillators operating at 18.5mc. One is fixed, with a 1 pp 10^7 stability. The other is a variable with equal stability, 1 pp 10^7. The shift is accomplished by means of a variable air capacitor. However, the same shift, at the same frequency, can be affected with a varicap.

This new ultra-stable shift oscillator is only one of many recent advances made by Bulova Electronics. For information on these specific units, or on how Bulova experience, in mastering component and system reliability, can help your program, write—

Department A-1361, Electronics Division, Bulova, 40-06 62nd Street, Woodside 77, New York

BULOVA

Visit Our Booth #2518, Wescon Show, San Francisco, California

Circle No. 2 on Subscriber Service Card.

GROUND SUPPORT EQUIPMENT

A Proven Kearfott Capability – Kearfott's prominence in the design and production of ground support equipment is a result of 15 years' experience in producing precision servo systems, computers, gyro reference systems and inertial guidance equipment. Kearfott test equipment is designed on modular principles which increase flexibility and economy and eliminate the obsolescence factor since modules can be readily modified or replaced. Modules are designed to be compatible with one another, thus providing test capabilities for a wide variety of applications.



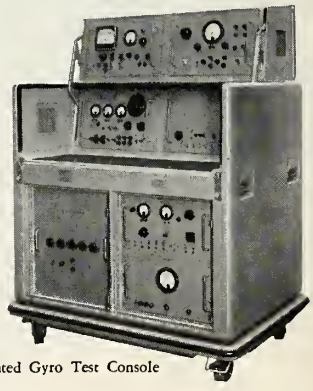
Inertial Guidance System Test Console

IN-PLANT TEST EQUIPMENT: Rack-mounted modules comprise the necessary metering circuits, signal generators and power supplies, switching circuits and junction boxes to perform the following tests on inertial reference systems:

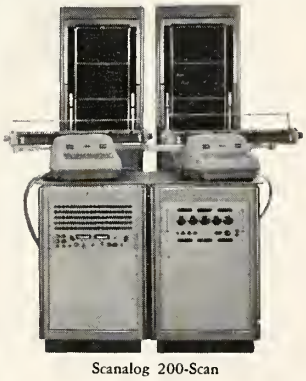
Voltage and phase • Current • Heating cycle checks • Verticality of platform in ground erection mode • First order erection time in ground erection mode • Measurements of platform roll and pitch output angles in ground erection mode • Measurements of free drift of platform in azimuth in ground erection mode • Measurement of azimuth gyro torquer scale factor in ground erection mode

FIELD-TYPE TEST EQUIPMENT: Modularized, self-contained unit that provides all power and signal voltages to operate, test or trouble-shoot a gyro. All inputs to and outputs from the gyro are accessible at convenient jacks where connections to measuring equipment can be made, thereby enabling operator to evaluate gyro performance completely. Modules are slide-mounted for ready access if repair, modification or product improvement replacement are required. This portable equipment performs these basic tests:

Insulation resistance • Warm-up time • Torquer scale factor measurement Gyro transfer function • Free drift • Gimbal offset drift • Continuity Signal Generator Null • Phasing • Gyro drift • Fixed torque restraint



Floated Gyro Test Console



Scanalog 200-Scan
Alarm Logging System

GENERAL PURPOSE DATA PROCESSING: This data handling system provides a reliable, precise means of monitoring, logging and performing an alarm function of up to 200 separate temperature, pressure, liquid level or flow transmitters. Manual controls are provided for scanning rates, automatic or manual logging, data input relating to operator, time, day, run number and type of run. 200 numbered lights, corresponding to specific points being maintained, provide a visual "off normal" display for operator's warning. This system has growth built in and can be expanded in capacity to 1024 points and in scanning rate to 2000 points per second.

Write for complete information on Kearfott's ground support equipment.

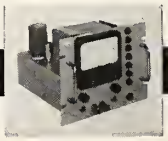
Engineers: Kearfott offers challenging opportunities in advanced component and system development.



VTVM-PSVM



High-Speed
Precise Angle
Indicator Module



Automatic
Ohmmeter
Module

Kearfott A GENERAL PRECISION COMPANY

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.
A subsidiary of General Precision Equipment Corporation
Sales and Engineering Offices 1500 Main Ave., Clifton, N. J.
Midwest Office 23 W. Calendar Ave., La Grange, Ill.
South Central Office 6211 Denton Drive, Dallas, Texas
West Coast Office 253 N. Vineda Avenue, Pasadena, Calif.

Circle No. 3 on Subscriber Service Card.

Washington Countdown

IN THE PENTAGON

Put *Polaris* in cruisers . . .

This is a Navy battlecry that you can expect to hear increasingly in the months ahead. The Navy believes firing the **Lockheed** missiles from cruisers would be easier to do than firing them from submarines. And it feels that *Polaris*-packing cruisers would be a natural strategic partner to the underwater fleet of *Polaris* subs.

• • •

Two types of rocket belt . . .

may be adopted by the Army. One—a light model that can be strapped around the waist—would be used for short jumps over obstacles. The other—a more elaborate harness with bigger rockets—would be used for longer one-man hops.

• • •

An anti-submarine satellite . . .

is under study by the Navy. Details of the project are highly classified. However, the satellite undoubtedly is being looked at as a means to solve the tough detection problem. (See page 24)

• • •

Number of *Lacrosse* battalions . . .

in FY '61 is very iffy with numbers being tossed all over the park. It's definitely decided, however, to equip eight battalions this year. Two more are to be activated before December and one battalion in March, April, May and June.

• • •

Navy also requires *Mauler* . . .

and, sources say, wants to put funds into its R&D. (See p. 13)

• • •

Army's new "vest pocket" system . . .

for tactical air defense probably will soon go to NATO forces as well as U.S. units in Europe. The Army can be expected to seek at least another 30 of the mobile **Hughes** units in the not too distant future to go with missile batteries already in the field. (See page 45)

ON CAPITOL HILL

American missile shipments . . .

to NATO forces will not necessarily be cut during the next year because of congressional multi-million dollar slashes in the foreign aid program. The Administration can probably find elsewhere in the big program the $302 million it planned to spend on missiles for NATO in FY '60.

• • •

Congressmen remain pessimistic . . .

about the chances of the Administration taking up Congress' desire for ordering eight more squadrons of **Convair** *Atlases* this year. The House and Senate have made an $85 million down payment on the extra squadrons available. But the Administration has made clear that it has no intention of making the $800 million commitment for the squadrons unless the international situation should change for the worse.

AT NASA

With one *Vanguard* . . .

attempt yet to go, fairly complete figures indicate that the "work good when it works" bird costs $3 million per shot.

AROUND TOWN

Watch for Japanese . . .

to make an official protest to the Soviet Union about Red missile firings passing over Japanese territory. The Japanese are already irritated about the Russian action several years ago banning their fishing ships from the Sea of Okhotsk and parts of the Bering Sea, claiming them to be contiguous to Russian territory. Japanese sources say that Russian missiles are landing in these waters, and that longer range missiles are passing over Japan itself.

Other reports . . .

. . . Some military and space planners are worried that Soviet Premier Khrushchev's forthcoming U.S. visit may take a lot of the starch out of U.S. missile-space efforts . . . On the other hand, Russia could decide that now's the time to announce another spectacular Soviet space achievement.

. . . The Air Force is considering establishment of a Ground Electronics Systems Center to control development of electronics systems in all AF weapons. This would split the weapon system concept.

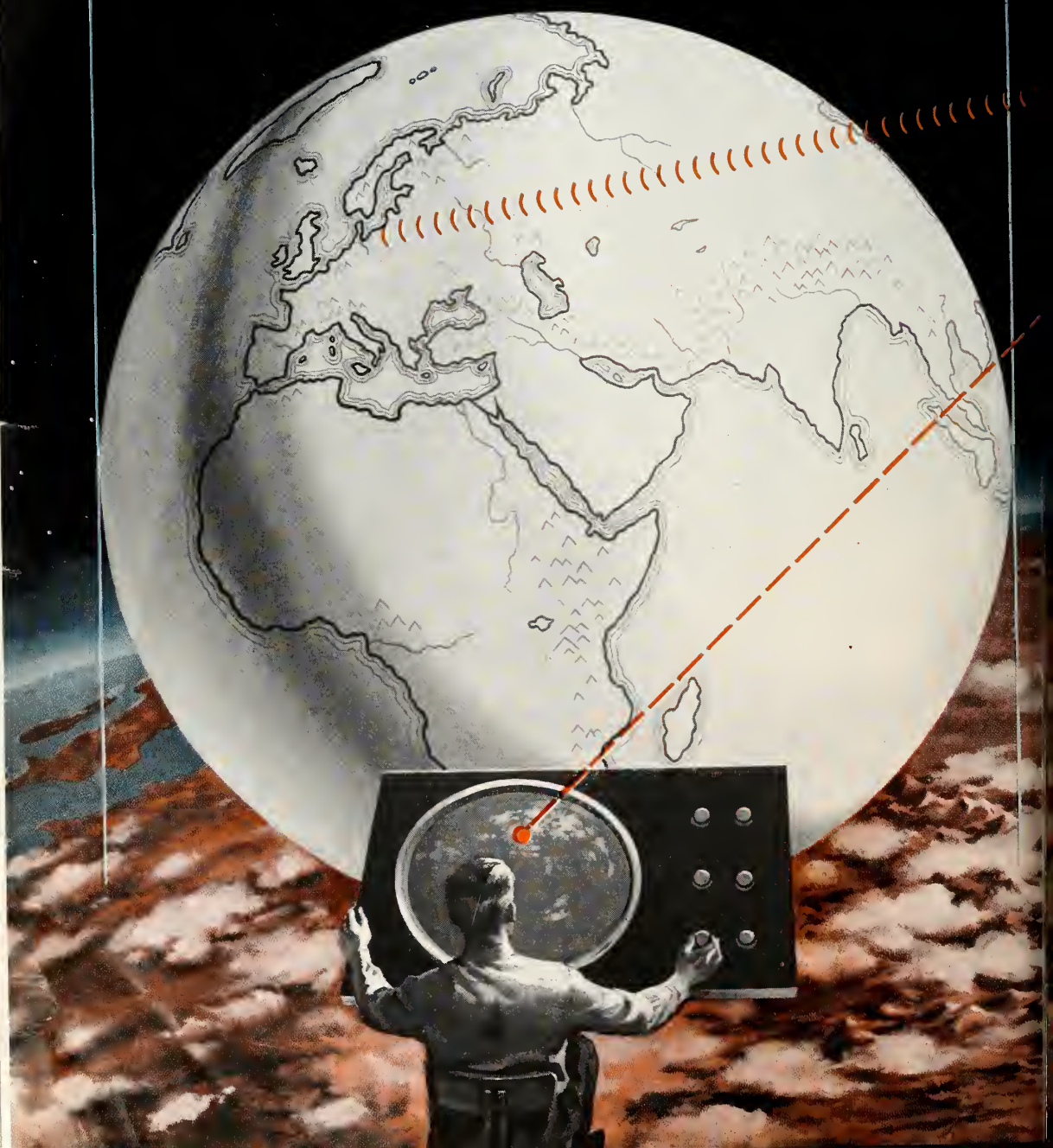
. . . Vice President Nixon will work behind the scenes for more money for the U.S. space program in the '61 budget.

Marquardt

ADVANCED SIMULATOR-TRAINING SYSTEMS

FOR AIR AND SPACE

UNIQUE MARQUARDT CONCEPT SHRINKS EARTH TO 14-FEET





Advanced land mass simulation concept demonstrates Pomona Division capability in realistic simulators for lower-cost training of America's air and spacemen.

IN DEVELOPMENT:

A Marquardt-conceived land mass simulation system that shrinks the map scale factor to 1:3,000,000, while enabling the operator to distinguish landmarks smaller than a football field from any altitude! Application today: ground-training airmen for intercontinental missions at great savings in cost — using a single 8-foot map to realistically simulate the radar reflectivity and shadow effects of a 4,000-mile mission. Application tomorrow: training the free world's first space explorer for his safe return to earth.

IN PRODUCTION TODAY:

Pomona Division's AN/GPS-T4 Radar Signal Simulator, a relatively low-cost training system that is simple, compact, flexible and realistic; producing synthetic target and IFF video information for radar display. Current mission: training USAF aircraft controllers to direct interceptor missions. Ready adaptability will permit the T4 to simulate missiles, radar surface targets and sonar targets.

IN THE U.S. DEFENSE INVENTORY:

The USAF's AN/APQ-T1, AN/APG-T1A, AN/APQ-T2 and T2A, and AN/APQ-T3 simulator-training systems, plus the USN's 15WV-2 AEW/CIC trainer system — all developed and manufactured by the Pomona Division and its predecessor companies. Numerous sub-systems, up-dating modification kits, adapters, spares, and a worldwide field service section add to the organization's total experience.

POMONA DIVISION of The Marquardt Corporation is an able and experienced organization with demonstrated capability in advanced research, design, development and production. The result is reliable hardware which provides solutions to the problems of training military operational personnel.

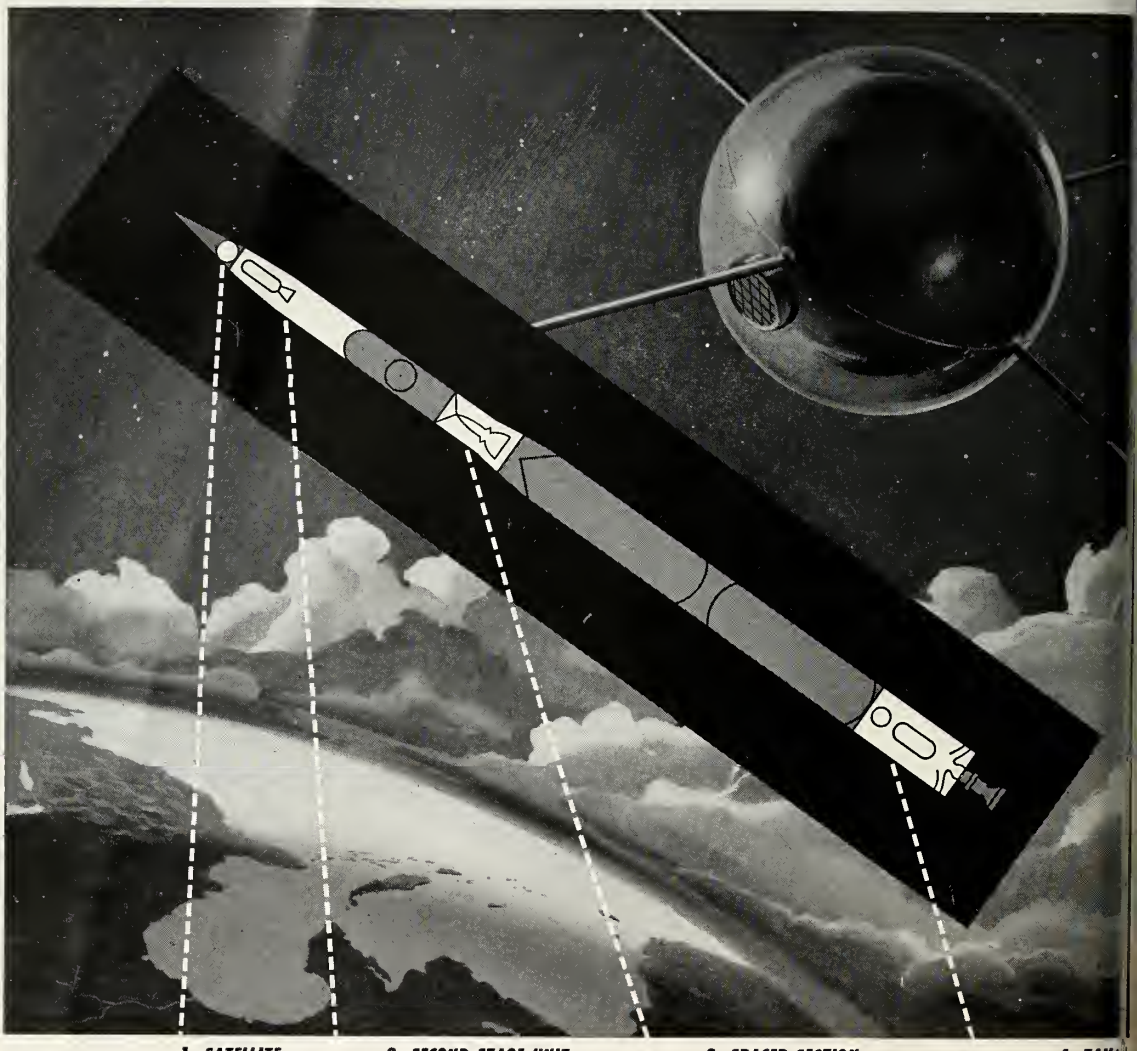
Drawing on the Corporation's overall management-engineering skills, additional facilities and financial support, Pomona Division now offers industry and the Armed Forces a unique and proven ability to get the job done—delivering vital simulator-training system both on-time and at minimum cost.

OPERATIONS AT:
Van Nuys and
Pomona, California
Ogden, Utah
SUBSIDIARY:
Cooper Development
Corporation,
Monrovia, California

THE Marquardt
POMONA DIVISION CORPORATION
2709 No. Garey Avenue, Pomona, Calif.

Engineers and scientists capable of contributing to advances in state-of-the-art are invited to write to: Dr. Wendell B. Sell, Vice-President.

DOW | MAGNESIUM PRODUCTS



1. SATELLITE
The rigid external skin of the weather satellite is made of magnesium alloy, AZ31B. It is plated with gold and other materials to reflect heat.

2. SECOND-STAGE UNIT
The skin is made of HK31A, magnesium-thorium alloy sheet. This elevated temperature alloy must withstand temperatures of 700° F. and above.

3. SPACER SECTION
The skin is formed of AZ31B magnesium alloy sheet. Magnesium was selected for its light weight and high strength-to-weight ratio.

4. TAIL
Again AZ31B magnesium alloy chasen because it is the world's ligh structural metal.

LIGHTWEIGHT MAGNESIUM SPEEDS WEATHER ROCKET FOUR WAYS

The shell of the satellite and several parts of the Vanguard Rocket are made of standard magnesium-aluminum-zinc and magnesium-thorium alloys. Why was magnesium chosen for this project? Because it is the lightest commercially available metal that could be easily fabricated—one with a high strength-to-weight ratio and able to withstand elevated temperatures encountered during flight. Magnesium alloys met these demanding requirements, as pro by tests conducted by the Naval Research Laboratory Washington, D. C.

Write today for new illustrated brochure on aircraft, m siles and rockets. Contact the nearest Dow Sales Office write to THE DOW CHEMICAL COMPANY, Magnesium Produ Sales Dept., Midland, Mich., Dept. MA1302CL8-10.

THE DOW CHEMICAL COMPANY · MIDLAND, MICHIGA

Circle No. 4 on Subscriber Service Card.

Industry Countdown

MANUFACTURING

***Missile A* competition . . .**
winner announcement is to be announced momentarily. Prime contract will go to **GE's Missiles and Space Systems Division.** Funding decision confirms M/R story (March 30, p. 13). While no official announcement has been made, sources inform M/R that **Convair** has go-ahead on the *Mauler* competition, an infrared homing missile for use against low-flying aircraft. *Missile A* is 65-70 mile range solid propelled successor to the *John* family.

Labor demands for coming year . . .
will include: equal pay for equal work; severance pay; per diem and expenses when relocating to another plant (now included in a **Lockheed** contract) and 15 cents more an hour.

• • •

Look for new IAM-UAW coalition . . .
to campaign for some kind of contract protection against surprise cancellations of missile/aircraft work. In forthcoming negotiations union bargainers may ask for job security provisions against sudden layoffs.

• • •

Single collective bargaining . . .
pact worked out last week by IAM-UAW will be tried out first in negotiations with **United Aircraft's Pratt & Whitney Division.** Contract expires in December; most other major contracts are up for renewal in the first half of 1960.

• • •

Keep an eye on $100 million . . .
oceanographic research program recommended by National Academy of Sciences National Research Council. It could be another good market for missile, rocket and spaceflight knowhow. Ten-year project would entail direct procurement of deep (18,000 feet) and mid-depth submarines, 36,000-foot bathyscopes and a great variety of other instrumentation akin to missile/space requirements.

PROPULSION

Best analysis . . .
of **Phillips Petroleum** withdrawal from its **Astrodyne** partnership with **Rocketdyne** is that Phillips decided small government contract profit didn't offer as good a percentage return on investment that could be obtained in normal commercial operations.

• • •

Latest model Rocketdyne X-1 . . .
from which company has developed all its liquid rocket engines now has only two basic components—turbopump and combustion chamber. A couple of years back there were 10 times that number of components.

• • •

Navy will use $3.5 million . . .
order of **Thiokol** Guardian II rocket motors for off-the-shelf stock as well as propulsion system for supersonic target drone being developed by **Temco.**

• • •

First silo shot . . .
of **Boeing** *Minuteman* with first stage solid-fueled **Thiokol** engine is due shortly at Edwards AFB. Engine will be scaled-down prototype with very limited thrust. Shot primarily will be test of configuration of the 100-foot silo.

ELECTRONICS

Uninterrupted telemetry . . .
transmission during atmospheric re-entry reportedly has been developed by **Avco** scientists. Hush-hush method penetrates ionized layer which builds up around re-entry vehicle and heretofore has blacked out radio signals.

• • •

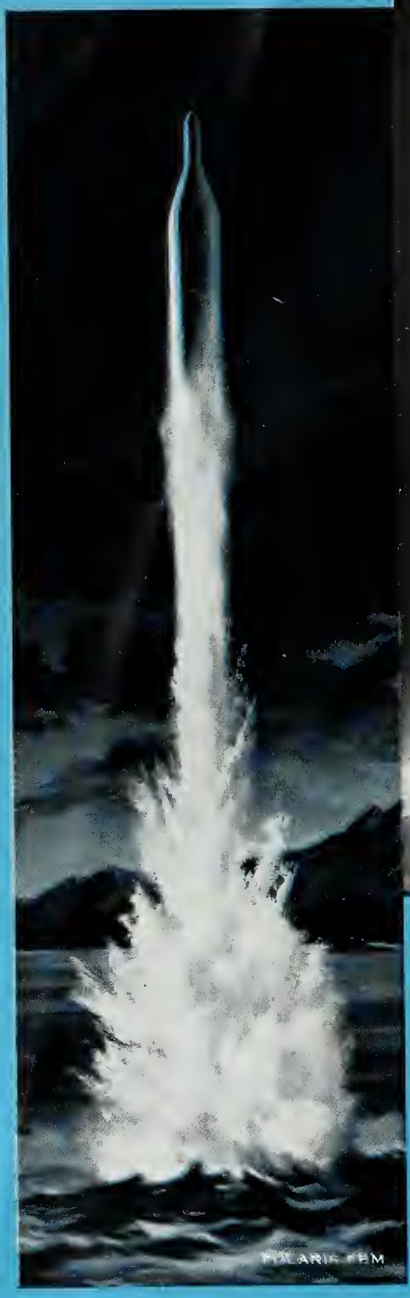
Big problem in engineering . . .
Mercury "satellite clock" programmer is gravity. **Waltham Precision Instrument Co.** must design it to operate in space where there is no gravity, and this means developing entirely new means to achieve zero gravity conditions on earth to test the device before it is sent aloft.

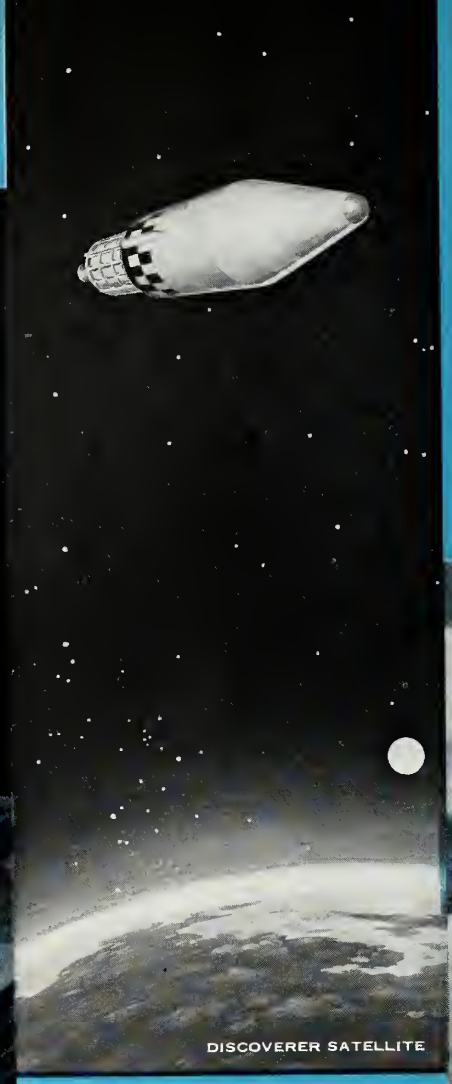
WE HEAR THAT—

Underground missile sites . . .
are being sought by British Air Ministry geologists for *Bluestreak* IRBM squadron—and perhaps for *Titan.* Trouble to date has been in finding militarily suitable locations which have proper subsoils . . .

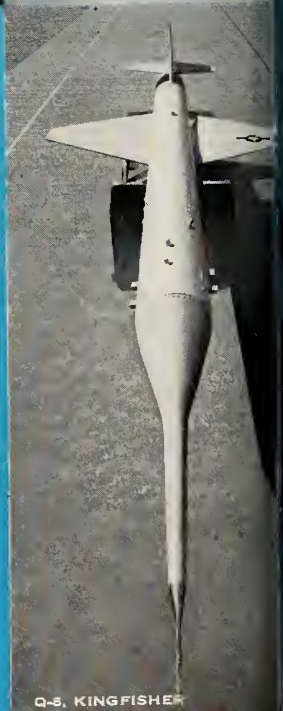
Richard Boutelle, former president of **Fairchild Engine & Airplane Corp.,** now is reported to be a consultant to **AC Sparkplug Division** of **General Motors** . . . Merger of **Victoreen Instrument and Tenney Engineering** will produce one company with combined annual sales of $15 million . . .

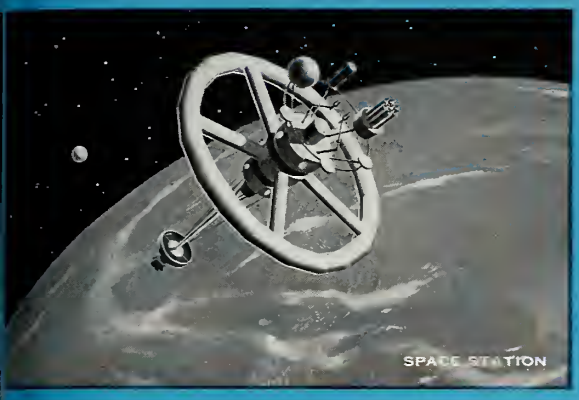
Restraint reel and harness systems for *Mercury* astronauts are under development by **Hardman Tool & Engineering Co.,** Los Angeles . . . Hardware for Naval Research Laboratory sun flare investigation consists of 12 **Cooper Development** *Aspan* rockets which weigh 1760 pounds apiece and can boost a 50-pound payload to 150 miles. They require only a 60-second countdown . . .




DISCOVERER SATELLITE




Q-5, KINGFISHER



EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

■

ADVANCED PROJECTS AT LOCKHEED

POLARIS FBM—Lockheed is missile systems manager for the Navy POLARIS Fleet Ballistic Missile, under the cognizance of the Special Projects Office of the Bureau of Ordnance. Submarine-launched, the POLARIS will travel through three mediums in a single flight: water, air and outer space. With three-quarters of the earth's surface being water, practically no target in the world is outside its range. The solid-propellant POLARIS was *designed with the future in mind*—an approach that the Navy states has cut nearly two years from the original timetable.

DISCOVERER SATELLITE; MIDAS; SENTRY Designed and built by Lockheed Missiles and Space Division, the first of a series of DISCOVERER satellites was successfully placed in orbit in February. The Division has also been assigned the responsibility of systems manager for PROJECT MIDAS – an early warning system against ballistic missile attacks. The project will investigate the use of infrared sensors for detecting aggressor missiles at the moment of launch; and PROJECT SENTRY—an advanced satellite reconnaissance system. DISCOVERER, MIDAS and SENTRY are programs of the Advanced Research Projects Agency under the direction of the Air Force Ballistic Missile Division.

X-17—The nation's first successful reentry tests were conducted by the Air Force with the three-stage, Lockheed X-17 solid-propellant ballistic missile. The X-17 has pioneered many new techniques and the valuable experience gained from this program has facilitated development of other, inter-service projects, including the Navy POLARIS FBM. The Navy's history-making, 300-mile-high, Project Argus radiation explosions featured the X-17 as the vehicle.

Q-5, KINGFISHER—Developed for the Air Force, and currently being manufactured for the Army, the Kingfisher is designed to simulate enemy attacks to test the efficiency of our various defensive weapon systems. It is equipped with extensive instrumentation to register "kills" without itself being destroyed and can be recovered by parachute and landing spike to be used again, with marked savings in cost.

X-7—Lockheed's X-7 recoverable ramjet-engine test vehicle, developed for the Air Force, has established speed and altitude records for air-breathing vehicles and is also recoverable for re-use following flight.

SPACE STATION—An orbiting research facility, to serve as an advance base for space exploration, has been proposed in practical detail by Lockheed's research and development staff. The station would carry a 10-man crew. Prefabricated compartments for the rim of the wheel, the spokes, and the three hubs would be launched separately by means of ballistic missiles and guided into a cluster on the same orbit.

The successful completion of projects such as these requires a bold and imaginative approach to entirely new environments. Lockheed's programs reach far into the future. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. H4-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed / **MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

Pick Your War – Then Plan for It

Pentagon's new instruction on industrial readiness planning leaves it up to individual services to choose type of war and make industry gear to match decision

by James Baar

WASHINGTON—The Defense Department is dramatically demonstrating once again its inability to answer the multi-billion dollar mlitary question: What kind of war should the nation prepare for in the Missile Age?

The demonstration is made for all to see in the Defense Department's new Instruction on Industrial Readiness Planning—a detailed outline of how the three services should go about making industrial war mobilization plans.

The multi-billion dollar missile-space market is caught directly in the middle.

In brief, the Pentagon has three obvious choices on which to base war mobilization planning:

- Total all-out war. This would begin with a catastrophic exchange of nuclear weapons and could be expected to conclude shortly thereafter.
- Limited war. This would be another Korea-type war—a war fought for a relatively short period in a limited area for limited objectives.
- General war fought without the big warheads. This would be a long war involving only conventional and possibly small fractional-yield nuclear weapons.

The United States could prepare to fight all three kinds of war. That is what Russia has done. Or, the United States could make a clear-cut decision on one or even two types.

But the Pentagon and the Administration have decided against taking either course at the present time. Instead, the Pentagon has clearly decided to let the decision continue to ride.

In effect, the new Defense Planning Instruction tells each of the three services to make industrial plans for whatever kind of war each believes would be the correct one to plan for under the present circumstances—budgetary and strategic.

As a result, the Air Force can be expected to proceed with its present policy of planning strictly for all-out nuclear war. This means little or no industrial war planning.

On the other hand, the Army and Navy can be expected to continue to proceed with their present policies of planning for limited and general wars fought without the big nuclear weapons. This involves millions each year.

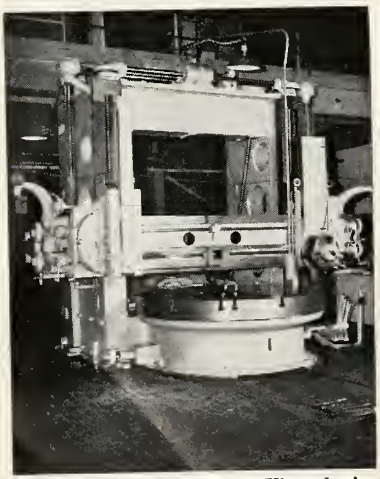
- **How it started**—Industrial war planning dates back to the early years after World War II. The governme decided that it would never again caught in the state of industrial unp paredness for war that it was in af Pearl Harbor.

Therefore, the government began vast program of stockpiling critical w materials. The services also put ir effect industrial preparedness and pla ning programs involving projects rar ing from drawing up paper mobili tion plans to mothballing factories.

The United States today has a st tegic material stockpile involving penditures and obligations totali nearly $6 billion. These include so 75 materials running from aluminu to manganese to zinc—not to for wattle and waterfoul feathers. All stored at some 216 depots and oth facilities throughout the nation.

Purchases of a number of items continuing. However, for most ite both basic and maximum objectiv have been achieved.

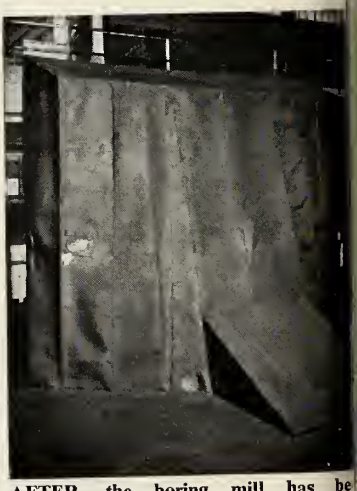
The Army has in reserve 73 plan for mobilization purposes—38 inacti and 35 active to varying degre Thirty-five are ammunition plan Twenty-six others for some type ordnance. Five of these are in the Arr missile program.



BEFORE mothballing, a King boring mill awaits joining machine tool reserve.



PART WAY, the boring mill is covered with protective paper and frame.



AFTER, the boring mill has be shrouded with heavy protective materi

The Army also is maintaining more han 169,000 items of war production quipment in storage. About 60% of hese items are part of plants in the rmy industrial reserve. Some are tored in big Atchison cave in Kansas.

The proposed Army budget for FY 50 provides $76 million for its in- ustrial mobilization program. But this s not a true picture of Army expendi- ures in this field. Many costs are scat- ered elsewhere.

The Navy is spending about $110 to 120 million a year on its mobilization rogram. However, the Navy is spend- ng only about $12 million on industrial obilization planning. The bulk of the oney goes for purchase of mobiliza- ion stocks and maintenance of the big othball fleet.

The mothball fleet today is made up f nearly 1400 ships of all types. These nclude 47 carriers, 15 battleships, 54 ruisers, 121 destroyers and 44 sub- arines.

The Air Force now is doing prac- ically no industrial mobilization plan- ing except for a number of very lim- ed programs. However, the new Air orce budget includes $40 million for ar readiness material. Most of this is or such rapidly consumed items as uxiliary fuel tanks for tactical jet ircraft.

• **Clarification overdue**—These learly divergent programs and the asic policies behind them has made it bvious for sometime in industry and ilitary circles that clarification of entagon policy on industrial war plan- ing was much overdue. Naturally, ny such clarification would also in- olve clarification of Pentagon policy n the far broader issue of limited vs. otal war.

But Pentagon officials faced great ifficulties in doing any such thing.

Money, of course, was and still is the main stumbling block. If there is enough cash, you can plan for all kinds of wars. But, when you have to operate under a $40 billion annual ceiling, you have to make some tough decisions.

The Air Force theory has been that the most likely war would be a total war no matter how it started. Therefore, it has argued that its limited funds should be spent on building and maintaining the most powerful force-in-being possible.

This policy is based on the conclusion that in any total war only the forces that the United States can bring into action at the beginning would have any meaning.

There would be no time to take plants, machine tools and ships out of mothballs. There would be no time to begin producing thousands of new missiles. There would be no time to order the manufacture of 50,000 planes.

Moreover, an all-out nuclear attack would make rubbish out of most advance planning along with much of the nation's industry and huge strategic stockpiles.

The Army and Navy have countered that limited wars similar to the Korean War and smaller are far more likely than total war. Therefore, industrial mobilization planning, stockpiling and mothballing of equipment are vital.

The Air Force reply is that it is not opposed to planning for such wars. But it argues that first the Defense Department should come up with an overall plan of what kind of limited war to plan for and someone should provide the money.

In any assessment of all of these arguments, it must be remembered that the Administration policy continues to be preparation for total war.

The Army's high-readiness reserve factories can be operating within three to four months. But the Army itself is not designed to meet the vast armies of Communism in any sizeable land war fought with conventional weapons.

After extensive review of all this, the Defense Department came up with its new War Planning Instruction—a broad compromise.

• **Possibilities**—The new instruction offers seven broad possibilities:

• Acceleration Planning. This is aimed at having current producers increase their rate of output in conflicts short of general war.

• Conversion Planning. This involves arrangements under which a manufacturer plans to produce in an emergency products that he does not normally produce.

• Compression Planning. This involves increasing a current contractor's normal production inventory so that in a national emergency he can complete a maximum number of finished products on a crash basis. The assumption in such planning is that all sources of supply have been destroyed.

• Subcontract Planning. This involves elimination of delays in an emergency.

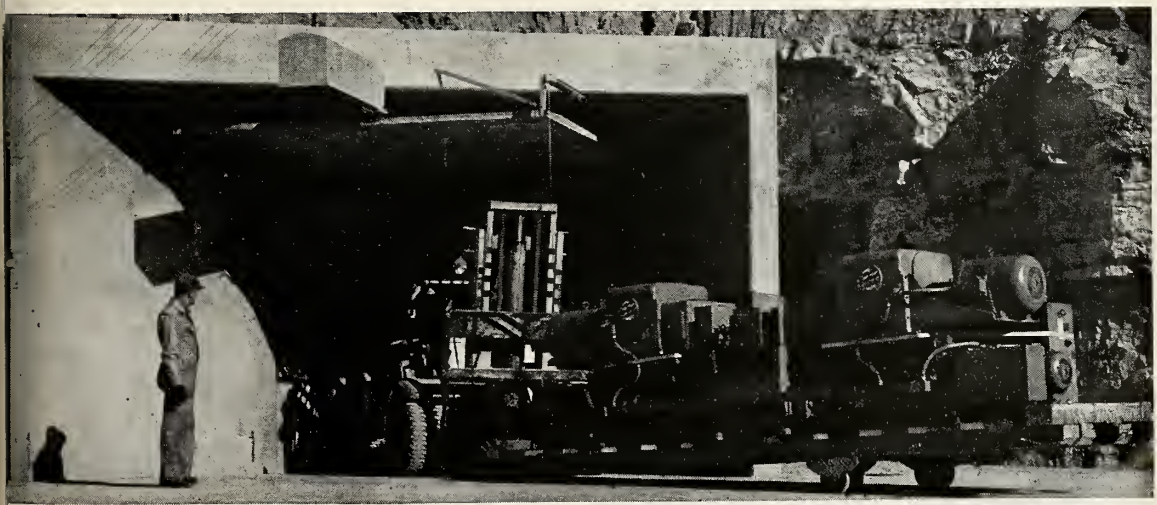
• Supplier Planning. This is aimed at production of normally commercial items that have a military application.

• Industry Preparedness Measures. This ranges from surveys of possible production problems to operation of pilot assembly lines.

• Special Studies. These are such things as broad surveys that might be needed from time to time.

Finally, the Defense Department left open the possibility of approving any other type of planning that any of the services might believe desirable.

In other words, pick your war and plan for it.



UNDERGROUND in huge Atchison Cave near Atchison, Kansas, the Army stores part of its big mobilization stockpile.

Antennas: There's a Limit in Size

What's needed is the ability to manufacture dishes and maintain them in an exposed environment to the close tolerances required

by Hal Gettings

WASHINGTON—What's needed in antenna design and fabrication to meet the extreme range requirements of missiles and space vehicles?

For example purposes, let's cite a 600-foot monster antenna now being constructed near Sugar Grove, W.Va. Costing $60 million and scheduled for completion in 1962, the Naval Research Laboratory facility will be able to look 38 billion light-years into space.

But the design of this unit merely serves to point up the emphasis being given to the extreme range requirements necessary for tracking. Boiled down, it means antennas must become bigger—because gains require larger apertures. And they must be better—because there appears to be a limit to bigness and advancement must also come in other areas.

Long-range communications can be improved by increases in three areas, under the present state-of-the-art: transmitter power, receiver sensitivity, and antenna gain.

Higher transmitter power is being obtained with new tubes and techniques. Receiver sensitivity is being increased with MASERS and parametric amplifiers. And antenna gain is being increased by larger and more precise reflectors.

But one of the primary limitations to larger reflectors is the ability to manufacture the dishes and maintain them in an exposed environment to the close tolerances required. Accepted practice calls for a reflector surface accuracy of better than 1/16 the wavelength from the focal point to any point on the reflector. (For a 60′ paraboloid with a 25′ focus at 2000 mc this would mean ± 1/6″ deflection).

These extreme accuracies even put a strain on present instrumentation to measure conformance. However, **General Bronze** has devised a special microwave interferometer to measure accuracies within one-tenth of an inch.

• **Design problems**—Several other problems have had to be overcome in the design and construction of large reflectors. Wind and weather loads, for instance, are tremendous. These are compensated for in several ways: counter-balancing sails, spoilers, and even, in case of the BMEWS for example, by covering the entire structure with a 140′ diameter radome.

Goodyear has just announced a new seamless hypalon-coated nylon radome which, it is claimed, will withstand wind velocities up to 150 mph and temperatures from −65 to +135°F.

Mechanical requirements, too, impose serious problems. Tracking accuracies demand extreme tolerances in the azimuth and elevation mechanisms and the servo drives. **General Electric's** precise *Atlas* command guidance antenna requires a tolerance of 0.000050″ on the bearing race of the 2½-ton azimuth pedestal. Other parts are built to within 0.00001″. Such precision is usually found only in fine watches and delicate instruments.

It is interesting that, so far as is known, Russia has made no effort to develop giant antennas. They reportedly use a series of medium-size interconnected "orange-peel" types, similar to our height-finders, for long-range tracking and telemetry reception.

Conventional mechanical scanning systems are made somewhat obsolete in the massive antennas. Rotating the mass of a mechanical scanner suspended 25′ from the dish, for example, would require prohibitive construction to contain the vibration and moments generated.

This problem was solved neatly b **Radiation, Inc.** in the case of the 6(Atlantic Missile Range tracking an tennas by using a rotating dielectri lens in the feed system. This applica tion was used also in the modifie multi-frequency diversity feed for th Jodrell Bank antenna.

One recent development by Ger eral Bronze goes around some of thes limitations by using an entirely new ap proach. This is an improved "end-fire element array which, it is claimed, i superior in gain, lighter in weigh smaller and cheaper than equivaler parabolic reflector types. In addition, single array can contain as many a three different antennas with negligibl interaction.

The largest movable antenna in us to date is the 240′ radio telescope a Jodrell Bank, England. Several 8(parabolas are in use and 60-footers ar almost common.

Narmco, with its "tension-truss" de sign, claims feasibility of 120′, an larger, diameter parabolas with les than 1/8″ deflection.

• **Big business**—Due to the ir creased emphasis on space communica tions, antenna design and manufactur has become a big and booming bus ness. Among the leaders in this field i **D. S. Kennedy & Co.,** which last yea did almost $14 million worth of bus ness. General Bronze reports a tota yearly volume of $10 million. **Blaw Knox's** share ran $8-10 million, an Radiation, Inc. $2 million. Goodyear' portion of the BMEWS contracts run to several million but no exact amount have been released.

Other important firms in the an tenna field include **Narmco, W. I Maxson, Philco, and Avco**—several o whom are working on classified de velopments on which no details o money amounts are available.



D. S. KENNEDY & Co.'s 120 ft. reflector swings continuously in azimuth at speeds up to six rpm.



ENERAL BRONZE's SVE tri-band tracking telemetering ntenna provides three simultaneous coincident beams on one edestal.

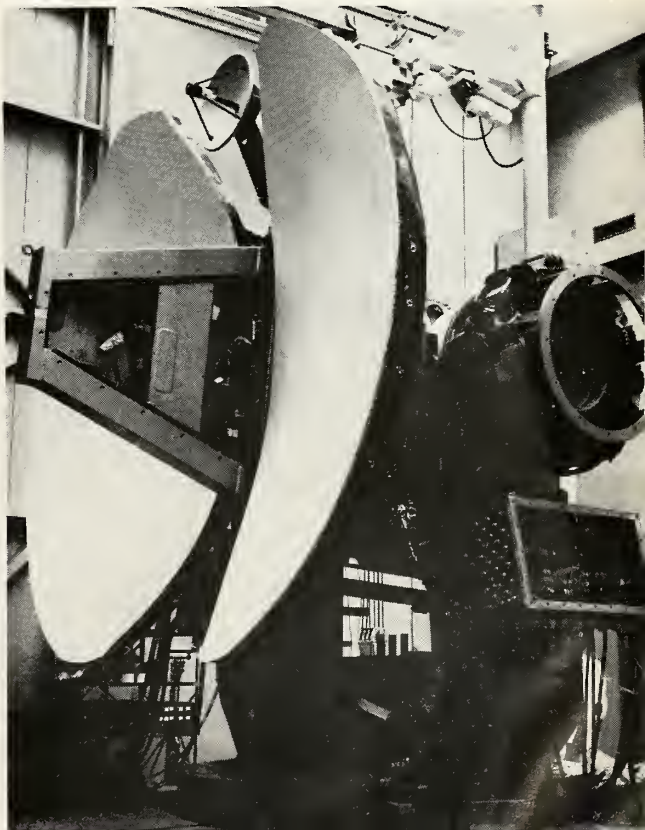


GOODYEAR'S BMEWS tracking antenna has spherical radome 140 ft. in diameter.



RADIATION/KENNEDY CO. TLM18 automatic tracking telemetry antenna has rates of over 7°/sec.

GE's high-precision *Atlas* tracker theoretically is accurate enough to measure an angle of one foot at 25 miles.



WESCON Trying New Method for Papers

SAN FRANCISCO—This year's Western Electronic Show and Convention—scheduled for the Cow Palace, August 18-21, promises to maintain its record as an interesting and progressive technical meeting and showplace for new developments in electronics.

Technical presentations will differ from the usual in two ways. First, each technical session will be limited to three outstanding papers in each classification. Second, each session will include a panel with several authorities on the subject being discussed plus authors of the three selected papers. The panel will comment on the papers presented, question the authors, and stimulate discussion with the audience.

Another innovation is an industrial design competition which will honor outstanding examples of electronic industrial design. Such a competition, it is hoped, will help design and packaging engineers to break away from the conventional "relay rack concept" and incorporate human engineering and visual appeal in their designs.

Not new—but unusual in such a convention—the third annual Future Engineers show will exhibit some 30 examples of outstanding work in electronics and allied sciences by high school students. These exhibits, representing nine western states and Hawaii, are selected by IRE sectional committees as the best in their respective areas. The students will compete for $2500 in scholarship awards.

To augment the technical sessions, a number of field trips to area facilities has been scheduled as part of WESCON. Selected on the basis of IRE professional group classifications, these include visits to **Dalmo-Victor, IBM's** San Jose computer center, **Hewlett-Packard, Eitel-McCullough, Lockheed, Ampex, Stanford Research Institute, Varian Associates,** and **Stanford's Biophysics Laboratory.**

A highlight for electronics industr management men at WESCON will b the annual meeting of the Weste Electronics Manufacturers Associatio The Wednesday luncheon meeting expected to attract about 350 weste industry leaders. P. E. Haggerty, pres dent of **Texas Instruments,** will be th featured speaker at the session.

An elaborate closed-circuit telev sion paging system will cover th entire Cow Palace and adjoining buil ings to carry messages and announc ments to the participants. Twelve more TV monitors will be installed i strategic locations to handle the mas ive problem of communication.

Program and arrangements for th show and convention—jointly sponsore by WEMA and the Los Angeles an San Francisco sections of IRE—ar handled by 15 voluntary committe made up of members of western ele tronics technical and business organiz tions. These committees operate und the direction of H. Myrl Stearns, chai man of the WESCON board, an B. M. Oliver, chairman of the executiv committee.

Plane-Wave Tubes Study High-Intensity Sound

ANAHEIM, CALIF.—The completion of a new series of plane-wave tubes for studying the effects of high-intensity sound on small electronic equipment has been announced by Altec Lansing Corporation. The 155-db 8-inch plane-wave tube is designed specifically to observe and determine electronic equipment malfunctioning in missiles and jets. The device is employed in establishing sensitive planes within equipment that might dictate particular mounting and location requirements. Also, support equipment, externally mounted devices, and support personnel are exposed to high-intensity noises under conditions similar to that of a free field; the plane wave tube is ide for studies of response of these el ments.

The wall of the tube confines th energy from a loudspeaker to a fr field in depth. By this energy co finement, the loudspeaker is require to generate much less energy than otherwise would have to develop establish a given energy level in a anechoic chamber.

According to Altec, these plan wave tubes are energized by compre sion type driver units. Two driver typ currently can be used interchang ably—the model 2801 high-pow unit for midfrequency testing and th model 288B driver for tests up to frequency of 15,000 cps.



ALTEC LANSING Corp. has developed a 155-db 8-inch plane-wave tube to observe and determine electronic equipment malfunctioning in missiles.

Automatic Sequencer

NEW YORK—A completely stat sequencer for control of the *Polar* missile countdown, capable of trigge ing 60 checkout operations per minut has been developed by **Magnetic Am lifiers, Inc.** of New York.

Constructed for the Missile an Space Division of the **Lockheed Ai craft Corporation,** the device is use to provide overall control of oth missile ground checkout equipment. issues its commands consecutivel compares information received in r sponse to its orders and verifies a curacy of test results.

Clustering: Big Payloads Quickly

These engines will add a greater degree of safety and reliability to manned space flight than the comparable single engine boosters

by Paul Means

WASHINGTON—The large boosters eeded to launch heavy payloads into ace during the next decade will be veloped by the technique of clus- ing.

Clustering is the method of mating isting reliable rocket engines into lger single stage with a much higher ust level. For a space program des- rately in need of larger engines, clus- ing produces the largest feasible oster in the shortest time.

But clustering is not just a stop-gap asure. Because it can perform mis- ns or abort under guidance after lure of one or two of its engines, e clustered engine adds a greater gree of safety and reliability to nned space flight than would a com- rable single engined booster.

The concept of clustering is not w. When it became unfeasible to ild larger ship or airplane engines, ater power was produced by com- ing the efforts of more than one gine. And, as in the case of the clus- ed rocket booster, multiple engined ps and planes have a greater degree safety and reliability in that they n still operate after the failure of e engine.

• **First is** *Saturn*—The first large stered rocket engine will be *Saturn*, itiated by the Army at ABMA in rd-1958, and accepted as a project the Advanced Research Projects ency in August, 1958.

The *Saturn* booster, whose eight werful H-1 engines developed by the **cketdyne Division of North Ameri- n Aviation** will produce a combined ust of 1,500,000 lbs., has a diame- t of 22′ and a height of 5′. It is pable of boosting such sophisticated ace experiments on their way as the st-landing of a one ton payload on t moon.

Static tests of this first clustered oster will take place in December, d the first flying tests will be initiated sometime next year. The completed space vehicle, with the **Martin Co.'s** *Titan* as the second stage and a **Pratt & Whitney** liquid hydrogen engine as the third stage, could be ready in approximately two and a half years.

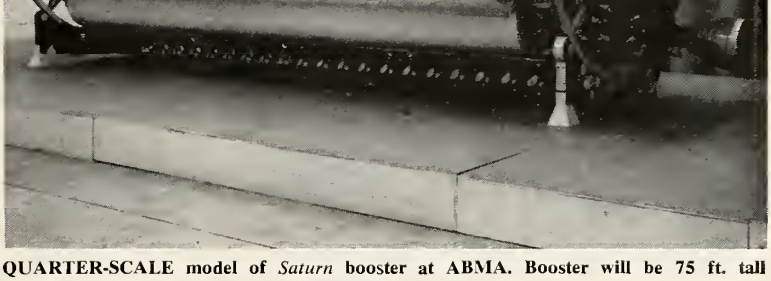
The eight H-1 engines are repack- aged, uprated, and simplified versions of the 150,000 IRBM engine currently in use in the *Jupiter* and *Thor*. This engine has been under development by Rocketdyne since its grandfather was used in the *Navaho*, and is also used in the *Atlas* and *Redstone*. It is the most reliable engine currently avail- able. (See M/R, July 20, page 53.)

Each engine operates independently with its own gas generator and turbo- pump. The propellant tankage is a common source for all engines. The eight outer tanks are of *Redstone* di- ameter (but not of *Redstone* length) and are clustered around the inner tank which is of *Jupiter* diameter.

Each of the eight engines operate independently, with the four outer engines movable so that they direct the course of the vehicle. They are mounted on gimbals, a part of their assembly, and have a six degree free- dom of movement on response from the guidance system.

Inertial guidance will be used, and the system will have the capability of automatically compensating for devia- tions resulting from loss of thrust should one engine fail to function. The guidance may also be able to operate step-wise shut down of the engines, allowing for a more accurate timing of first stage burnout.

• **Second is** *Nova*—The second large clustered booster will be *Nova*, whose million pound engines are cur- rently undergoing development by Rocketdyne for NASA. Initial designs cluster four of these large engines, but the payload penalty in case of an engine failure indicates that the final



QUARTER-SCALE model of *Saturn* booster at ABMA. Booster will be 75 ft. tall and 22 ft. in diameter, giving 1.5 meg thrust.

clustering: big payloads quickly . . .

configuration will use at least six engines. No firm date has been given for the completion of this booster.

The three distinct advantages of a clustered vehicle: (1) the ability to build a large thrust vehicle in a short time; (2) the reliability and safety advantages for manned flight; and (3) the great flexibility and flight control that can be maintained.

Engine development for space vehicle use operates in a cycle. The immediate need for a higher level of thrust is satisfied by clustering an existing engine of proven reliability. This can be done in a fraction of the time necessary to scale up to a single engine developing the higher level of thrust.

So a cluster of the smaller engines is used until the larger engine is developed and demonstrates a high degree of reliability. Then the larger engine is clustered, providing a booster with a higher thrust level which will be used until a still larger engine is developed, which after it achieves a high degree of reliability will be clustered . . . etc.

Therefore, at any given stage of engine development, the booster providing the highest thrust level would in all probability be a cluster.

• **More applications with cluster**—But what if it were possible to build the larger single engine in the same amount of time it took to cluster the smaller existing engines? Most rocket experts agree that the clustered engine would still have more applications because of its greater safety, reliability, and flexibility.

If, for example, one of *Saturn's* eight engines failed after launch, the following four options are available: (1) the booster could complete the mission on the seven engines with a payload that had been originally been reduced by 1/8 of full capacity; (2) the mission could be completed if part of the payload is jettisoned, (after 30 or 40 seconds of burning, the payload penalty is very small); (3) the mission can be aborted under power and guidance making possible recover of vehicle and payload (this is possible with the failure of two or more engines); and (4) the vehicle can continue into space to perform an alternate, less demanding mission.

None of the above options are available upon failure of a single engine booster. Unless the payload has an escape rocket system, both the booster and payload would be lost.

The clustered booster also achieves a greater reliability in the area of thrust decay. The characteristics of each engine may not be the same, but you can predict closer the mean value of the thrust decay of eight engines than the variance of thrust decay of one engine on a given flight. Because of this, and also the possibility of a step-wise shutdown of the engines, the clustered vehicle allows for a greater predictable accuracy from the propulsion system.

Because of the individual compartmenting of the cluster's engines, engine failures can be kept from spreading except for the rare "bomb" type of explosion.

• **Limitations**—There are limits as to how many or how few engines can be feasibly clustered. Because of the intricate relationship between the various components of a cluster, 10 or 12 engines is thought to be the largest feasible cluster. Because of the payload penalty incurred when too few engines are clustered, six is considered by some to be the minimum feasible cluster.

Saturn, whose booster clusters eight times the thrust level, must accept a payload penalty of only 12% to allow for the failure of a single engine. A booster clustering only four times the thrust level would have to accept a 25% payload penalty.

Clustering large boosters out of existing engines is not merely just clustering missiles. The parts of the missile must be fully redesigned before they go into the cluster. Many components must be reinforced because of the greater stress and pressure. Nozzles must be redesigned so that th are very short, and *Saturn's* 16 suctic lines will have to be flexible for gir balling.

Many of these problems are n within the present state-of-the-art, a must be solved through new enginee ing. The biggest problem is simplific tion of parts.

The telemetry system must have t capability of providing data insta taneously so that the vehicle aft engine failure can be kept in the m sion trajectory or switched to the abc trajectory. In a clustered engine, t guidance carries the thrust vect through the center of mass by adjusti the outer control engines.

As in all multiple fuel systems, clu ter designers must make sure that of the propellant is used up so th part of the payload does not becon unused propellant.

Clustering of the upper stages of space vehicle is slightly less desirab than clustering boosters because the is less chance of engine failure a therefore less need for multi-engine liability.

Upper stage clustering would al raise the problem of how to get f thrust from all engines instantaneous at ignition. This is done with boost clusters by clamping them down un full thrust is achieved.

• **Doubtful in solids**—Though clu tering has applications in the advanc space engines of tomorrow such as t ion, plasma, and nuclear engines, it doubtful that the principle will ev be used in solid rocketry.

One major problem with a sol cluster is that the electrical wiri together of the engines would ta place with the propellant in place. short in any of the electrical pa could mean a catastrophe.

Another problem with solid clu tering is control or determination thrust. This could be accomplished designing a grain with a small e plosive film lamination that wou rupture the propellant grain and te minate thrust. The problem with th method is that the rocket could n be restarted unless the ignition devi would also be located in the grai

The third problem with clusteri solids is that a single solid grain th could develop a million pounds thrust would probably have to be ma at the launching site because of t possibility of damage to such a lar grain during shipment.

Rapid advancements in the field solid rocketry could overcome ma or all of these objections, but prese indications are that the large space v hicle boosters of the next decade w be clustered combinations of liqu rocket engines.



ARTIST'S concept of clustered *Nova* vehicle and its support equipment.

автоматический перевод
вычислительные машины
способствуют исследова-
нию языков



AUTOMATIC TRANSLATION

Computing machines aid language research at Ramo-Wooldridge

To formulate rules for automatic language translation is an enormously subtle and complex project. Yet significant progress is being made. During the past year of research at Ramo-Wooldridge over 60,000 words of Russian text have been translated and analyzed using an electronic computer. From the beginning several hundred syntactic and semantic rules have been used to remove ambiguities that are otherwise present in "word for word" translation. Our present computer program for automatic translation is a considerable improvement over earlier attempts.

Apart from the question of translation itself, electronic computers are invaluable for language research. The expansion of existing knowledge of the rules of language, through statistical analysis, is made practical by mechanized procedures. A clear symbiosis between linguistics and computer technology has emerged.

Automatic translation research is one of many R-W activities addressed to problems of communication of scientific information. These problems are increasing at an accelerating pace. In this area, as in others, scientists and engineers find at Ramo-Wooldridge challenging career opportunities in fields important to the advance of human knowledge. *The areas of activity listed below are those in which R-W is now engaged and in which openings also exist:*

Missile electronics systems
Advanced radio and wireline communications
Information processing systems
Anti-submarine warfare
Air navigation and traffic control
Analog and digital computers
Infrared systems
Electronic reconnaissance and countermeasures
Basic and applied physical research

For a copy of our brochure or other information, write to **Mr. Donald L. Pyke.**

RAMO-WOOLDRIDGE
P. O. BOX 90534, AIRPORT STATION • LOS ANGELES 45, CALIFORNIA
a division of ***Thompson Ramo Wooldridge Inc.***

Circle No. 5 on Subscriber Service Card.

USW: A $4-Billion Yearly Market

Many missile companies are realizing that this great technological challenge is as important as space flight and in the next few years will be just as expensive

by The M/R Staff

WASHINGTON—Missiles are—among other things—a matter of markets. And one of the most demanding and untapped missile markets today is USW (Under Sea Warfare). It already accounts for $4-billion a year in Navy spending—including some $2-billion in direct procurement and 85% of the cost of fleet operations.

Proportionately, over the next decade the USW market will grow as much, if not more than the spaceflight market. And, that growth will draw heavily on missile, rocket and spaceflight technologies—as many companies are beginning to realize.

Though at the opposite end of the altitude spectrum, USW is every bit as important as space flight, and, over the next few years, it will become every bit as expensive. Probing the depths of Earth's oceans is no less a technological challenge than reaching up into depths of solar space. The nuclear-powered deep-diving submarine poses the same problems of closed self-sufficient environment as does the interplanetary space ship.

As an environment for missiles, the same basic problems exist: High velocity flight—200-to-300 knots; complete three-dimensional maneuverability; greater and greater operational depths (altitudes); missiles that operate entirely in the water realm; missiles that go from water to air, from water to air to surface, from water to air to underwater; underwater missiles to intercept and destroy other underwater missiles; missiles that decoy attacking missiles away from their targets; drones that are used for practice and training; unmanned advanced warning, detection and tracking units, etc., etc.

• **What USW includes**—USW now includes strategic bombardment of land targets, anti-surface ship activities (both merchantmen and military ships), and, most important of all, ASW—Anti-Submarine Warfare. In fulfilling these missions, use is made of aircraft, surface vessels, other submarines, and weapons—in being or planned. T mention a few:

Polaris, Subroc, Asroc, Weapo Alfa, Mark 37, Mark 39, and *Mark 4* torpedoes, *Regulus* I, missile min and depth charges.

However, the ocean is a strange an mysterious place. We know less abou its depths than we do about the surfac of the moon. Yet it poses as great threat to our national security as do space—perhaps even greater. And i turn, knowledge and supremacy of th oceans demands many of the sam technologies as does the conquest c space.

The submarine first started in Nav service 58 years ago. And even throug World War II it was essentially a su face vessel which could submerge t make its attack. Otherwise, it was surface vessel. Its hull was efficient o the surface; inefficient underwater. It powerplant was designed primarily fc surface operation. On the top of th sea it ran on diesel engines. Under water it ran on batteries—which ha

Market Needs in USW

—Submarines capable of 50-to-60-knot underwater speeds.

—Torpedoes and missiles able to go at least five times that fast in submerged pursuit of their prey.

—Sub-carried anti-missile-missiles to intercept 200-knot torpedoes and other high-speed ASW weapons.

—45-knot hydrofoil ships for high-speed ASW search within 200 miles of the coastline.

—High-speed missiles designed specifically to destroy hydro-foils—a kind of Hawk concept that breaks out of the water, gains altitude and then seeks the target by radar, heat, etc., from above.

—Drone helicopters that range and search and fire their ASW weapons without the benefit of direct manned control.

—Submarine-launched anti-aircraft missiles.

—Submarine-launched tactical amphibious assault support rockets.

—Anti-Polaris missiles designed to shoot down submarine-launched ballistic missiles soon after they brea through the water.

—Long-range anti-submarine weapons—includin an extended range SUBROC and adaptations of th Polaris—launch a pattern of ASW missiles just befor impact (probably employing recovery gear to slow ther down). This weapon could be fired from thousands o miles away.

—Podded Polaris and other missiles that can b anchored to the ocean floor to be launched later b remote control or by automatic sensing.

—Air and sea launched high-speed missiles tha seek out and destroy undersea craft.

—Both submarines and weapons capable of operat ing at depths of 10,000-to-20,000 feet.

—Diversionary missiles designed to draw an attack ing missile from its intended target.

—High-speed underwater drones for test, practic and maneuver.

) be charged periodically.

Today's modern submarine is nu-lear-powered, whether surfaced or sub-nerged. Its hull is designed to ignore ow-wave problems. It's faster under-ater than it is on the surface. And its nderwater speed is more than twice ne World War II's surface speed. Sud-enly it has become at home in the eep—out of its element when wallow-ng in the surface waves.

• **USW arriving in fact**—Undersea arfare has been around a long time n theory. But only recently has it nally arrived in fact. And with this rrival has come a whole new family f concepts and requirements. The rctic ice cap, once a forbidden land as suddenly become playground and nctuary.

Whole packs of submarines, either ussian or American, can lurk in eadiness indefinitely under the protec-ve layer of ice above. Where a 300-ot depth was a dangerous limit in Vorld War II, today's submarines dive adily to a depth of 1000 feet, and oats capable of operating effectively nd safely at 3000 feet are now under onstruction. Research vessels to go own three miles or more are on the rafting boards.

These are precursors of submarines nat will be at home and fight to the reatest depths of the world's oceans—hich include depths of 30,000 feet or ore, where the crushing pressure of ne waters above exceed 10,000 pounds er square inch.

Today, however, the attack capa-lities of submarines are moving ahead r more rapidly than are our capa-lities of submarine defense. For this ason the bulk of our undersea war-re efforts are devoted to ASW. Sur-ce ships, submarines, helicopters, air-anes and missiles whose sole mission to kill other subs are being bought volume. And, in turn, the Navy, ving to look ahead, is already design-g weapons to counter the weapons ey're buying now to kill subs.

But out of it all, a full spectrum of eapons emerges. Some are already thorized for procurement. (See box, larket Needs in USW) Some are tually on order. Others beg for "pro-sals with promise" from industry. ver the next decade, they add up to multi-billion-dollar market.

• **Need electronic backup**—But the rformance capabilities of these new eapons will be useless unless they ve adequate electronic backup. rgets must be detected, located, entified and tracked over great dis-nces and with great accuracy.

Currently the only operational derwater detection and tracking sys-ms rely, one way or another, on

PODDED *Polaris* **missiles that can be anchored to ocean floor and launched later are a future requirement in USW.** →

sound. And this is limited on all counts. Detection is possible at great distances, particularly with recent developments in very low frequency (below the level of human hearing) sonar equipment.

However, direction and ranging over more than a few miles are virtually impossible. Thus, so is tracking. You can tell if "something is out there," but that's about all. You don't know how far or in what direction.

Not only that, but underwater devices are growing more and more silent. Contrarotating propellers have reduced high-speed hydrodynamic noise to a heretofore unachieved low. The French use rubber propellers to minimize transmission of engine noise—very high in fast nuclear submarines—and similar developments are believed to be underway in the U.S.

Work by **Coleman Engineering Company** on the West Coast on special boundary layer control skins for underwater vehicles has reduced drag (and cavitation noise) from fast-moving underwater bodies by 65%—with 85% theoretically possible.

• **The complaints**—A major complaint of every naval officer connected with USW is that attack capabilities are moving ahead at a far faster rate than ASW's ability to counter them. This is especially true in the realm of detection, identification, location and tracking. Underwater vehicles are becoming more silent at a more rapid rate than the range, sensitivity and accuracy of tracking gear.

A really noisy beast like the nuclear-powered submarine Nautilus on a high-speed underwater run can be heard thousands of miles away. It's a detection, but that's all. No range. No bearing.

Effective, operational detection of submarines is good only over a few dozen miles—even with the latest gear. And then, distance and direction readings are only probable—due to the ever-present salinity and temperature gradients that lace the ocean and bend sound waves over considerable angles.

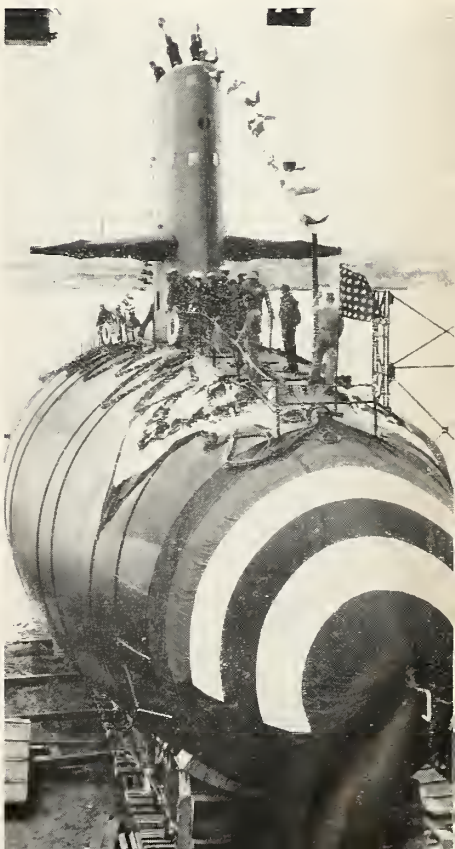
Current efforts to make up for the low effective range of sonar detection take two directions:

One involves development of sonars with a greater range coupled with employment of vehicles able to cover a lot more territory in a given period of time. Helicopters, airplanes, blimps,

→

SKIPJACK, U.S.'s fastest submarine will be outmoded in a few years with the requirement for 50-60 knot underwater speeds.





USW: $4-billion market . . .

and fast surface ships such as destroyers, destroyer escorts, and various smaller ships.

Important to remember is the fact that aircraft (airplanes, helicopters and blimps) are only effective in finding surfaced or (sometimes) snorkling submarines. Their main piece of detection gear is radar. Magnetic detection gear is limited only to a few hundred yards and cannot begin to cope with the great expanses of ocean involved.

• **Hydrofoil to be funded**—Scheduled for funding during the current fiscal year is a hydrofoil—length, 115 feet; displacement, 100 tons; speed 45 knots; armament, twin ASW torpedo tubes, stern depth charge racks and twin 50-caliber machineguns—one escort research ship, a special hull configuration that is expected to do for surface ship design what the Albacore did for underwater hull design, and incorporating the latest in both long-range and variable depth sonar detection gear.

New long-range sonar is reported to have an effective range five times anything now operational. Variable depth (dunking) sonar equipment is designed to permit surface vessels to see below the thermocline—a layer of water a few hundred feet down where the temperature changes rapidly with depth-below which submerged submarines have been virtually free of detection. Presumably the variable depth sonar can be towed at whatever depths are required.

The other major approach to ASW rests in pure weight of numbers—an approach, incidentally, by which we cannot possibly afford 100% assurance of safety from underwater attack. Towards this end, however, (and this will give you a partial idea of the mounting size of this market) the fiscal 1960 Navy budget provides for two Dealy class DEs (destroyer escorts), eight ASW DDs (destroyers); one MSS (minesweeper special); three ASW submarines (Thresher class); three guided missile frigates (7500-ton displacement compared to 4000 for a destroyer)—totaling some $494.4-million for ASW ships, not including modernization of existing vehicles. An ASW submarine now under development, the Tulibee, will have a depth capability of 3000 feet.

In addition, the 1960 budget provides for 26 **Lockheed** P2V-7 Neptune ASW aircraft; 36 **Grumman** S2F Attackers; 70 torpedo and detection gear-carrying helicopters; and the first of the modified Lockheed Electra P3V-1 new-generation ASW aircraft—a total of over $400-million for ASW aircraft, if you include aircraft modernization.

Add to this some $160-million for Continental U.S. and ocean ASW sonars, radars, electronic countermeasures, etc., plus $174.7-million for ASW research, development, test and evaluation, plus a large portion of the $516-million request for procurement of ordnance and ammunition, plus nearly $300-million in ASW-related construction . . . and this market begins to take on an appreciable size.

• **Capricious sound**—The only signal that man knows can travel through water is sound, and while it travels faster and farther in water than it does in the air, it is capricious at best.

In an effort to beat the limitations of sound, the Navy is spending considerable amounts of money on a large variety of underwater detection tracking and communications projects that do not involve sound phenomena.

These, lumped together, bear the unofficial title of *Project Unsound*—including efforts to find a window in the ocean for electromagnetic waves, the study of electrical phenomena, such as the motion of the ionized particles in the ocean; to see if the underwater wake of a submarine can be tracked by a homing device; investigation of both magnetic and gravitational disturbances due to the presence of metal, etc.

The cost of completely covering the coastal waters of the U.S. by present methods would be absolutely prohibitive. And, the expense of trying to patrol the oceans of the world, including those lying under the polar ice pack, would be proportionately greater. In a word, by present methods—namely, sonar—it is not possible to establish an effective anti-submarine defense. Another principle of detection capable of great accuracy and very long ranges must be developed. The Navy would pay well for such a discovery.

Meanwhile, every effort is being made to do with what's on hand. A major portion of the Navy's R&D budget is being expended on two-way communications between submerged submarines—over both close and long ranges; communications between surface ship and sub; between aircraft and sub; long range communications with shore stations.

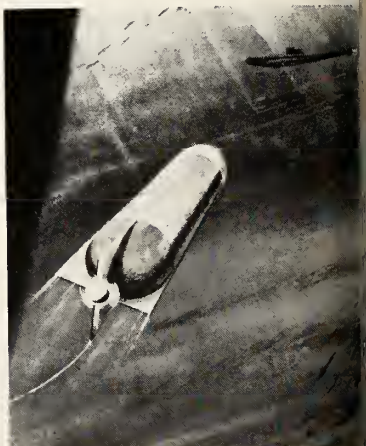
Specifically, current effort is being directed toward further procurement and development of single sideband techniques for tactical communications between widely dispersed task force units; ultra-high-frequency double sideband techniques for line-of-sight communications; fast frequency chang equipment; ionosphere scatter; an Moon relay.

For the future, there is a windo in the ocean for infrared transmissio over considerable ranges, but which so far impracticable. Also, there tantalizing evidence of an electr magnetic phenomena that is effectiv to a considerable depth (normal atter uation of low frequency waves is som 90% in 300 feet) which is "somewh less than well understood . . ."

In a word, there are hints of breakthrough, but the "actual" has y to be achieved.

• **Computers important**—Also in portant in the ASW electronics mark are computers for firing underwat missiles at high-speed targets. Prob lems not only include calculation c firing time and angle (in three dimer sions), but en route arming, so that th torpedo's (missile's) acoustic homin device is activated only when a saf distance from the launching vessel. A example of this kind of equipment the *Mark 112* Torpedo Fire Contr System being produced by **Sperry Gy roscope** under a $12-million contract.

USW divides into two basic cat gories: Attack and defense. For th moment, attack includes standard ant surface ship operations and strategi land bombardment with ballisti *(Polaris)* or air-breathing *(Regulus* missiles. Defense includes everythin else, and accounts by far for the bul of USW expenditures. And of thi submarine detection, location, identif cation and tracking is the major prob lem. Until this is solved satisfactorily submarine destruction is an importan but still secondary problem.



MARK 39 wire guided underwater m's sile may have 60-knot speed but in 197 period torpedoes will require 200-30 knots.

• **Submarine attack capabilities**—The submarine attack capability against surface ships has improved materially in the 14 years since World War II's end. Whereas surface ships were faster (18 knots for merchantmen, about 30 knots for Naval warships vs. the submarines 12-to-15 knots short duration submerged speed), submerged submarines are now faster than most surface vessels (30-to-40 knots vs. the still-the-same 18-to-30 knots for surface ships). This means that submarines now chase, overtake and attack vessels that before they had to intercept or lay in wait for. For anti-surface ship attack, torpedoes have increased range, higher speeds and better homing guidance.

The *Polaris* system is designed to attack major strategic land targets. With its range due to increase from 1200 to over 1500 nautical miles, it is capable of attacking all of the Russian land mass except for a small 100-mile square in the Siberian heartland. A small increase in range will readily bring this, too, under potential submarine attack.

• **$612 million for** *Polaris*—In fiscal 1960, the Navy has asked for $611.6-million to support the *Polaris* Weapon system program. Of this, $220-million is for research, development, test and evaluation.

Other *Polaris* spending includes: ships and facilities, $16.3-million; servicewide operations $3-million; shipbuilding and conversion, $54-million; procurement of ordnance and ammunition, (including *Subroc* procurement for tactical defense) and military construction, $4.2-million.

Included in these figures are pipeline, shake-down and flight test for *Polaris* missiles; production engineering and tooling; special training equipment; pop-up test devices; R&D on reentry bodies, guidance, structures, controls, systems integration, command communications systems, etc.

Currently there are six *Polaris* submarines under construction. Three more starts are planned during the current fiscal year, plus placement of initial orders for long lead time equipment for three more to be started in 1961. The missile itself may yet achieve operational status during 1960, as has been forecast, but only with a 1200-mile range—compared to the 1500-mile original target.

• **Assault and logistical supply**—Work is already underway on the development of undersea craft for landing troops for amphibious assault work and for the supply of overseas bases with operational essentials such as fuel, food, weapons, etc. This involves not only large troop carriers but cargo "tracker-trailers," as well. In the latter category, **Goodyear** is working on a rubber, wormlike petroleum transporter that can be towed behind a submarine. This would have practically no drag and would be almost 100% transparent to the effects of underwater blasts. In line with this is thinking and planning for undersea-launched tactical missiles to lend the same kind of close support to amphibious troops as is now supplied by aircraft.

And, as always, for every system of weapons, there must be counter-weapons. There will be a need, for example, for land troops to be equipped with effective mobile ASW weapons to fire back at this kind of underwater artillery.

• **ASW warfare** — With current technologies and physical equipment, it is not possible to spot more than a small percentage of any fleet that might be lurking off our coast. It is impossible now to detect either one or a whole fleet of atom-submarines lurking under the Polar ice pack. And even if they could be detected, they would be very difficult to attack.

It's a standard rule of thumb that torpedoes should be five times as fast as the submarine they are attacking. This means that a torpedo should have a speed of 200 knots to attack a 40-knot submarine. They need this extra speed to make up for time lost in following sound twisted and turned by ocean conditions.

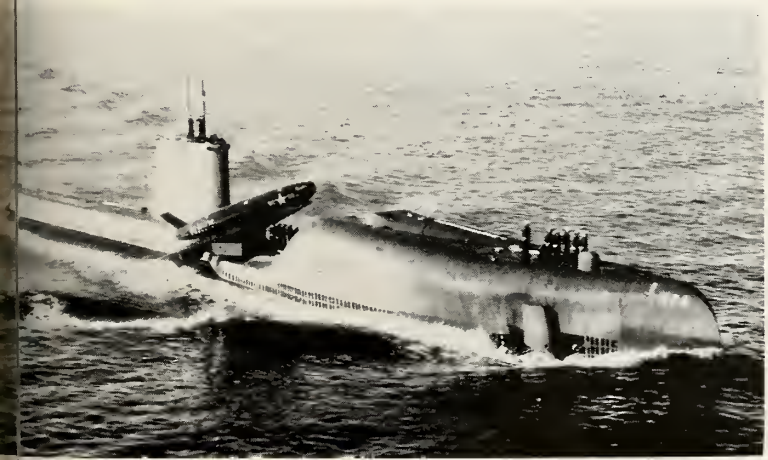
Not only must it be this fast, but its self noise must not be so great as to interfere with its own sonar homing gear. Such a torpedo is a requirement still, and not an achievement. Even though the speeds have been attained using both rockets and lithium-fueled hydroducts, noise due both to cavitation (boundary layer separation) and the propulsion unit itself has made them worthless as weapons. Current West Coast efforts to develop an underwater body skin system to provide boundary layer control show some promise and may provide a partial answer to this problem.

• *Subroc* **purpose**—A major purpose of *Subroc* is to make up for the torpedo's lagging speed capabilities, as well as to extend the submarine's effective attack range. However, once back in the water on its final target run, *Subroc* will suffer from the same speed limitation as an unboosted torpedo, unless a break-through is made in quieting down torpedo propulsion or coming up with homing systems other than sonar.

Nearly everything the Navy is developing is designed to make up for the lack of range of both detection devices and weapons. The hydrofoil is designed to cover great areas in a minimum of time—like the airplane, only the hydrofoil will search with sonar as well as radar. Similarly, both manned and unmanned helicopters can cover considerable distances during a single flight, using sonar equipment dropped into and dragged in the ocean.

DD's, DE's, frigates, etc., though not capable of the other crafts' speeds can carry much heavier search equipment, which have a much greater range. The same basic approach is also true of ASW submarines, though these have the added advantage of being able to operate in the submarine's natural submerged environment. The submarine is, perhaps, the most effective ASW weapons system, and is certainly the most feared by another submarine.

And these are being designed to go faster and deeper. Current depth limit of operational submarines is about 1000 feet. Craft now on order will be capable of diving to 3000 feet. Research models are already funded capable of going down 10,000 feet and better.



SS GRAYBACK and *Regulus I*. **The 1970 submarine will have ability to launch anti-aircraft missiles and tactical amphibious assault support rockets.**

$$$—Biggest Barrier to Effective ASW

But industry hits other factors: Lack of single ASW group in Navy; lack of consistency in requirements; and difficulty in getting state-of-the-art information

by William E. Howard

WASHINGTON—Top Navy and industry ASW experts agree the biggest barrier existing today in developing an effective counter to the Soviet submarine-missile threat lurking beneath the sea is plainly—money.

Unless more basic research is funded soon—and in large amounts—there is serious doubt that the United States ever will achieve in time an ASW system capable of defending its cities from submarine-launched missiles, or keep vital sea lanes open in a limited war.

Anti-submarine techniques—particularly in the area of long-range detection—lag woefully behind rapidly advancing submarine technology. Nuclear subs, as made painfully clear by this country's own Nautilus and Seawolf, can out-dive, out-race and outsmart every ASW detection system in existence today.

What is urgently needed to close this gap are breakthroughs to new methods of detection—something which, unlike indiscriminate sonar, will home-in only on submarines and at great distances. And these breakthroughs can be achieved only at tremendous research cost.

That Congress and the Administration have failed to realize fully the scope of the problem and furnish more money dismays many persons in the ASW field. For they consider ASW equal, if not more important to the nation's security than space research. However, the chances of having ASW funds increased by any significant amounts this year or next are rather dim.

In 1959, ASW appropriations for research, development, test and evaluation amount to about $174 million. For the 1960 FY they are expected to be about the same level under the $40 billion budget ceiling.

• **Need $100 million more**—Actually, the Navy feels an additional $100 million should be spent on ASW R&D in 1960. Vice Adm. J. T. Hayward, deputy chief of naval operations for R&D, says the extra $100 million was needed this year. And for lack of it "many new ideas which were of a high risk nature have been left unfunded."

Points out Hayward: "It is entirely possible that one of these new ideas could hold the secret to a real successful improvement in ASW."

As programmed now, there may be a slight step-up in ASW R&D aimed principally at active and passive systems for detection, localization, classification and kill of all types of enemy subs—including the quiet deep-running nuclear boats. The Navy is asking for $27.9 million for sonar development and $5.2 million for oceanography. In the latter area, Russia has devoted a major part of its International Geophysical Year program.



MARK 44 torpedo, new ASW weapon, can be launched from ships or aircraft.

The Navy today feels that ASW is its prime mission. Says Rear Adm. Howard A. Yeager, acting ASW readiness executive, "ASW is practically Mr. U.S. Navy right now." It cuts across the function of practically every Navy division and bureau, from aircraft carriers to *Polaris* submarines.

Actively working on various phases of ASW is the office of the Chief of Naval Operations headed by Adm. Arleigh Burke, BuOrd, BuShips, BuAer, the Naval Ordnance Laboratory, Navy Research Laboratory and the Office of Naval Research.

But, by and large, almost all of this activity is of an operational or an applied nature that basically is no different from what the Navy was doing in World War II. As one expert puts it, "All our carriers, destroyers, blimps, submarines and helicopters today are still just as ineffective against modern Red subs as they were against German U-boats. What we need are brand new ASW techniques—and the only way to find them is through basic research."

• **Industry survey**—The Navy by saying its overall mission is ASW is distracting attention from the primary problem, in the opinion of several experts. They firmly believe that instead of allowing BuAer, BuOrd and other agencies to dabble in ASW, the Navy should set up one main ASW bureau or division to push basic research—chiefly in the all-important area of detection/identification.

Until the entire emphasis shifts to finding the answers to a foolproof detection system, the feeling in industry is that progress will be haphazard and the necessary breakthroughs won only by luck.

A confidential industry survey which will appear in the September issue of ARMED FORCES MANAGEMENT, an American Aviation publication, pinpoints these industry-Navy problem areas:



OTS-developed *Weapon Alfa* is one of the oldest ASW weapons in use y fleet. *Subroc* will largely make the weapon obsolete.

• Lack of sufficient ASW R&D unds.

• Lack of a single ASW group in ne Navy.

• Lack of consistency in Navy SW requirements.

• Difficulty in obtaining need-to-now and information about the cur-ent state-of-the-art.

• Failure to expedite field testing f R&D items.

Industry, through the National Se-urity Industrial Association, today is ying to overcome many of these dif-culties. NSIA established an ASW dvisory Committee a year ago headed y Fordyce Tuttle of **Eastman Kodak,** hich is developing infrared detection nd film data processing systems for SW. Eighty companies and more than 00 individuals—all ASW experts—re on the committee.

An NSIA official explains that the ommittee's job is basically to "make possible for industry to become ware of what is going on in ASW." he NSIA group is dedicated to pro-ding the technical assistance and in-rmation machinery to further a close orking relationship between industry nd the Navy. Problems it submits to ne Navy are in the form of recom-endations only, and it does not have ything to do with the actual placing contracts for hardware.

• **Shipboard visits** — Committee embers maintain close liasion with e Navy's "HUK" hunter-killer groups lfa and Bravo now at sea. "We go oard ship," says one, "to talk to the aman third class who is actually op-ating the equipment to find out how od it is and how it can be improved."

Chairman Tuttle spends more than 0% of his time on the move, as do any other members. All of this ac-ity is company-funded.

Major interest of the NSIA com-ittee is in the detection and classifica-n area, where a 50-member sub-committee headed by R. A. Wilson, vice president of **Daystrom Inc.,** is probing into electro-magnetic effects, environmental effects, acoustics and nuclear effects.

Other committee interests include: evaluation of sonar, wire, radio and data handling, greater depths for submarines, propulsion systems, submerged navigation, oceanographic research, weapons and fire control.

• **Company research**—Private industry long has been acutely aware of the Red submarine menace. For years —despite the lack of military funding—many companies such as **General Dynamics, General Electric, Chance Vought, Lockheed, Magnavox, Motorola, American Machine and Foundry, DuMont Laboratories, Yardney Electric, Westinghouse, Grumman Aircraft, Sparton Electronics, Acoustica Associates, ACF Industries, Goodyear Aircraft, ITT Laboratories, Western Electric, DuPont, Raytheon** and others have been maintaining ASW R&D out of their own pockets in addition to working on Navy contracts.

"They haven't been looking for profits, either," says "Red" Yeager. "These companies have made important contributions right down the line to ASW and I don't know what the Navy would have done without them.

"They have been acting as citizens —for the country's welfare. And what they are producing on their own may mean the difference in keeping the peace."

General Dynamics for some time has been moving ahead in ASW with a company-wide "task force" which is headed by Lawrence B. Richardson, engineering senior vice president. One of its divisions, Stromberg-Carlson, presently is building a $250,000 underwater acoustic laboratory.

At Lockheed Aircraft there is another intra-company ASW "task force" called LAWSO (Lockheed Anti-Submarine Warfare Systems Organization.) The company is working now on a pre-production contract for engineering design data for a model P3V-1 and holds contracts for other ASW aircraft and airborne systems.

Lockheed, whose LAWSO operation is headed by E. M. Davis, has 3700 employees engaged in ASW work —and more than 850 in ASW engineering. The company says it has devoted almost 250,000 man hours to anti-submarine operations research and more than 15 million man hours of engineering effort has gone in design of ASW aircraft.

Nearly all ASW work—from detection to weapons—is heavily classified. But some noteworthy developments have become known recently.

Vitro Laboratories, developer of the wire-guided *Mark 39* torpedo is working on a unique underwater television device *SOLARIS* (submerged object locating and retrieving/identification system) which has possible ASW detection applications. The ball-shaped apparatus is designed for retrieving missile nose cones, experimental torpedos and other objects from the ocean floor—but also might be used to sweep areas of the sea for hostile submarines.

Chance Vought reportedly is hard at work developing an advanced detection system without sonar.

A nuclear depth bomb—*Betty*—is under development by American Machine & Foundry.

At Acoustica Associates engineers are perfecting *SEFAR* (sonic end-fire for azimuth and range) acoustic transducers which will permit the design of extremely long range sonar systems at deep depths.

Grumman Aircraft now is flight testing a "futuristic" S2F-3 tracker plane, an improved version of presently operational anti-subtrackers which have hunt-kill capability in one plane.

Now operational with the Navy is the air-launched target-seeking electrically propelled *Mark 44* torpedo which was developed by GE and the Naval Ordnance Test Station, Pasadena. The Navy also recently unveiled two mines, *Mark 52* and *Mark 55*, which can be dropped from high speed aircraft.

• **What's ahead?**—Industry experts believe a big shift is on to adapt aircraft techniques to both the operation of submarines and in fighting them. Along this line, the **Electric Boat Division of General Dynamics** recently was awarded a contract to devise a submarine which would operate with a small crew. Concept may embrace the creation of whole squadrons of "fighter subs" which could patrol great areas of the sea at high speed and fight like aircraft interceptors.

Torpedoes—Neglected Factor in ASW

They'll have to be vastly more sophisticated and reliable if they are to be equal to their mission in coping with missile submarine threat

by Hal Gettings

WASHINGTON—"We forget too quickly between wars!" That's how one ranking Navy officer sums up today's widespread apathy and neglect in development of torpedoes—the first guided missiles and the number one weapon in antisubmarine warfare.

While the torpedo undoubtedly is the most universal and flexible weapon in our arsenal, their detection and running ranges must be increased. While they can be launched from the air (by blimp, helicopter or airplane), from a large or small surface ship, or from under the sea, and against either submerged or surface targets—they still must run faster and deeper to cope with future undersea targets.

First developed almost a century ago, the torpedo has progressed relatively slower than most of its contemporary weapons. Until recently, advancement has been primarily in improvement of range, speed, and accuracy.

In the last few years more significant steps have been taken with the development of rocket-powered units (*Rat* and *Asroc*) and the hybrid water-air-water missile (*Subroc*). The major effort today, however, is toward improvement in propulsion systems, target detection, and greater range and speed.

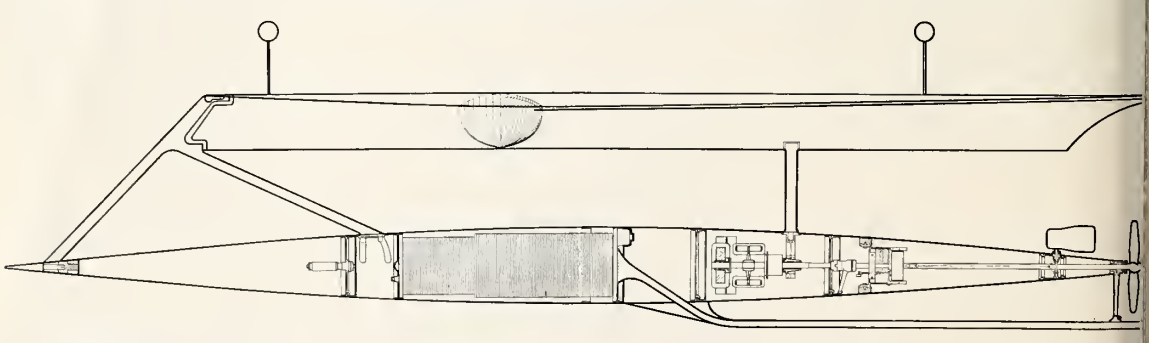
Many problems have plagued torpedo development. First, of course, has been lack of money and general apathy and neglect between wars.

• **Propulsion**—Methods for propelling torpedos have gone through several cycles of trial and error development. The first "successful" method was electric power supplied from ship or shore

CURRENT TORPEDOS

MODEL	MANUFACTURER	DESCRIPTION	STATUS
Astor	Westinghouse	Wire-guided antisub	Development
Asroc	Minneapolis-Honeywell	Antisub Rocket*	"
Subroc	Goodyear	Water-air-water missile*	"
Mark 35	GE	First production target-seeker	Operational
Mark 37	Westinghouse	Acoustic-homing	"
Mark 39	Vitro	Wireguided	"
Mark 43	Clevite	. . . . .	Obsolescent
Mark 44	GE	Antisub acoustic-homing	Operational

SIMS-EDISON TORPEDO (circa 1880)



The Sims-Edison electrical fish torpedo probably represents **General Electric's** *initial entry in the field of underwater ordnance.*

It was described as an "indestructible" copper float about 20' long, supporting a copper torpedo that varied in length from 28 to 31' and in diameter from 18 to 25". On the float's deck, two vertical rods topped by balls, flags, or lights showed the operator the path of the torpedo.

A sharp steel blade that caused the unit to dive under cables or friendly vessels protected both hull and float.

The bow section carried a 200-pound dynamite charge. The center section contained a coil of cable and the motor. Total weight was 1½-2 tons.

The torpedo was driven by an electric motor powered by a generator on shore or aboard ship through a cable 1-2½ miles long. Steering was controlled by an operator from a small keyboard. The charge could be exploded by the operator or by contact.

The speed of early models was 10-11 miles per hour; later units reportedly traveled at 20 knots.

The unit shown in the drawing was probably the successor to the one developed by the **Sims Electrical Fish Torpedo Company.** *Sixty tests were made on the unit in 1880 at the Army Torpedo School, Willet's Point, N.Y.*

hrough a cable paid out as the tor-
edo moved toward its target. Since
his method had its obvious limitations,
he next step was a battery carried in
he torpedo.

But the conventional lead-acid bat-
ery was found to have too many short-
omings. It didn't have enough power
nd the hydrogen gas given off pro-
ided some spectacular explosions—
ometimes even before the torpedo was
aunched. Acid splashed around during
aunching was apt to have deleterious
ffects on wiring and homing equip-
nent.

Battery, steam, and air-powered
nits all saw service during World War
I. All worked with more or less suc-
ess but had many undesirable char-
cteristics.

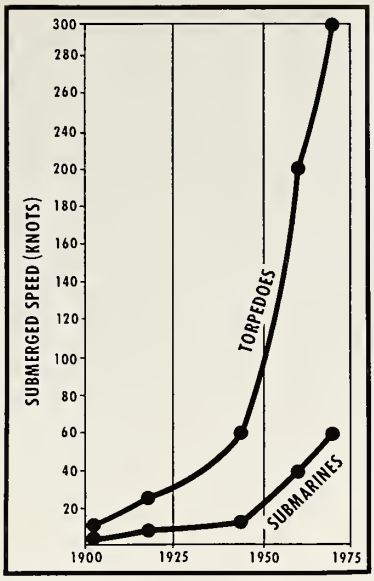
The problems of the lead-acid bat-
ery have already been mentioned. The
lcohol-burning steam generator and
he compressed-air types were short on
ange and long on malfunctions. Of
ourse, the availability of alcohol "tor-
edo juice" was considered by many
ubmariners to be an important morale
actor. The battery was sufficiently im-
roved toward the end of the War to
urn in an impressive record when com-
ared to the earlier score of the steam
orpedo.

Probably the greatest improvements
n batteries was the development of the
eawater battery (SWB) after WWII.
eawater, scooped into the battery after
aunch, serves as the electrolyte in
lace of acid. The battery is therefore
ry until the instant of use and poses
o problems in storage and handling.
he unit is approximately five times
s powerful and one-tenth as heavy as
n equivalent lead-acid type. It does
ave disadvantages—principally in cost
$6000-8000 each)—but is far supe-
ior to the old unit in most respects.

• **Rocket propulsion**—The trend to-
ay is to use rocket power for torpedo
ropulsion. Several projects using solid
ropellants are in development (*Asroc*
nd *Subroc*, for instance) but work is
o classified that no results are avail-
ble. The *Rat* (rocket-assisted torpedo)
as developed and test-fired, then
cratched.

• **Aerojet-General** has a Bureau of
rdnance contract for close to $30
illion for a torpedo development—
robably a solid-propellant type—but
ot even the model designation has
een released to date.

• **Guidance**—Torpedo guidance de-
elopment has traveled full cycle. The
ims-Edison was guided through a cable
y an operator on board the launching
hip who visually tracked the progress
f the missile toward its target. Now,
he latest operational unit—the *Mark*
9—is also wire-guided. Such a system
virtually immune to countermeasures



BASED on requirement that torpedo must be five times as fast as its target.

and evasive action.

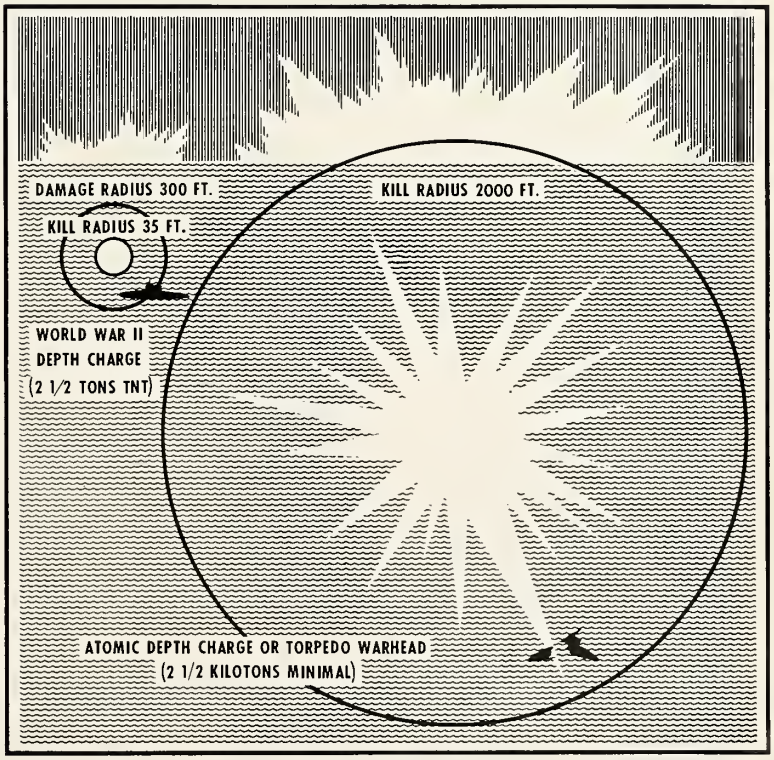
In the interim, various types of gyro mechanisms—the first inertial guidance—controlled the torpedo on a preset intercept course. The target-seekers are guided by target noise or returned sonar echoes.

• **Dynamics and construction**—The modern torpedo is an extremely complex mechanism. It not only is a combination of systems itself, but is part of a larger and complex weapons system. It is subject to long storage, shock, extreme environmental changes, and must perform a difficult and complicated task. Reliability must be as close as possible to 100%.

Modern instrumentation methods and equipment have been an important factor in torpedo progress. Engineers can tell exactly how a torpedo has reacted and performed throughout its run and test evaluation becomes more precise. With accurate test results, areas of weakness can be improved and the entire system made more efficient and reliable.

The target seeking torpedo brought its own problems. One writer has compared the detection problem to that of trying to locate a black cat in a dark room with a rapidly-failing flashlight. The floor and ceiling are covered with mirrors at crazy angles and the walls are indefinitely located. And . . . the cat may have a flashlight, too.

• **Echo return drawbacks**—Present methods use both passive and echo-return sonar. As described in the fore-



KILL RADIUS of submarines has greatly increased since World War II when a depth charge with 2.5 tons of TNT could inflict damage to 300 feet.

torpedoes—neglected factor . . .

going analogy, however, sonar return is subject to any number of erratic conditions such as bottom or surface bounce, fish noise, temperature gradients, or other presently unexplainable phenomena. In addition, the target-seeker can be fooled by countermeasures. And, of course, there is always the possibilty that the homing torpedo may turn and attack its launcher.

The *Subroc* has a reported range of 30 miles and the *Mark 39* five miles. These distances are far beyond the effective range of sonar, however, and there is some question as to the merit of range capabality so much greater than detection capability.

Much effort is being directed toward improvement in this area, but little is known publicly as to direction and success of present research. It is generally assumed that inherent limitations of acoustic methods make necessary breakthroughs in other techniques to obtain any significant progress.

• **Future**—One company official, queried as to research in torpedo improvement said ". . . work being done to improve torpedo characteristics cannot be described in detail without giving aid and comfort to the enemy and valuable data to our competitors."

Future undersea targets are going to run faster and deeper and torpedos must be built to meet these new requirements. Detection and running ranges must be increased. Higher speeds are a necessity and better target acquisition and classification are vital.

In short, tomorrow's torpedos must be vastly more sophisticated and reliable if they are to be equal to their mission. Significant breakthroughs are demanded.

M/R SPECIAL REPORT

Soviet Subs Bigger Threat than ICBM's

Intelligence reports assume Reds converting to nuclear and deep diving boats armed with KOMET III IRBM. Red China now third biggest submarine builder

by James Baar

WASHINGTON—The Soviet submarine fleet is a gun pointed at the head of every American.

In a total war, Red submarines can smash nuclear-tipped missiles into any part of the United States without warning. In a limited war, they can reach for the jugular vein of ocean commerce that links America to its worldwide alliance.

These are considered to be the Red submarines' capabilities today. Tomorrow they are expected to be much greater.

One glance at any map of the world shows America's vulnerability to the submarine. The United States is a continental island. The front door for any all-out attack is across the Arctic. The cellar door is beneath the sea.

Soviet submarines armed with 1500-mile missiles could hit any part of the United States from beneath the Atlantic or Pacific Oceans. Top U.S. officials say it would be foolish to doubt that Russia already is capable of doing this.

Russia's specific missile capabilities aren't known. However, the Russians have had a long head start beginning in 1945 with full access to German Peenemunde plans for the *V-3* (an encapsulated *V-2* to be towed under water by submarine to enemy shores) and to data on experiments with underwater deck-launched solid propellent rockets.

The Soviet submarine fleet of some 450 boats is reported to include some 100 "W" class and some 60 "Z" class types. The big "Z" class submarines are considered capable of launching missiles from inside tubes as U.S. *Polarises* will be launched. The "W" Class is considered capable of launching air-breathing type missiles from its deck.

• **Building nuclear boats**—Russia also is reported to be building at least three to five nuclear-powered submarines. A number of them are expected to be missile launchers. And Red China has become the world's third biggest builder of submarines.

Moreover, the Russians have turned over some of their latest model subs to both China and Egypt. Also, Red submarines based in Albania may in fact have been turned over to them. This means Russia now has a number of countries to do her undersea dirty work for her in the event of any more "local" wars.

Finally, recent intelligence reports note a sharp cutback in Russian submarine building activity. The official assumption is that this is for purposes of converting to nuclear-powered craft with all their advantages of speed and underwater endurance. Simultaneously the Reds are known to be building deep-diving submarines.

All of this, combined with an effective fleet of ballistic missiles, can pose a bigger threat to U.S. security than the Red ICBMs.

• **Two series of Red missiles**—The Russians have been developing two series of missiles for their submarines. The *Golem* and the *Komet*.

The *Golem I* is a two-stage liquid missile similar to the Soviet *T-2* IRBM. Both are direct descendents of the German World II *V-2*. Its range is estimated at 400 miles.

The *Golem II* is a two-stage liquid missile with a range of 1200 to 1500 miles. The *Golem III* is a two-stage solid equivalent of the Lockheed *Polaris*. Its range is estimated at between 1500 and 2000 miles.

All three *Komets* have solid motors. *Komet I* has a range of about 100 miles. *Komet II's* range is about 500 to 600 miles, and may be capable of being fired from underwater. The two-stage *Komet III*, which is reported to be still under development, has a rang

more than 1500 miles.

These weapons coupled with the ussian "Z" and "W" Class submarines ve Russia the capability of striking crippling blow against the United ates at any time.

The *Golems* and *Komets* probably ould not be used against U.S. cities it rather against bases of the Strate- c Air Command.

This is certain to be Russia's first al in any all-out war: An attempt rough surprise to catch SAC on the ound. Then DA—the Soviet inter- ntinental bombers—and the Soviet BM's would be loosed on U.S. cities d industry.

Submarines slipping through the st oceans of the world have much ore chance of reaching the North merican coasts unobserved than would viet bombers and later missiles pass- g through the gauntlet of the U.S. rctic warning nets.

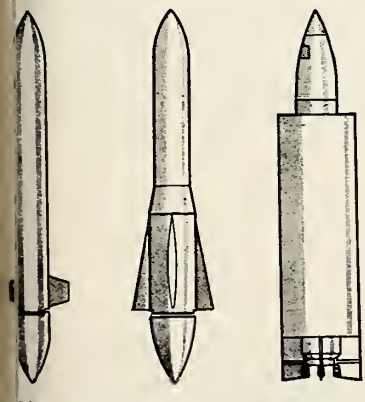
Nor does the submarine threat in- lve only all-out missile attack. In y future limited war, the sea lanes the world must be kept open for e United States and its Free World lies to supply any defense effort.

Even today in the North Atlantic one 2000 merchant ships are at sea any average day of the year. An- her 16,000 are scattered in ports on the other seas of the world. Ships avelling the sea lanes to and from the nited States carry nearly 99% of U.S. overseas tonnage.

• **Would cut sea lanes**—In time of ar, the Russian submarine fleet would empt to cut these sea lanes as Ger- any did in World War II. Only, while itler began World War II with only out 60 U-boats, Russia would have ore than 450.

The Navy faces twin challenges:

• It must hit Russian submarines fore they launch their missiles.



OLEM-1 GOLEM-2 GOLEM-3

ED submarine missiles include the *olem* and *Komet* series.

• It must wreck wholesale destruction on the Soviet submarine fleet.

The principal problem is detection and identification. Once found a whole series of new weapons such as the nuclear *"Betty"* depth charge and the *Mark 44* torpedo have made the kill of a submarine not too difficult. But each year the finding becomes a tougher job.

The North Atlantic alone comprises 12 million square miles of ocean surface. The floors of the world's oceans are mostly unexplored. The enemy can hide anywhere.

In World War II, radar could be used for locating submarines when they surfaced to get fresh air and recharge their batteries. Now, only the wastebasket-size snorkel, has to be exposed. And soon the Soviet nuclear-powered subs with their ability to remain submerged almost indefinitely will be introduced.

• **Special ASW group**—The United States has designed a special hunter-killer task group to meet the challenge. The first of these is Task Group Alfa. The second is Task Group Bravo. Each group is comprised of a carrier, eight destroyers, two hunter-killer submarines, land and carrier-based planes and helicopters.

At the same time, the Navy is attempting to push forward rapidly with new means of detection from planes, ships and by the creation of some form of underwater DEW line.

In all, the United States also has 300 ocean escorts and 720 ASW aircraft at present to meet the Soviet submarine threat. It also has about 80 anti-submarine submarines—the bulk of the U.S. underwater fleet.

At the height of World War II the Allies had about 930 ocean escorts and about 2200 ASW aircraft. Germany had a maximum U-boat strength of 440—only a few less than Russia has today.

This force in time of war would strike first at the submarine ports and the narrow seas. Russian submarines would have to run a gauntlet in order to reach the open North Atlantic.

Those that made it would face the hunter-killer groups as well as the ASW submarines which include the fast *Polaris* types.

Russia might try to avoid running such a gauntlet by deploying her submarines in open water before the outbreak of war. But such a mass deployment would also carry the disadvantages of giving warning.

Of course, for an underwater missile attack no mass deployment would be necessary. Only a relative handful of "Z" Class subs could destroy much of America.

Milestones in Torpedo History

1864—*First ship (Union Sloop* Housatonic*) sunk by moving torpedo.*

1864—*Robert Whitehead began experiments*

1869—*First torpedo station founded (Newport, R.I.)*

1870—*First production units of Whitehead's torpedo (11-foot, compressed air unit. Speed 6 knots; range 200 yards)*

1872—*Electric drives first appeared*

1879—*Lay cable-controlled torpedo used by Peru against Chile. No success*

1880—*Sims-Edison electric fish torpedo developed (see sketch)*

1898—Howell torpedo, *using flywheel power and stabilization, obtained range of 800 yards and speed of 38 knots*

1903—Whitehead torpedo, *improved with a gyro and Curtiss turbine, launched (300 ordered by Navy in 1905)*

1915—*U.S. Navy began work on electric torpedo*

1917—*Germans developed electric torpedo*

1928—*Navy electric finally tested but sank in process*

1931—*Navy abandoned electric torpedo*

1941—*U.S. entered war with five types of torpedoes:* Mark 8 *and* 15 *(surface ship);* Mark 13 *(aircraft);* Mark 10 *and* 14 *(submarine). Electric torpedo work reactivated*

1942—Mark 24 *airborne target-seeking torpedo qualified and put into production. Several thousand built and credited with stopping German submarine threat*

1943—Mark 18 *battery-powered torpedo (speed 40 knots, range 4 miles) turned over to fleet where it gradually took over from steam torpedoes*

1943—*Germans began use of "intelligent" (Noise-homing) torpedo*

1945—*Work begun on "universal"* Mark 35 *(air, surface, or submarine) acoustic homing torpedo. (Modified units, less air-launch capability, went into production four years later)*

1948—*Development begun on* Mark 41, *air-launched version of* 35.

1950—*Work begun on lightweight, small, target-seeking* Mark 43

1958—*Wire-guided* Mark 39—*an "underwater guided missile"—introduced*

1959—*Surface or air-launched* Mark 44 *introduced.*

Servovalves Need Fresh Approach on Temperature

Moog Valve believes 1000 F reachable by using acceleration switching servos

by Jay Holmes

EAST AURORA, N. Y.—How would you like to be the largest stockholder in a company that doubles its sales every year?

William C. Moog, a development engineer formerly with Cornell Aeronautical Laboratory in nearby Buffalo, was in this happy position from 1951 until 1957. His **Moog Valve Co.,** now **Moog Servocontrols Inc.,** had $200,000 sales in its first year and approached $9 million six years later. After a recession dip in fiscal 1958, the company set another record of more than $10 million in the year ended June 30.

Moog, while employed by the Cornell Lab, invented an advanced and sophisticated servovalve of a type requested by the military for service in the rugged environments anticipated for guided missiles. When **Bendix** ordered four of the valves for use on a defense job, the lab gave Moog the order. The Cornell lab is set up for research alone and is not interested in production contracts.

• **Manufacturers decline**—He inquired of several manufacturing companies but none of them thought the market was large enough for them to go into it. And so he decided to take six months' leave and do it himself. Moog found a machine shop willing to make the valves and to wait for its money until Bendix paid. The first valves were assembled in his basement.

At about this time, **Philco** ordered 75 units for $30,000. With this encouragement, Moog decided to incorporate. He has never had reason to regret it. The market has been growing steadily almost all of the time since then.

What is a servovalve? It is an automatic error-correcting device for critical flight applications, foremost of which is controlling the flight of aircraft and missiles. When the attitude changes from that prescribed, an electronic sensor transmits the change to the servovalve, which then adjusts the flow of oil through an actuator po tioning a control surface or engi Sophisticated controls of this type fi became necessary when aircraft spee reached the neighborhood of that sound and it was no longer possib for human pilots to make correctio fast enough.

After a while, Moog began man facturing servoactuators which cor bine the valve, cylinder and feedba device in one mechanism.

Missile and aircraft servovalves a incredibly small for the work they pe form. The first Moog valves weigh about a pound, with dimensions about 2″x2½″x1½″. Later mod have been reduced to about a ha pound. William Thayer, Moog's chi engineer, says a servovalve has two di tinctive features: high power contr from a low power signal and contin ous control that can change the dire tion of output in two directions. Th contrasts with a thermostat, for e ample, which can increase temperatu but cannot decrease it.

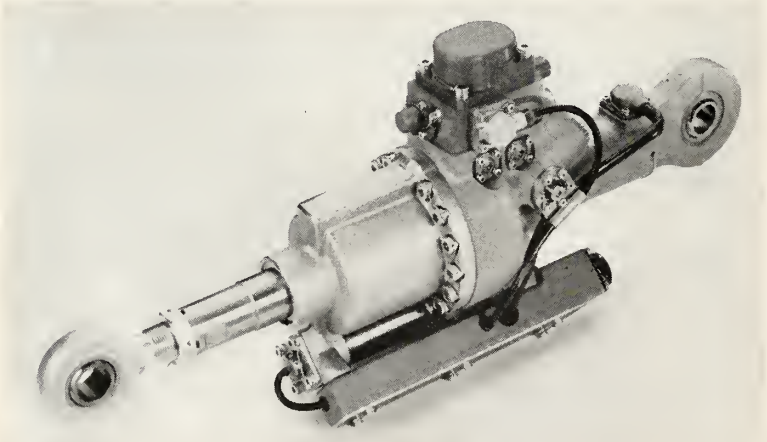
• **Musical valves**—A servoval can accept an input on the order 50 milliwatts and regulate an outp of many horsepower—a power gain the order of 10^7. It acts rapidly, a most as fast as an electric current. Th signal from a phonograph needle ca be fed into a servovalve and somethi recognizable as music will come out.

Servovalves in use at present w operate within a temperature range –65° to 500°F. The most importa new requirement is for an increase i the upper temperature limit. Models i development will bring this to 700°F but Moog says a fresh approach needed for an attack on the next ten perature barrier, 1000°F.

One possible solution is the use acceleration switching servovalve Basically, the difference between suc a valve and the earlier types is tha the valve force motor operates on simple on-off basis, rather than b graduated variation of signal strengt

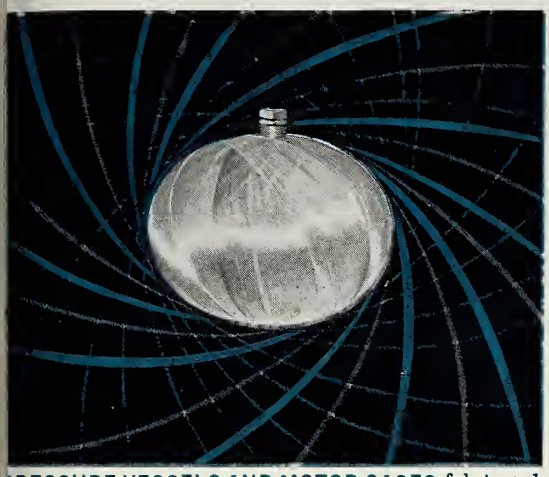
Under such an arrangement, elec trical hysteresis does not affect opera tion and it is possible to use plain cold rolled steel for the motor magnetic cir cuit. Theoretically, it would be pos sible to operate a switching valv motor to temperatures well abov 1000°F—possible to almost 1400°– with acceleration switching.

On a rocket, servovalve system are used to actuate control surfaces on-off switching of control engines an thrust-vector controls. With a four nozzle solid-fuel engine, adjustment o the four can control pitch, roll an yaw. With a single-chamber liquid-fue rocket, this is accomplished by swivel ing the entire engine.

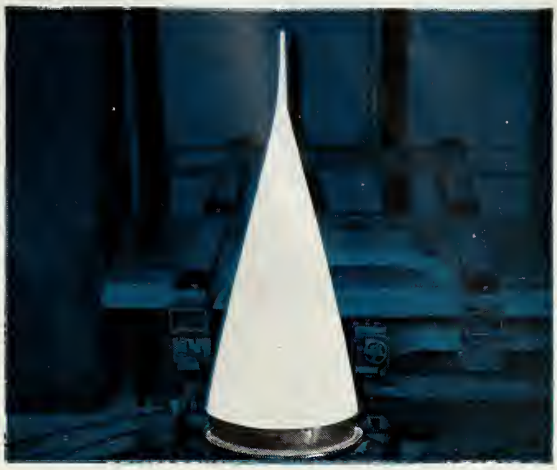


TINY SERVOVALVE can accept input near 50 milliwatts and regulate an output of many horsepower—a power gain on the order of 10^7.

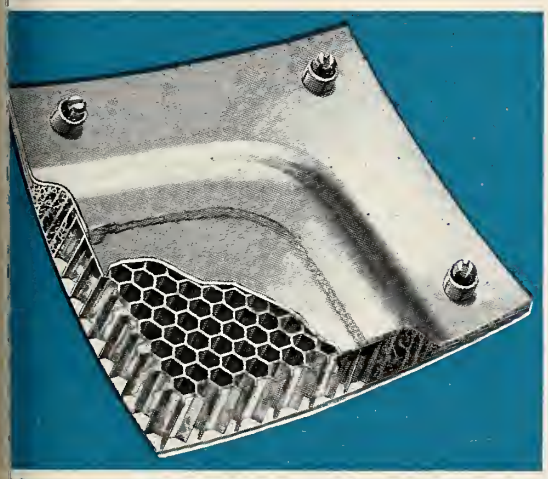
Brunswick technology leads the way in three critical space-age components



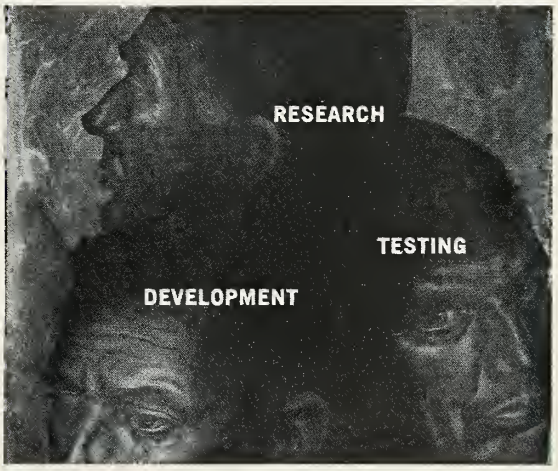
PRESSURE VESSELS AND MOTOR CASES, fabricated by Brunswick's exclusive Strickland "B" Process, now have the highest strength-to-weight ratio ever obtained in filament-wound components. Brunswick is *now* producing these virtually leak-proof pressure vessels. Brunswick also fabricates motor cases capable of withstanding extremely high pressures and temperatures.



RADOMES AND NOSE CONES, created by Brunswick's outstanding research and development efforts and filament winding process, are being used on supersonic aircraft such as the advanced Convair F-106 and McDonnell F4H, as well as on missiles such as the Boeing Bomarc, Lockheed Q5 and similar missiles. And, of course, Brunswick capabilities include complete electronic design and test facilities.



HONEYCOMB ASSEMBLIES, now developed by Brunswick can support two million times their own weight. Brunswick research has created honeycomb assemblies of paper, fiber glass, aluminum and stainless steel as well as conventional forms. Using the most advanced adhesive systems, these assemblies can be formed in compound curvatures with extremely close tolerances.



RESEARCH, DEVELOPMENT AND TESTING—carried on by Brunswick teams have contributed heavily to space-age technology . . . most notably in solving problems of increasingly high operating temperatures (600°—4,000°F.) for critical components and new heights in strength-to-weight ratios. For full information on how this leadership can help you, write or call Brunswick today!

BRUNSWICK

DEFENSE PRODUCTS DIVISION • 1700 MESSLER STREET • MUSKEGON, MICHIGAN

Circle No. 6 on Subscriber Service Card.



RELIABILITY

is what determines the success or failure of any weapon system at launch and during flight. Here at the Missile Division of North American Aviation, we are constantly striving to improve this most vital state of the art through analysis and evaluation of environmental criteria, system design analysis, statistical test programs, and other advanced reliability techniques. Engineers and statisticians with a minimum of five years full time related experience in aircraft or missile engineering will find this a most stimulating career in present and future efforts under development.

Write or send resume to:

B. H. Cunningham, Mgr.
Employment Services
12214 Lakewood Blvd.
Downey, California

MISSILE DIVISION
North American Aviation, Inc.

missile support

Air-Supported Space Platform Is Advocated



ARTIST'S conception of air-supported space platform structures.

BUFFALO—The first space platform will be an air-supported structure, a Buffalo manufacturer predicts.

Walter W. Bird, president of **Birdair Structures Inc.,** maintains that light weight, portable plastic housing is ideal for the first habitable satellite, since the rockets carrying such materials into orbit will have very small payloads.

The housing could be built in units carried into orbit on successive flights, Bird said. Air could be carried up in liquid form and boiled into the structure to inflate it.

Bird is well qualified to discuss the building of large, inflatable plastic structures. His company manufactures the Pentadome, a missile maintenance shelter 150′ in diameter and 85′ high with four smaller auxiliary domes, for the Army. The Pentadome maintains its shape without rigid supports, poles or frames—just with constant low pressure, high volume air supplied by motor driven blowers.

The center dome of the Pentadome consists of five sections that have to be joined together. This makes it easier to handle the dome in erection, dismantling, packing and shipping operations. However, Bird said it would be possible to make a housing in one piece for space use.

Many types of material are used in Birdair structures. The Pentadome consists of 18,000 square yards of vinyl-coated nylon. The central dome material weighs 24 to 25 ounces per square yard. The smaller domes, 100 in diameter and 50′ high, weigh abou 18 ounces per square yard. The struc ture is designed to withstand a con stant wind load of 70 miles per hour It has a safety factor of 3 to resis gust loads of greater velocity. Th fabric is designed to retain its flexibil ity at –40°F. The material is designe to carry full loads up to 160°F.

What about meteorites and micro meteorites in space? Bird asserts tha a resilient plastic material will with stand such blows better than rigi structural materials. Some particles tha would penetrate a firm jacket, he says would bounce off or be absorbed by resilient material.

The Pentadome, which stands 8½ stories high, can serve as a protectiv cover for a *Jupiter* missile while it i being readied for firing. Smaller plasti covers are used to protect other mis siles. In come cases, a missile is fire after a quick release, sometimes on th order of 1½ seconds. In other case the missile is fired through the dom

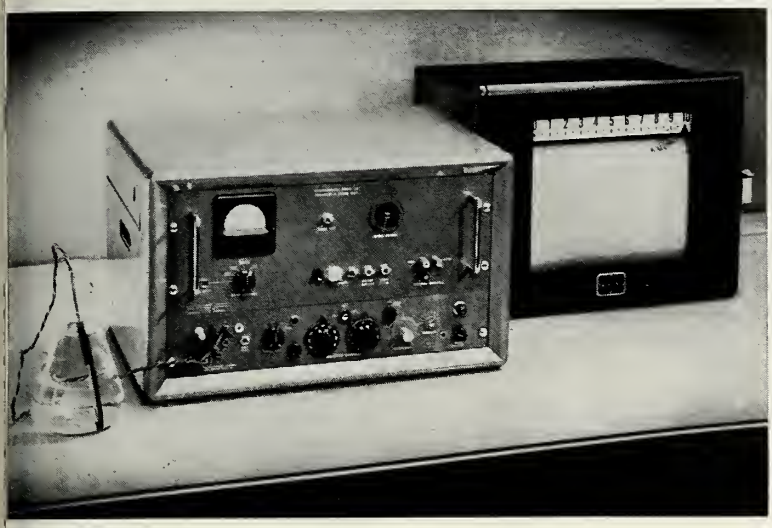
Bethlehem Research Center Going Up Despite Strike

BETHLEHEM, PA.—Foresight i stocking structural steel has enabled contractor to maintain construction o a **Bethlehem Steel Co.** research cente despite the steel strike.

Turner Construction Co. of Ne York is the general contractor for th multi-million-dollar center for metal research and development. The firs buildings are to be completed nex year.

Bethlehem is building the center o a 50-acre site high atop South Moun tain in Bethlehem, near the campus o Lehigh University. When it is complet several years from now, about 40 will be employed.

The center will provide facilities fo work in process metallurgy, mechani cal engineering, physical metallurg mechanics, chemical engineering ceramics, chemistry, physics an nuclear engineering.



Corrosion Now Measured Automatically

Automatic corrosion measurements are now possible, using a new servo-controlled corrosometer manufactured by **Crest Instrument Div., Magna Products, Inc.**

The Model L-2 corrosometer is capable of detecting as little as one millionth of an inch of corrosion on a routine basis and one billionth of an inch in some special applications. It automatically "tracks" corrosion as it occurs, providing a permanent record of the total thickness of metal corroded. This record is presented as a function of time which is quickly converted to the rate of attack.

In the laboratory, the Model L-2 corrosometer greatly simplifies the job of evaluating the effects of corrosion inhibitors on the resistance of various metals to known corrosive conditions. The pattern of corrosion differs from metal to metal, and the Model L-2 eliminates the tedious, point-to-point plotting required when the timing and extent of the initial attack is unknown.

A single Model L-2 may be used to monitor up to twelve individual tests by adding additional measuring units. A single multipoint recorder can be used to record data from these tests being run in parallel at the same time.

The Model L-2 also finds use in oil refineries and chemical plants, where it detects the change in corrosion rate resulting from the addition of inhibitors or from changes in process conditions. The effect on the corrosion rate may be immediate, or it may extend over a long period, and again the Model L-2 saves time and trouble over point-to-point plotting.

In the case of inhibitors, the instrument may be used to evaluate various proprietory compounds under actual plant conditions, or it may serve as part of the plant's basic instrumentation system, telling operating personnel exactly when corrosion has reached a dangerous level and new inhibitor should be added to the process stream.

Like other corrosometer instruments manufactured by Crest, the Model L-2 detects corrosion by measuring the ratio of resistance between exposed and protected metal elements mounted on a "probe" that extends into the corrosive medium or sample. As the exposed metal is corroded, the resistance ratio between the two elements increases. This increase is a direct indication of corrosion. Since both elements are mounted together, resistance changes due to temperature fluctuations have no effect on the readings.

In the Model L-2, the two metal elements in the probe form two legs of a bridge circuit, with a servo-driven potentiometer acting as the automatic balancing mechanism. The position of this potentiometer is a direct measure of corrosion. The gear train connecting the servo motor and the balancing potentiometer also drives the recorder output potentiometer.

The tracking "range" of a probe is typically divided into one thousand corrosion units, each unit being one microinch. Corrosion totalizer dials on the face of the instrument indicate how many micro-inches of corrosion have occurred. The recorder, on the other hand, swings full scale with only 10 microinches change, thus providing a high level of resolution.

Circle No. 225 on Subscriber Service Card

Miniature Servo Picked for *Pershing* Guidance Unit

The heart of the inertial guidance system for the new Pershing IRBM—a miniature servo-package—will be produced by the **Bowmar Instrument Corporation.**

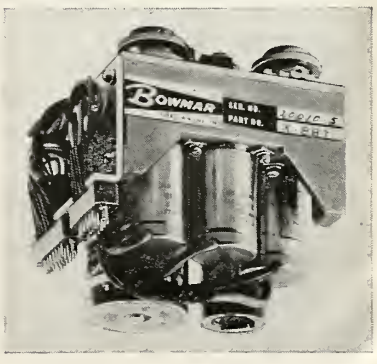
Edward A. White, Bomar president, said that the firm has been awarded $65,000 in contracts for the manufacture of an initial order of the units.

The new unit is a program transmission servo-package which plays a key role in the ST-120 air bearing gyro stabilized platform. It transmits tilt program pulses from a programming tape to the Pershing steering mechanism, in a smoothly changing voltage, that corrects for course deviations.

To meet size and weight requirements, Bowmar engineers had to reduce the package to one-third of its standard dimensions, producing a package 2½ x 2¼ inches and weighing less than 34 ounces.

Housed in the package are essentially two systems, each performing a function in the overall control and guidance of the missile. The first system consists of a stepper motor, dual cams and microswitches, synchro control transmitter and gear train. It ultimately indicates the position of the synchro control transmitter of this first system via a signal proportional to its shaft angle.

The second system of this assembly consists of a motor rate tachometer, synchro control transformer, synchro control transmitter, one dual and one single cam and microswitch together with separate gear trains between the motor tachometer and first synchro, the first synchro and the dual cam-



Expanding the Frontiers of Space Technology in

SYSTEMS ANALYSIS

■ Lockheed Missiles and Space Division has complete capability in more than 40 areas of science and technology. As systems manager for such major projects as the DISCOVERER Satellite; Navy POLARIS FBM; Air Force Q-5 and X-7 and Army KINGFISHER, the Division is extensively engaged in improving the art of systems analysis and integration.

ENGINEERS AND SCIENTISTS

The Division's programs reach far into the future and deal with unknown and stimulating environments. It is a rewarding future with a company that has a continual record of progress and achievement. If you are experienced in one or more of the following, we invite your inquiry: classical dynamics, vector analysis and matrix operations, with the ability to establish and analyze weapon systems performance; inertial guidance systems; dynamics of missiles systems; or long range ballistic fire control systems. Ability to prepare and edit technical reports documenting results of systems analysis studies is a requirement.

Write: Research and Development Staff, Dept. H-1-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed
MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM, DISCOVERER SATELLITE; Army KINGFISHER, Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO • HAWAII

microswitch and the second synchro and the cam-microswitch. From the second synchro to the single cam-microswitch is 1:1 gearing. This second system ultimately indicates the position of the synchro control transformer and transmitter.

Backlash between synchro control transmitter and synchro transformer of the second system portion measured at the synchro control transmitter of the first system is 3 minutes maximum. Backlash between the motor and the synchro control transformer is 30 minutes maximum. Basically, four different gear reductions are included in the entire package. Reduction between the stepper motor and the synchro control transmitter is 9:1 and reduction between the motor rate generator and synchro transformer is 100:1. Reduction from the synchro transformer of the first set of cams and microswitches is 3:1 and reduction from the first set of cams and microswitches to the synchro control transmitter is 40:3. A ratio of 1:1 exists from the synchro control transmitter and the single cam and microswitch.

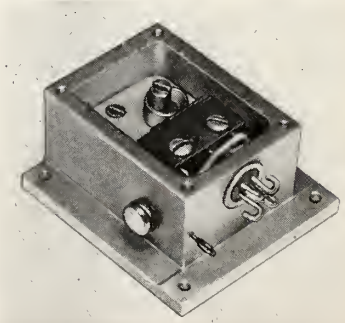
The housing of this package is of clean anodized aluminum and bearings are ABEC Class 5 or better. Gearing tolerances are Class 2 or better. The entire unit is designed for operation in ambient temperatures of −55°C to +100°C. Unit construction was designed to withstand environmental conditions as generally specified in MIL-E-5272.

Circle No. 226 on Subscriber Service Card.

Tiny Mechanical Timer Weighs Less Than 4 oz.

The nation's smallest mechanical timer (fits into 1 cubic inch of space) is now in production at **Timech Corp.**

Weighing less than 4 ounces, Model TMC-50 timers are available over a time range of 1 to 20 seconds with accuracies of 3% and 5%. Designed primarily for use on missiles and target drones, the new mechanical timers are used as events programmers and timers, and to release recovery parachutes.



An unusually rugged device, capable of withstanding all of the environmental hazards of missile operation, the new Timech timer performs its function with extreme reliability. It is engineered to perform reliably in ambient temperatures from −65°F to +250°F; Shock of 300 G's-millisecond duration, and vibration of 25G's from 25 to 2,000 cps. The Model TMC-50 mechanical timer is also built to meet the standards of MIL-STD. 202 and MIL-E-5272A.

Circle No. 227 on Subscriber Service Card



Delay Relays Feature Adjustable Timing Ranges

Two new lines of time delay relays, with guaranteed accuracy ratings of 10% to 5%, have been announced by **Tempo Instrument Inc.**

These units are said to be the only known adjustable time delay devices that meet all the accuracy and reliability requirements of high performance electronic systems, particularly for airborne and ground support missile applications.

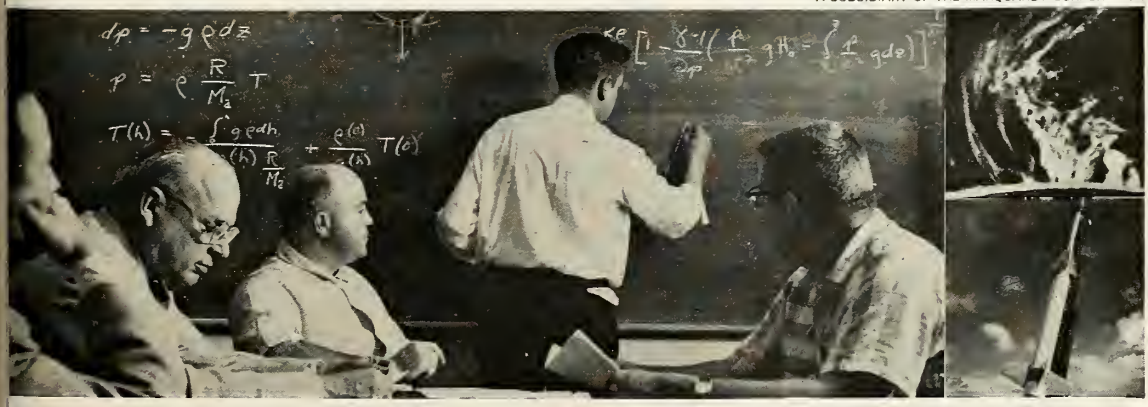
The new Tempo units, of subminiature size and weight, include provision for simple, quick field adjustment of the time delay period. Adjustment may be accomplished with a precision potentiometer located remotely from the unit, or with a stable fixed resistor wired directly across the terminals provided on the unit. A standard calibration table is supplied showing the resistance value required to result in a given time delay period.

Six basic units are available, with overlapping time delay ranges—each is capable of a 20 to 1 adjustment range as follows: .050 to 1.00 seconds, .5 to 3.00 seconds, .750 to 15.0 seconds 3.00 to 60.0 seconds, 9.00 to 18 seconds, 15.0 to 300 seconds.

By stocking only 6 units, the user has immediately available a wide range of highly accurate time delays, from

Southern California opportunity for creative rocket systems scientists, engineers. CDC's current expansion has created several key openings. Specialist in complete rocket systems, CDC offers you opportunity to join the team that has helped orbit America's satellites...to contribute to upper-atmosphere and space research programs like Explorer, Vanguard, Sunflare, Eclipse and Project Mercury. Rewards are high if you can generate original ideas and take responsibility on your own shoulders. A subsidiary of The Marquardt Corporation, CDC assures you outstanding career stability. High-level Engineering Writer. Capable of assuming responsibility for creative engineering writing on preliminary design concepts. Aerodynamicist. B.S. in A.E. Familiar with drag prediction in subsonic and supersonic flows. To perform drag and stability analyses on rocket motors. Physicist. Ph.D. or M.S. preferred. Experienced in research and analytical studies in upper atmosphere physics. Knowledge of meteorology helpful. Instrumentation Engineer. B.S. in M.E., E.E. or physics. Experienced in development of instruments and instrumentation systems. Electronics Engineer. Experienced in transistor theory, instrumentation, and telemetering systems. Project Engineer. B.S. in physics, M.E. or A.E. Familiar with sounding rockets, aerodynamic heating problems and stress. Experienced in organizing a project. Senior Systems Analyst. M.S. or Ph.D. To head group. Experience in propulsion, guidance, instrumentation, aerodynamics, thermodynamics preferred. Senior Mechanical Engineer. To head mechanical development group. Experience in rocket vehicles, mechanical auxiliaries, ground handling equipment, and rocket launchers desirable. Systems Engineers. B.S. or M.S. Broad systems knowledge. To work in field of design concepts. Live and work in Southern California, a healthful, year-around vacation land. Call or write Ben Hedding, Personnel Director, immediately. Cooper Development Corporation, 2626 South Peck Road, Monrovia, California, MUrray 1-5664

A SUBSIDIARY OF THE MARQUARDT CORPORATION



Circle No. 7 on Subscriber Service Card.

.050 to 300 seconds in missile testing and checking operations.

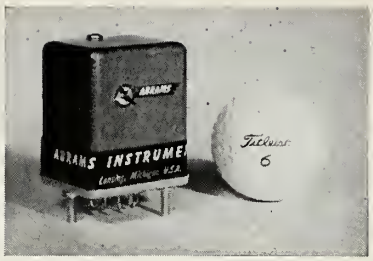
The rated accuracies, either 5% or 10% of nominal time delay, are guaranteed under any combination of environmental and operating conditions including input voltage variations from 18 to 31 vdc, temperatures from −55 to +125°C, vibration to 20 g's, 2,000 cps., shock to 50 g's, 11 milliseconds, acceleration to 20 g's.

Circle No. 228 on Subscriber Service Card

Accuracies of .025% Provided by Transistor

The Abrams Instrument Corp. has announced the development of transistor, crystal controlled dc inverter to 400 cycle ac output with frequency accuracy of .025% through a temperature range of −60°F to +165°F.

The time base comprises a crystal controlled oscillator, transistor divider and output amplifier. For even greater accuracy, the unit can be furnished with a crystal oven at slightly higher cost and current requirement. Dip potted, the unit withstands high acceleration, vibration and shock. Input dc



voltage can vary as much as ±25%.

Encapsulated in a dustproof stud mounted relay case approximately 1 9/16 x 1 3/8 x 2 1/8; the inverter weighs approximately 4½ oz., and has enough power to drive a synchronous motor with a .002 inch oz. torque. By increasing the power amplifier at some sacrifice in size, larger torque motors or multiple synchronous motors can be used with the same accuracy of output.

The Model DB-1 time base for a synchronous motor, makes possible a multitude of applications in the airborne timing and control field where only dc voltage or unregulated ac is available. The advantages of extreme accuracy (.025%), no radio noise interference from motor brushes to filter, extreme environmental capability and maintenance free motor life, (well over 10,000 hours); are the answers to previous major design problems.

Circle No. 229 on Subscriber Service Card

New Comparison Bridge Model Features Simplicity

Southwestern Industrial Electronics Co., a division of **Dresser Industries, Inc.**, has announced the introduction of its new-series model E-2 Comparison Bridge.

A replacement of a previous SIE model of the same number and type designation, the new model is said to encompass ranges from 1 ohm to 5 megohms resistance, 500 mmf to 2000 mf capacitance and 3 milli henrys to 10,000 henrys inductance at accuracies from 2.5% to 0.1%.

Advantages of the new model are said to be increased accuracy, a reduction of component selection time, minimal operator fatigue, a simplicity which allows unskilled operators to obtain 0.1% accuracy and to detect component differences as small as one part in ten thousand.

Circle No. 230 on Subscriber Service Card

"Multi-Zone" Platecoil Cuts Heat-Up Time 17½%

Improved performance resulting from a change in product design has been proved by **Tranter Manufacturing Inc.**, in a test of its new multi-zone platecoil heat transfer unit under actual operating conditions.

The test was performed in a rinse tank at the **Ideal Finishing Co.**, where the original header-type Tranter platecoil had been used for several years for heating up the water in the rinse tank. The tank has 600-gallon capacity and the desired operating temperature is 200°F.

With steam at 15 psi, the old style platecoil heated the water from 60°F to 204°F in 182 minutes. With the same steam pressure, the multi-zone platecoil heated the water from 60°F to 203°F in only 150 minutes—a saving of 32 minutes, or more than 17½ percent faster, to reach the desired temperature.

The tests were run under identical conditions, with the old coil being removed from the tank after the first test and the multi-zone platecoil being placed in exactly the same position.

The units are two embossed sheets of metal, welded together to form channels for the passage of heating or cooling media, such as steam or water. In the old style header platecoil, one common header extended the width of the unit, feeding all of the lateral passages that carried the steam across the unit to the common condensate return.

In the multi-zone platecoil, the steam inlet header is divided into three branches so that steam is carried directly to all areas of the platecoil simultaneously. In effect, the new unit provides three platecoil units in one.

Circle No. 231 on Subscriber Service Card

Oil-Damped Transducer Withstands Rocket Blast

Statham Instruments, Inc., announces the P285TC miniature pressure transducer developed for use in rocket engine test environments.

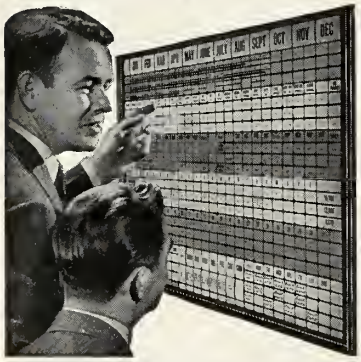
Because it is oil-damped, the P285TC withstands the violent pressure transients generated in shock tubes or transmitted from firing chambers. In addition, the high natural frequency of undamped miniature flush-diaphragm instruments is retained.

The P285TC measures pressure from 0-50 to 0-1000 psi with the operational, environmental and service life advantages of unbonded strain gage transducers. Case length: 49/64". Width (between hexagonal sides): 1.0". Weight: approximately 3 ounces.

Output approximately 28 millivolts full scale open circuit at 7 volts (AC or DC) excitation. Non-linearity and hysteresis not more than ±1% of full scale.

Circle No. 232 on Subscriber Service Card

How To Get Things Done Better And Faster



BOARDMASTER VISUAL CONTROL

- ☆ Gives Graphic Picture—Saves Time, Saves Money, Prevents Errors
- ☆ Simple to operate—Type or Write on Cards, Snap in Grooves
- ☆ Ideal for Production, Traffic, Inventory, Scheduling, Sales, Etc.
- ☆ Made of Metal Compact and Attractive. Over 350,000 in Use

Full price $49.50 with cards

FREE 24- PAGE BOOKLET NO. JC-20 Without Obligation

Write for Your Copy Today

GRAPHIC SYSTEMS

55 West 42nd Street • New York 36, N. Y.

Circle No. 11 on Subscriber Service Card.

propulsion engineering . . .

By M/R STAFF

Liquid oxygen-ozone mixtures . . .
containing up to as much as 30% ozone can be safely used as a rocket engine oxidizer for gaseous hydrogen if the temperature is controlled properly. National Aeronautics and Space Administration researchers have used the combination successfully in carefully-designed engines, and have determined the limits of brisant detonability. Riley O. Miller of NASA's Lewis Research Center, Cleveland, described O_3-O_2 experience to the American Rocket Society's propellant thermodynamics and handling conference in July.

Ozone handling apparatus and procedure . . .
can now be specified for many use and handling situations, thanks to Miller's work. He attempted detonations of ozone-oxygen in various sizes and shapes of stell and glass tubes. Some were triggered by an initial pure ozone detonation, others by direct spark. The degree of fragmentation was one measure of brisance. Miller reports that a steady-state Chapmen-Jouguet detonation propagates from a spark in liquids containing 50% to 100% ozone. From 50% down to about 35% ozone (by weight), it is still possible to achieve detonation if it is initiated by a 100% ozone booster charge. At 35% or less ozone, no brisant propagation is obtained.

Safe mixtures may not stay safe . . .
if they are improperly handled, Miller points out. The biggest ozone handling worry is that, due to O_3's physical properties, ozone can be concentrated inadvertently. Miller points out these three ways this can happen:

(1) High concentration liquid ozone may condense from a dilute gas.

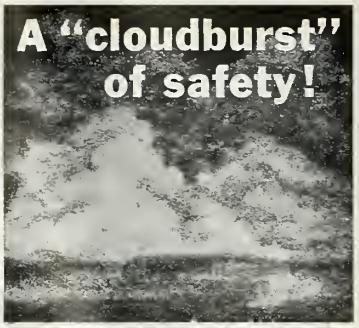
(2) Dilute liquid ozone may lose some of its diluting oxygen if the temperature increases.

(3) There is a two-phase region which is dependent on temperature and composition of the liquid mixture. In this area, the liquid separates into two phases, one more concentrated than the other.

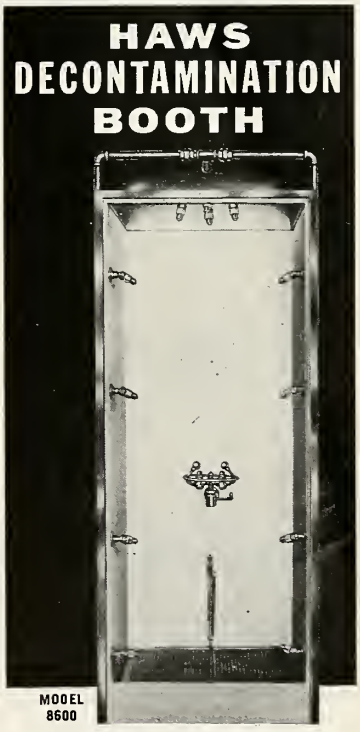
Propellant tank was mixing bowl . . .
in the NASA experimental ozone rocket. "The required liquid O_3-O_2 mixture was prepared directly in the propellant tank," Miller reports. "Specially purified oxygen was passed through a specially cleaned ozonator . . . into the bottom of the refrigerated propellant tank where the ozone and all or part of the oxygen were condensed." All components that contacted the mixture were refrigerated. Liquid nitrogen was used when the ozone concentration was to be only 2%, but liquid oxygen was used as the refrigerant when higher ozone concentrations were used.

Few unexpected problems came up . . .
when Miller ran the engine. Runs were 3-seconds each, with continuous spark ignition. Miller found that the oxidant inlet valve should not be refrigerated when *gaseous* ozone-oxygen was passed through. Small amounts of ozone would condense on it and detonate, breaking up the Teflon packing. The result was leakage and Teflon fragments in the system.

A brisant detonation occurred . . .
in the line between the oxidant control valve and the oxidant tank at the start of one run. Tubing and flowmeters were fragmented, Miller says. Heavy forged valve bodies were split. The refrigerant trough was torn into several pieces and scattered "with considerable velocity." Miller says the detonation appears to have been initiated by a low energy source, away from the rocket combustor. That explosion, Miller says, emphasizes the need for careful consideration of all operations before they are tried.



Volatile chemicals and propellants can cause serious accidents—but serious injuries need not result if water irrigation is immediately available! Haws Decontamination Booth provides the "cloudburst" that rapidly rids the body of harmful irritants. Victims walk on the foot treadle and are instantly bathed in water from a dozen nozzles. Haws Eye-Face Wash is simultaneously activated—a pressure controlled unit with a perforated face-spray ring and twin eye-wash heads. Booth is acid resisting fiberglass plastic, and is delivered complete, ready for tie-in to existing facilities. Write for details on the full line of models.



HAWS 50 YEAR

HAWS DRINKING FAUCET CO.
1443 FOURTH STREET • BERKELEY 10, CALIF.
EXPORT DEPARTMENT: 19 Columbus Avenue
San Francisco 11, California, U.S.A.
Circle No. 12 on Subscriber Service Card.



WHO READS MISSILES AND ROCKETS?



Well, for instance ... ENGINEERS AT WESTINGHOUSE DEFENSE PRODUCTS

Molecular electronics—a technological breakthrough at Westinghouse—is producing electronic systems *1,000 times smaller and lighter* than anything now in existence.

Through molecular electronics, drastic reduction in weight, size, power and heat dissipation requirements will permit space vehicles and satellites to perform a greater number and wider range of tasks. Greatest advantage is the vastly improved reliability achieved by the replacement of numerous components by a single solid state unit.

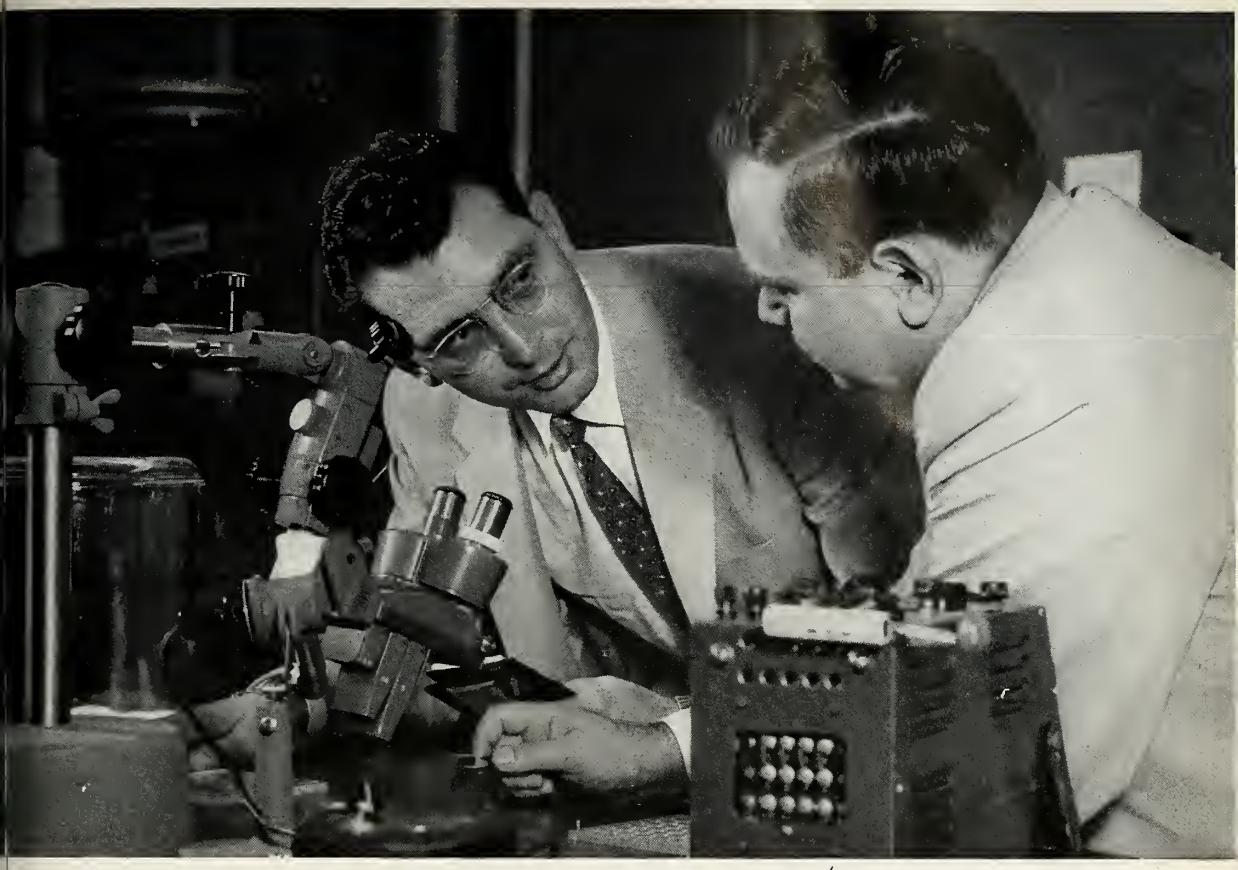
Recently, the Air Research and Development Command of the U. S. Air Force awarded a development contract to Westinghouse as a part of a broad program effort in this new electronic area. Experimental "hardware" is being fabricated by Westinghouse for infrared, reconnaissance, communications, telemetry, flight control and other military applications.

"Missiles and Rockets deals exclusively with astronautics. Spawned by aviation, missilery and outer space exploration today is an industry by itself." — George Shapiro (right), Fellow engineer of the Westinghouse Astronautics Institute, located at Air Arm Division.



"One company can't build the entire bird ... it takes thousands of p and scores of companies. Missiles and Rockets keeps us informed of products and capabilities of the other companies throughout the in try — a most definite aid in selecting contractors." — Harvey Sa (right), Manager, power systems, Westinghouse Advanced Syst Planning group.





Gene Strull (right), Manager of the Semiconductor Divi-
's Solid State Advanced Development Laboratory at the
tinghouse Air Arm Division, discusses molecular elec-
ics with Charlie LaFond of the editorial staff of Missiles
Rockets magazine. Westinghouse engineers have devel-
. on a single semiconductor wafer, a system that performs all the functions of much larger conventional and transistorized electronic systems. Typical application is a tiny light sensing device for satellite telemetry less than ½" in diameter and 1/100th of an inch thick, one of several subsystems including pulse generators and multiple switches, already built and demonstrated by Westinghouse.

is fast-growing, dynamic industry (missiles and
onautics) demands week-to-week technical and
s coverage. Month-old news and developments
of little use to today's engineer." — Jim Currie
), Radar Engineering Section Manager, Westing-
e Electronics Division.



WHY YOU SHOULD ADVERTISE IN MISSILES AND ROCKETS ... Missiles and Rockets has *no waste* circulation—just those who manufacture missiles, space vehicles and allied equipment—and active Government and military personnel. *Over 29,000 missile technicians pay for their subscriptions to Missiles and Rockets*—the *best* circulation story among magazines covering the missile market. Missiles and Rockets reaches the thousands of companies, NASA and the Department of Defense who are purchasers in this multi-billion dollar market.

TELL YOUR PRODUCT OR CAPABILITY STORY THROUGH THE PAGES OF MISSILES AND ROCKETS—THE TECHNICAL/NEWS WEEKLY OF THE MISSILE/SPACE MARKET.

M/R

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

Many Missile Programs Changed by Congress

by Betty Oswald

WASHINGTON—Major revisions of missile programs were recommended by Congress in approving defense appropriation of $39.2 billion for FY '59-60. Funds do not include an additional $1.3 billion for construction of missile bases and other military installations, a separate appropriations act.

While Congressional emphasis, centered on ballistic missiles and strategic weapons, there were signs of a growing concern over the capability of the U.S. and particularly the Army to handle a limited war. There were also indications Congress would take more of a hand in actual programming of military production if the Secretary of Defense did not take a firmer stand to eliminate interservice rivalries and what Congress considers duplicate development of equipment.

Some $1,407,300,000 was provided the Army for procurement of missiles and other equipment. Of this total, Army was ordered to take at least $100 million which had been made available for *Nike-Hercules* to make a start on Army modernization. Originally, the House provided the Army with $1,232,300,000 for procurement which the Senate boosted to $1.45 billion.

Navy will have $3,860,063,000 for procurement of missiles, aircraft, ships, and other hardware items. This includes $1,961,644,000 for missiles and aircraft; $1,330,700,000 for shipbuilding, including *Polaris* submarines and $35 million for planning for a second nuclear powered carrier; and, $567,-719,000 for procurement of ordnance and missiles (other than those used in aircraft).

Air Force will have $7,934,800,000 in new procurement money. Of this, $2,540,550,000 is for missiles, with the strong recommendation that the number of missile squadrons be increased and *Minuteman* be accelerated.

Actually, this could be increased if DOD decided to act. The Appropriation Act provided that the Secretary may take unobligated balances previously provided for aircraft and other procurement to boost ballistic missile programs. This is about $60 million under the budget.

Aircraft procurement money totals $4,284,000,000. This includes funds for armament, specialized handling equipment of the ground variety and other specialized equipment, including machine tools which may be needed. This account may also be boosted by use of previously appropriated but unobligated funds.

For research, development, test and evaluation a total of $3,165,615,000 was made available in new money to Army, Navy and Air Force. Of this, Army gets $1,035,715,000; Navy $970,000,000; and Air Force $1,159,-900,000.

Advanced Research Projects Agency gets an additional $455 million as requested by the President, and the Secretary of Defense's emergency fund of $150 million.

Defense Department has already changed some of the programs for which these funds will be used. Out of Army funds, $137 million will be used for preproduction preparation for *Nike-Zeus* missiles and equipment.

Nike-Hercules program has also been changed. A total of $10.8 million originally planned for research, development, test and evaluation won't be used under changed air defense plans. In addition, some $100 million of *Nike-Hercules* production funds will be used for Army modernization.

Air Force *Bomarc* program is also being reduced sharply under the so-called "master plan." The House originally took a little more than $162 million out of the *Bomarc* program. DOD asked a return of $129.9 million for *Bomarc* installations on the east and west coast. Senate provided about $80 million of the amounts which DOD asked to be returned. The Appropriations Act as it went to the President was a compromise giving the Air Force a little more than half of what the Pentagon had asked.

Congress made it clear that it didn't like either the *Bomarc* or *Nike* programs. Secretary McElroy is barred, by legislative history of the Appropriations Act of using any part of the emergency fund for *Nike-Ajax, Hercules* or *Bomarc*. And there is a strong suggestion, in addition, that the Secretary of the Army ought to start phasing out *Nike-Ajax*.

Plans to buy *Mace*, will have to be sharply revised. Originally $127.5 million was requested by DOD. The House knocked the entire fund out. However, the Senate gave the program a reprieve. It did not restore the money, as requested by the Pentagon, but provided that if the Secretary of Defense really wants the missile, he can take the money out of "maintenance and operation procurement and research and development funds in his discretion—."

Radar improvement programs of the Air Force were also cut slightly, hitting the SAGE project.

Simulator Delivery

Minneapolis-Honeywell Regulator Co. will deliver an 8 x 12-foot space flight simulator to the Air Force School of Aviation Medicine late next month. AF pilots are being screened for two volunteers to spend 30 days in the chamber. The eight-ton device includes air and water recycling devices. Solid wastes will be burned in an incinerator with gases disposed by afterburner. Environmental system will permit the volunteers to smoke cigarets and listen to recorded music.

Boeing has awarded RCA "Multi-million dollar" contract for command and information networks for *Minuteman* launch-control system . . . $1.9 million follow on for more *Minuteman* telemetry equipment has been ordered from **Radiation Inc.** by Boeing. Earlier contract was for $4 million . . . **Bell Aircraft** has picked up three AF R&D contracts totalling $575,000—one of them for development of a storable propellant flow system.

Corps of Engineers will soon ask bids for construction of *Nike-Hercules* bases at Barksdale AFB, La.; Dyess AFB, Tex.; Bergstrom AFB, Tex. Walker AFB, N.M.; Offutt AFB, Neb. Schilling AFB, Kan.; Robins AFB Ga.; Lincoln AFB, Neb. and Turner AFB, Ga.

DOD also has okayed construction of *Bomarc* bases at Camp Adaire, Ore. Paine AFB, Wash.; Vandenberg AFB and Travis AFB, Calif.

Aerojet-General Corp. is donating $400,000 to California Institute of Technology for construction of a new research laboratory. The lab will be named in honor of Dr. Theodore von Karman, who found Aerojet back in the late 1930's.

Boeing Proposes New Vehicle

Boeing Airplane Co. is advancing nd "interplanetary reconnaissance ve- icle" proposal that is a very blue-sky ntity with very real technical appeal.

According to the company's de- cription of the manned orbital- nterplanetary system, it would be apable of:

- Transport between planets by eactor-powered plasma jet;
- Reconnaissance of the orbited lanet by means of a "Boeing Martian xplorer" carried within and dis- atched from the main vehicle;
- Housing shuttle vehicles for per- onnel movement of vehicular service;
- Releasing personnel via self- ontained individual *Mercury* type scape and re-entry capsules.

The principal structure would be a 0x74-foot spherical-ended cylindrical shell. The interior would be divided into two ellipsoids independently pressurized and separated by a hanger deck.

Capable of being fully assembled in outer space, seven levels would be provided within the capsule. Nylon nets would compartmentize various levels.

The power plant would be separated from the habitated area by a truss structure and shadow shield. Communication to earth would be by paraboloidal reflectors and a solar-optical transmitter.

Study Shows Obsolescence

A **Johns Hopkins University** study for the Army labelling 75% of U.S. manufacturing facilities obsolete may increase chances for Congressional approval of changes in current tax depreciation rules.

Fast tax write-offs of equipment and facilities (amortization within 5 instead of 20-30 years) is due to end this year unless extended by Congress. The program was started during the Korean War and in the past few years has been reduced to mostly R&D for missiles and space systems.

Venus' Atmosphere Poses Entry Problem

Tests conducted in shock tubes by **Lockheed Missiles and Space Division** scientists indicate that for vehicles approaching Venus aerodynamic heating may be 50% higher than re-entry into the earth's thinner atmosphere.

AUSA Unveils New Army Missile Equipment

WASHINGTON—The Army last week elebrated the annual meeting of the ssociation of the U.S. Army by un- eiling a series of new Missile Age de- elopments ranging from a GI rocket elt to a "vest pocket" mobile air de- nse system.

The "vest pocket" system is con- dered capable of development as a eld anti-missile missile system.

Gen. Lyman Lemnitzer, Army chief f staff, set the tone of the meeting y warning that the Cold War is rapidly eaching the point of nuclear stalemate.

"The situation will then mean real- tically that the other components of ur power will play the vital role in pping with the tactics and strategy f Communism short of the threat of eneral nuclear war," he said.

He made clear that "the other com- onents of our power" meant very uch a missile-packing modern Army.

The Army disclosed that a soldier such an Army will be equipped with ich weapons as:

- Rocket belts of various sizes— ne belt under development by **Thiokol** ould give a GI up to 50 feet of boost om five solid rockets. Another bigger pe under development by **Aerojet- eneral** is capable of taking a man 200 feet into the air in 20 seconds.
- Rocket foxhole diggers—The ouble-tubed device is designed to dig foxhole by firing two rockets into the round.
- *Redeye*—The Convair anti-air- aft missile that can be handled by ne or two men in the field. It weighs ly about 20 pounds. (m/r Aug. 3)

The new **Hughes** "vest pocket" air defense systems are designed to semi-automatically direct the fire of from one to eight batteries of anti-aircraft missiles—*Hawks* and *Nikes*. They replace much manual operation.

The systems are comprised of from two to eight two-and-a-half ton trucks crammed with electronic equipment. The equipment—much of it modular—has been installed and designed to withstand travelling at high speeds over rough terrain.

One truck in each system serves as operations central. It detects and tracks attacking aircraft and routes the information to the appropriate coder-decoder truck. The coder-decoder truck in turn automatically routes the information to its battery.

The mobile systems already are being deployed with U.S. troops in Germany. In all, Hughes will manufacture 29 five-truck systems under a $30 million contract.

The cost of additional systems is estimated at about $500,000 each.



"VEST POCKET" DEFENSE against enemy jets is provided by the Army's new mobile tactical air defense system. The system—developed by Hughes Aircraft—is capable of semi-automatic direction of the firing of from one to eight Army anti-aircraft and missile batteries. Several of the five-truck systems are already in the hands of U.S. troops in Europe for use with Western-Electric *Nikes* and Raytheon *Hawks*.


HAMMER

Recent appointment of Brig. Gen. **Stephen R. Hanmer** as Deputy Chief of Engineers for Military Operations has been announced. Gen. Hanmer, who has been Assistant Chief of Engineers for Troop Operations, will have supervision over the Corps' military activities, including training and assignment of Engineer personnel, and research and development of missile ground support equipment and techniques.


CAIRELLI

C. P. Cairelli, new chief engineer of M. H. Rhodes, Inc., Hartford, Connecticut, has been with the company for three years as design engineer. He will direct Rhodes' expanded engineering program.

Irving H. Young has been named manager of engineering administration at Litton Industries' Maryland Division. He formerly was an engineer with General Electric's aircraft nuclear propulsion department in Cincinnati. **Fred E. Burnham** assumes position of manager, antenna and microwave section at Litton after ten years with Wright Air Development Command. He was assistant chief of the antenna techniques and applied research section.

William James Weaver takes over as product specialist at F. J. Stokes Corp., Philadelphia. He was formerly with Air Products, Inc.


SOLARI

Sterling Precision Corp. has announced election of **Joseph Solari,** vice president, as a director of the corporation. Solari has also been elected to the board of American LaFrance, Yawman and Erbe, Prescott, Alf-Herman, Weck and Wood and Brooks. He will continue responsibility on the operation of the Instrument Division at Port Washington, New York; the Inertial Navigation Division at Cambridge, and the Weck Division in Brooklyn.

France's Nord-Aviation has named **Leon Beaussart** as vice president (technical) of their Missiles Department. **Roger Chevallier** is promoted to chief engineer of the target missiles section; **Jean Guillon** chief engineer of the autorotating missiles and **Roger Fleury,** chief engineer, for missile development and support equipment.


ROSS

Harvey M. Ross, chief engineer of Motorola's Defense Systems Laboratory has been named manager of Program Development, a new position "reflecting the continued expansion of Motorola's military activities in Phoenix." He joined Motorola's Communications and Electronics Division in 1948 and was promoted to department head in the Military Electronics Division.

Paul R. Ellis, former manager of ACF Industries, South Albuquerque Works, has been promoted to manager of the division.


DUNCAN

Dr. Donal B. Duncan, 34, has moved to Aeronutronic, a Division of Ford Motor Co. as assistant general operations manager of Space Technology Operations. He was manager of Advanced Engineering at Autonetics, a Division of North American Aviation Inc.

Barnett Pomerantz takes over as project engineer at Bulova Research and Development Laboratories, Inc., for aircraft altimeter development and production programs. Pomerantz came to Bulova a year ago, from Swivelier, Inc. where he was chief engineer.


SILK

C. Earnest Silk heads development of solid propellants and explosives operations of the Energy Division, Olin Mathieson Chemical Corp. and will be responsible for development operations at East Alton, Ill., and Ordill, Ill. Silk, who joined the then Olin Industries in 1930, and has worked in research, manufacturing and engineering phases of the business, holds patents for explosive processes.

flight approved . . .

by Able, Baker and Jupiter!

3 POLE 30X10 COMMUTATOR, 28 VOLT D.C. OR 115 VOLT 400 CYCLE HYSTERESIS SYNCHRONOUS

#1 Pole 30 BBM contacts 75% duty cycle, data
#2 Pole 30 BBM contacts 75% duty cycle, data
#3 Pole 30 BBM contacts 50% duty cycle, sync pole

Interpole phasing to within ± 20 minutes arc maximum. Sync pole leading edge electrically lags data pole.

MILITARY: MIL-E-5272A, MIL-I-6181B, IRIG

Temperature	—55°C to +85°C
Altitude	0 to 100,000 ft.
Vibration	15g 70-2,000 cps 3 major planes
Shock	50g 3 major planes
Acceleration	75g 3 major planes
Service Free Life	Minimum of 500 hours without service
Weight, 2,375 pounds	Full hermetic case.
Motor & Power	115 volts hysteresis synchronous 400 cycle less than 12 watts. 28 volt d.c. ungoverned less than 4 watts.
Contact Resistance	Less than 0.2 ohms total with a lifetime variation of approximately 0.03 ohms for the first 500 hours life.
Insulation Resistance	100 megohms at 500 V. d.c.
Hi Potential Test	100 megohms at 500 V. rms

Continuous Commutation from Pre-launch through Recovery


PAM or FM/FM COMMUTATOR

WESCON BOOTH 1519

Write for Technical Bulletin 500416 (DC Motor) or 500417 (AC Motor) giving specification data and pricing.

INSTRUMENT DEVELOPMENT LABORATORIES, INC.
A Subsidiary of Royal McBee Corporation
28 Mechanic Street • • Attleboro, Massachusetts, U.S.A.

Circle No. 13 on Subscriber Service Card.

west coast industry . . .

By Fred S. Hunter

Ryan Aeronautical Co. keeps pushing . . .

toward higher altitudes with its *Firebee* jet target missile. When Ryan first started drawing lines on paper for the XQ-2 in 1947, it was to meet a requirement for 15,000 feet of an anti-aircraft target. Its newest model, the Q-2C, has achieved a record of 59,500 feet and, in addition, has set a duration record of 77½ minutes above 50,000 feet. Next step will be a supersonic *Firebee*. Ryan, says Frank Fink, vice president-engineering, is thinking in terms of Mach 1.5 and then going on from there.

First objectives in Ryan's program . . .

to provide supersonic capabilities in the *Firebee* may be met with a two-stage version of Continental's J69-T-29 engine which powers the Q-2C. This would increase the Dash 29's 1700-pound thrust rating by approximately 50%. Ryan's own engineers are working on the development of an augmentation system for this same engine. This would be in the form of a simplified afterburner which could be cut in after the drone is on station. Cost of a current *Firebee*, including augmentation and scoring equipment, comes to $50,000 or $60,000. A supersonic *Firebee* probably would cost twice as much. But higher and higher performance target systems have to be developed to meet the requirements of advances in weapons systems. And Ryan's people make a cogent point—often the cost of the munitions (rockets) used up in a target mission exceeds the cost of the recoverable *Firebee*.

Steel strike may affect missile industry . . .

on the labor front as well as in the supply of material. Roy M. Brown, International Association of Machinists general vice president for the southwest area, made this observation at the recent western states conference of the IAM in San Diego: "What happens in steel will affect negotiations in other industries, including contract talks coming up in the aircraft and missile fields next spring."

NASA will come into the X-15 flight . . .

program at an early date. Immediately upon conclusion of proving flights, **North American Aviation** will turn the No. 1 aircraft over to NASA for test by its pilots. With two B-52s available for mother ships, North American will continue with its program on the No. 2 aircraft. A major change in flight technique will take place with the entrance of the No. 3 aircraft into the program. Interim engines in the No. 1 and No. 2 aircraft will be lighted after the rocket plane is dropped from the mother B-52. The big 60,000-pound thrust rocket specially developed for the X-15 will be lighted just before the aircraft is released.

How big is the missiles and rockets business . . .

getting to be? Well, **Aerojet-General** says at Sacramento it has the largest telephone switchboard west of the Mississippi and is expanding it. The company's telephone bill is $85,000 a month. And if the stock market is your barometer, consider, then, in the last 18 months, prices of shares of **Ampex** and **Hoffman Electronics** have increased more than fourfold, **Hewlett-Packard** and **Stratham Instruments** more than threefold . . . J. E. Rheim, **Rohr Aircraft** president, says the next two or three years should be "the best we've ever had." Rohr has $150 million of business lined up already for fiscal 1961.

Transfer of satellite launchings from . . .

Vandenberg Air Force Base to the Navy's Point Arguello will probably become effective after January 1, 1960. The switch is purely in the interest of geographical efficiency. There's nothing between Arguello and the South Pole except ocean.

ADVANCED PRELIMINARY DESIGN ENGINEERS

The creation of the new Preliminary Design Department of our Solid Rocket Plant has led to several unusual and challenging positions for experienced engineers and scientists.

We are expanding:

into new fields of rock propulsion and space technology, far beyond "classical" solid propellant rocketry. For this we are an internationally acknowledged leader.

We are looking for:

mature, experienced and highly versatile engineers, preferably over 30 years old. These men will be mechanical, aeronautical, or missile engineers. They may also be engineering-minded physicists or chemists. An M.S. degree is essential, a Ph.D. welcome. A high degree of proficiency in such fields as thermodynamics, aerodynamics, heat transfer, stresses, and physics is required, as well as a practical understanding of manufacturing fundamentals. Each of the men we are seeking must be capable of integrating the essentials of a new design, based on the more quantitative work of our several analytical groups.

Eight positions as "Technical Specialist" in our Preliminary Design Department are available. Each successful candidate will work on this team as an equal among equals. These top engineers will be given enough responsibility and freedom to work as they see fit. Excellent salaries are offered, commensurate with demonstrated ability and experience. The Sacramento, California, area offers a favorable, healthy climate and living conditions which are among the finest in the country, one and a half hours driving time from either the Sierra Nevada Mountains or San Francisco.

Please send your resume and direct any detailed questions to:

Mr. Emil L. Eckstein
Head, Department for Preliminary Design
Through:

Mr. E. P. James, Supervisor
Technical and Scientific Placement

AEROJET-GENERAL CORPORATION
Box 1947J
Sacramento, California

AEROJET-GENERAL CORPORATION

a subsidiary of the General Tire & Rubber Company
Azusa & near Sacramento, California

Circle No. 14 on Subscriber Service Card.

—contracts—

AIR FORCE

Radio Corp. of America has received a "multi-million dollar" major research and development contract for work on the sensitive-command and support information networks of the *Minuteman* launch-control system. (Subcontract from **Boeing Airplane Co.**)

$83,966,000—**Pan American World Airways, Inc., N.Y.**, for increased funds for services and material for management, operation and maintenance of the Atlantic missile range facilities and related activities of the AFMTC. (Two contracts.)

$1,900,000—**Radiation Inc.**, Florida Div., for the ground portion of the PCM/FM telemetry equipment for the *Minuteman* ICBM. (Subcontract from **Boeing Airplane Co.** and is in addition to an earlier $4,000,000 contract.)

$1,000,000—**The Garrett Corp., AiResearch Div.**, Phoenix, for vent and relief valves and high pressure regulators for the *Titan* ICBM. (Subcontract from **The Martin Co.**)

$575,000—**Bell Aircraft Corp.**, Buffalo, N.Y., for development of a storable propellant flow system for rocket engines; feasibility study for the electrostatic suspension of accelerometers, and a method of determining the effect of structural flexibility on the stability and control of hypersonic air vehicles. (Three contracts.)

$450,000—**Consolidated Diesel Electric Corp., Aircraft Equipment Division**, Stamford, Conn., for transformer-rectifier type power supplies.

$36,000—**Traid Corp.**, Encino, Calif., for 16mm hi-speed camera.

$30,530—**Boeing Airplane Co.**, Pilotless Aircraft Div., Seattle, for technical data for IM99A missile components.

$20,000—**Southwestern Industrial Electronics Co., Div. of Dresser Industries, Inc.**, for electronic instrumentation Model K-1 microsource.

NAVY

Contracts totalling $12,000,000 have been awarded **Sperry Gyroscope Co.**, Great Neck, N.Y., for the development of the Mark 112 Torpedo Fire Control System, an electronic "brain" that controls torpedos even after they are fired. The first will be installed on the *Polaris*-launching submarine, the USS George Washington.

$1,920,000—**Ryan Aeronautical Co., Electronics Div.**, for additional spare parts and other support equipment for the Model APN-122(V) Doppler Radar Navigator.

$425,000—**Elgin Micronics, Div. of Elgin National Watch Co.**, Elgin, Ill., for the production of safety-arming devices used in the *Sparrow* missile.

$330,000—**Brubaker Electronics, Inc.**, Culver City, Calif., **Div. of Telecomputing Corp.** of Los Angeles, for the manufacture of complex radar test equipment and spare parts.

$225,000—**Vitro Laboratories**, Silver Spring, Md., **Div. of Vitro Corp. of America**, for the expansion of services in the field of weapon system simulation and training devices. (Four contracts.)

$134,000—**Packard Bell Computer Corp.**, Los Angeles, for data gathering system.

$71,876—**Bendix Computer Div.**, Los Angeles, for digital computing system.

$61,840—**Avion Div., ACF Industries, Inc.**, Paramus, N.J., for radar beacon assembly.

ARMY

$9,950,000—**Western Electric Co., Inc.**, N.Y., for *Nike-Zeus* industrial planning program.

$3,023,204—**Chris Berg. Inc.**, Seattie, Wash., for construction of tracking and data acquisition station at Donnelley Flats, near Fort Greeley, Alaska.

$2,500,000—**North American Aviation**, Canoga Park, Calif., for design and development.

$2,358,670—**HRB-Singer, Inc.** and the **Singer Manufacturing Co.**, a joint venture, State College, Pa., for infrared surveillance system.

$1,934,519—**Hazeltine Electronics, Div. of Hazeltine Corp.**, Little Neck, N.Y., for radar set An/TPS-25.

$803,452—**Ford Instrument Co., Div. of Sperry Rand Corp.**, L.I., N.Y., for airborne guidance receiver transponder.

$800,000—**ITT Laboratories, Div. of International Telephone & Telegraph Corp.**, Nutley, N.J., for three ground stations for *Courier* communication-satellite systems.

$700,000—**Philco Corp.**, Philadelphia, Pa., for *Courier* communication satellites, shrouds, code tapes.

$440,000—**The Trustees of Columbia University**, N.Y., for research and experimental work in the continued investigation of electromagnetic spectrum, together with technical reports. (Two contracts.)

$420,315—**Firestone Tire & Rubber Co.**, Los Angeles, for engineering services.

$350,000—**Union Carbide Development Co., Div. of Union Carbide Corp.**, N.Y., for research in physical and chemical principles affecting high temperature materials for rocket nozzles.

$349,403—**Gilfillan Brothers Inc.**, Los Angeles, for engineering services.

$340,948—**Ford Instrument Co.**, L.I., N.Y., for eight sets of modified *Redstone* guidance and control components.

$226,021—**Collins Radio Co.**, Dallas, Texas for microwave relay for wide band telemetry, White Sands Missile range, spare parts list.

$179,364—**Radio Corp. of America, Defense Electronic Products**, Moorestown, N.J., for investigation into requirements of special test equipment for cross section measurements, design, fabricate and installation of necessary special test equipment determined to be applicable.

$139,000—**Bulova Research & Development Labs., Inc.**, Woodside, N.Y., for study, design and fabrication of nine prototype accelerometer monitors and mico-miniaturized three-speed synchro assemblies utilizing size eight synchros for the ground equipment to be used in the *Jupiter* guidance system and for study and development of basic research tool applicable to gun launchable guidance systems. (Two contracts.)

$81,950—**Defense Electronic Products**, Camden, N.J., for investigation studies pertaining to advance development of microwave radio relay systems together with technical reports.

$65,060—**Atlantic Research Corp., Alexandria**, Va., for one design and test plan for radiosonde AN/DMQ-6 and subsequent delivery of 15 development and 50 engineering test models.

$53,720—**Wild Heerbrugg Instruments Inc.**, Port Washington, N.Y., for modification of government-owned ballistic cameras.

$51,539—**University of Wisconsin** for research work for 24 months to conduct surface wave antenna and microwave filter engineering study and technical reports.

$42,736—**University of Pittsburgh**, for basic research related to low energy nuclear and electron physics and research and development entitled "The Reactivity and Molecular Constitution of Some Metal Hydridies in Solution."

$40,182—**Western Electric Co.**, N.Y., for *Nike* spare parts and components.

$38,000—**Litton Industries**, San Carlos, Calif., for magnetron tubes.

MISCELLANEOUS

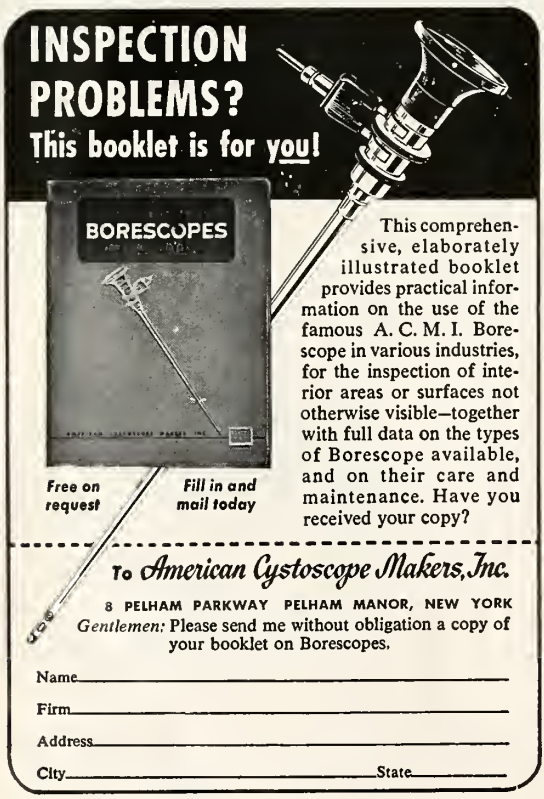
$794,000—**Applied Science Corp.** of Princeton, N.J., for digital data transmission systems for the Eglin Gulf Test Range. (Subcontract from **ITT Laboratories**, a division of **International Telephone & Telegraph Corp.**)

$350,000—**Consolidated Avionics Corp.**, subsidiary of **Consolidated Diesel Electric Corp.**, Westbury, N.Y., for automatic test equipment for testing electronic missile components and circuits. (Subcontract from **General Electric Co.**)

$75,000—**Consolidated Avionics Corp.**, Westbury, N.Y., for data reduction system. (Subcontract from **Boeing Airplane Co.**)

BIDS

U.S. Army Engineer District, Pittsburgh, Corps of Engineers, New Federal Bldg., Pittsburgh, Pa.: Construction of ground-air transmitter and receiver facility for the *Missile Master*, Pittsburgh Defense Area, Collier Township, Allegheny County, Pa. Bid sets available after 24 July 1959. Completion 165 calendar days—Job—IFB Eng-36-058-60-1B—Bid opening on or about 25 Aug. '59.



—letters—

Reliability Interest

To the Editor:

I have read with interest the articles written by Managing Editor D. E. Perry and Col. J. N. Dick, USAF, Ret., in the July 13 issue of MISSILES & ROCKETS and was prompted to reply with some thoughts of my own. The fact notwithstanding that new materials and components will be required for future equipments, I question how much we know about the reliability attributes of those presently available.

It is my belief that our knowledge is inadequate and our needs are immediate. Further, that we are actually attempting to design reliable equipments without sufficient reliability information concerning the parts from which they are to be constructed. With sufficient component reliability data available to the design engineer at the time that he is building his dream, there should be marked decrease in the number of nightmares that occur in test and production.

To stress my point, let us suppose that the designer had a reliability requirement in addition to accuracy, altitude, size, etc. A rather unsophisticated technique for a rough computation could be explained to him. Suppose further that some of these computations require the data that associates failure rate, temperature and electrical stress (voltage, wattage, etc.) for the various components that he is to use. Where does he obtain this information concerning either new or relatively new components. It appears that he doesn't unless either his company has been funded for a large components evaluation program or has access to data from another company or a government agency.

To gather these types of data through testing program is a costly process for any company, but it could be done on a national scale at Government expense. Dissemination of these design data could be either upon request or included with the documents associated with an equipment specification.

Considering military component specifications for a moment and the fact that they contain certain requirements for size, rating, etc., should they not contain reliability requirements as well? It would seem that we are not exploiting to best advantage those components that are in and today because of the lack of sufficient information concerning their reliability attributes.

This does not mean that we cannot expect to require new component types to meet the demands of future equipments. However, suppose that the suggestions made by Col. Dick are accepted and new materials are developed. Will we know any more about their failure rates in equipment application than we now about those that we are using today? Certainly not, if the developmental investigations are conducted without forethought for the reliability data required to make use of them.

In summary, and as Col. Dick's article suggests, let's really put "first things first" and find out what our components will do in a reliability sense. If we are able to accomplish this, we should be able to design reliability into equipment just as any other design requirement. Reliability is no longer an art but a science; therefore, there is a need for scientific information in its aplication.

E. G. Lebre, Manager
Reliability & Specification
Compliance Department
Raytheon Manufacturing Co.
Maynard, Mass.

—when and where—

AUGUST

Metallurgy Division, Denver Research Institute, Eighth Annual Conference on Applications of X-Ray Analysis, Stanley Hotel, Estes Park, Colo., Aug. 12-14.

Institute of Radio Engineer's Professional Group on Ultrasonics Engineering, First National Ultrasonics Symposium, Stanford University, Stanford, Calif., Aug. 17.

Institute of Radio Engineers, Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 18-21.

AFOSR/Propulsion Research Division, Directorate of Aeronautical Sciences Office of Naval Research, Office of Ordnance Research & National Aeronautics and Space Administration, Symposium on "The Dynamics of Ionized Cases," Northwestern University, Evanston, Ill., Aug. 24-25.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare, (classified), San Diego, Calif., Aug. 24-26.

International Commonwealth Spaceflight Symposium, Church House, Westminster, London, England, Aug. 27-29.

Army-Navy Instrumentation Program, Annual Meeting, Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Texas, Aug. 31-Sept. 2.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkeley, Calif., Sept. 2-4.

Air Force Association and Panorama: Send Reservations to AFA Housing Bureau, P.O. Box 1511, Miami Beach, Sept. 3-6.

AFOSR/Directorate of Aeronautical Sciences, Office of Naval Research, National Science Foundation, Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Sept. 9-11.

New York University's College of Engineering, Titanium Metallurgy Conference. For information: Dr. Harold Margolin, New York University, University Heights 53, New York, Sept. 14-15.

Institute of the Aeronautical Sciences, Western Regional Meeting on Frontiers on Science and Engineering, Los Angeles, Sept. 16-17.

Standards Engineering Society, Boston Section Eighth Annual Meeting, Hotel Somerset, Boston, Sept. 21-22.

Industrial Nuclear Technology Conference, Sponsored by Armour Research Foundation of Illinois Institute of Technology and Nucleonics Magazine and Atomic Energy Commission, Morrison Hotel, Chicago, Sept. 22-24.

Advertisers' Index

Aerojet-General Corp., Sub. General Tire & Rubber Co. 47
Agency—D'Arcy Adv. Co.
American Bosch Arma Corp. 2
Agency—Doyle, Kitchen & McCormick, Inc.
American Cystoscope Makers, Inc. .. 48
Agency—Noyes & Sproul, Inc.
Brunswick-Balke-Collender Co. 35
Agency—McCann-Erickson, Inc.
Bulova Watch Co., Electronics Div. 7
Agency—Duncan-Brooks, Inc.
Cooper Development Corp., Sub. Marquardt Aircraft Co. 39
Agency—Allen, Dorsey & Hatfield, Inc.
Dow Chemical Co., The 12
Agency—MacManus, John & Adams, Inc.
Electro Instruments, Inc. 52
Agency—Clyde D. Graham, Adv.
B. F. Goodrich Aviation Products, Div. The B. F. Goodrich Co. .. 51
Agency—Batten, Barton, Durstine & Osborne, Inc.
Goodyear Aircraft Corp. 3
Agency—Kudner Agency, Inc.
Graphic Systems, Inc. 40
Agency—Diener & Dorskind, Inc.
Haws Drinking Faucet Co. 41
Agency—Pacific Adv. Staff
Instrument Development Laboratories, Inc. 46
Agency—Richard Thorndike Agency
Kearfott Co., Inc. 8
Agency—Gaynor & Ducas, Inc.
Lockheed Aircraft Corp., Missile System Div. 14, 15, 38
Agency—Hal Stebbins, Inc.
Marquardt Aircraft Co. 10, 11
Agency—Grant Adv., Inc.
Minnesota Mining & Mfg. Co., Missile Industry Liaison 6
Agency—Batten, Barton, Durstine & Osborne, Inc.
North American Aviation, Inc., Missile Development Div. 36
Agency—Batten, Barton, Durstine & Osborne, Inc.
Ramo-Wooldridge, Div. Thompson Ramo-Wooldridge, Inc. 23
Agency—The McCarty Co.
S. S. White Dental Mfg. Co., Industrial Div. 4
Agency—W. L. Towne Co., Inc.

Navy Fails to Solve ASW Problem

It is basic military doctrine that close behind any new offense will appear a defense. The time and the effectiveness vary but historically the doctrine has proven itself, the world has watched this spectacle of defense and offense leap-frogging each other over the war-marked centuries.

It is in the periods when the development of the defense lags unduly that nations find themselves in the greatest danger, whether the weapon be the phlanx, the catapult, the long bow or the satellite missile-firing platform.

The United States today finds itself facing such a problem in not one but two fields. The first is the anti-ballistic missile missile. The second is in anti-submarine warfare. Of the two the second seems to us to be much the more dangerous for two reasons.

First: despite a great deal of talk about the "missile gap," the probability is that both the United States and the Soviet Union will actually perfect long range ballistic missiles in roughly the same time period. Any advantage the Russians may have for a short time will be offset by the Western Allies long range bomber force. These factors seem likely to prolong the same sort of stand-off under which the world has been living, perhaps indefinitely.

Second: No such equality of force exists between the Soviet and U.S. submarine fleets. It is true that we have the first atomic submarines and are building more, and that their feats have been spectacular. But indications are the Russians will not be far behind with their own atom-powered subs. Certainly their accomplishments in the reactor field in other endeavors can leave little doubt that they have such a capability.

The more important fact is that the Russians have a huge fleet of some 500 submarines as opposed to 113 in operation by the United States (five nuclear).

Times and tactics have changed a great deal since World War II. Then the submarine was intended and directed to operate exclusively against other ocean craft. Today the submarine has the capabality of operating not only against shipping but against the cities and military installations of the enemy as well.

In the first instance, in the words of Rear Admiral John S. Thach, commander of the Navy's Task Force Group ALFA;

"Hitler started his war with about 60 U-boats, the old fashioned kind that could submerge only temporarily, and he nearly strangled us. The Russians have eight times that many right now. Most of them are new. They're fast. Snorkels are standard equipment. Nuclear propulsion is only a matter of time." Admiral Thach is one of the Navy's sailors responsible for building a submarine defense. He will admit that in war games his own opposing snorkel subs confound his defenses all too frequently.

Even if we ignore the possibility that the Red subs might throttle the sea lanes, concentrating on the theory that the next war will be short, if unhappy, and that supplies can be handled via the air, this does nothing to dispose of the missile-throwing sub which could operate in the Atlantic, the Pacific and the Gulf.

Since we have not and probably will not have for some time a defense against a ballistic missile—certainly not against one fired from short range—then the problem here is exactly the same as the problem of protecting shipping. The only defense is to get the submarine itself. And a conventional sub can toss a missile just about as well as a nuclear sub.

Industry, which has been working fitfully on this problem for some years, details two main obstacles they have run into—and many responsible Navy officers agree. These are:

Lack of money—The price of one carrier, for instance, would go far toward the solution.

Concentration of effort—Instead of scattering the responsibility between The Bureaus of Ordnance, Ships, Aeronautics and the Office of Naval Research.

A poll of more than a score of companies who have worked on the ASW problem, including putting their own funds into it, has revealed almost an unanimity of response on the latter fact. Almost invariably it went like this:

"One of our greatest problems in dealing with the Navy on ASW is that there is no single group within the Navy Department responsible for the entire anti-submarine field and, therefore, it is difficult for a contractor to anticipate or, indeed, discover the total needs of the service in this area."

And another, from a company which had spent $100,000 of its own funds:

"The most difficult problem encountered to date in conjunction with ASW is the lack of consistency among many Navy agencies as to what the requirements of the Navy really are in the ASW area."

It seems to us that the conclusion is inevitable. There are many precedents in the Services for establishing a special group—task force, division, command, call it what you will—to concentrate the best skills of the Navy and industry toward solving one of the most dangerous threats which the country faces. It should be done quickly. And it should be given a priority on money and manpower to be successful.

CLARKE NEWLON

SUBSCRIBER SERVICE
missiles and rockets

For additional information about any product or service advertised mentioned in the editorial pages of this issue of Missiles and ckets:

Use the attached prepaid reply cards. Circle numbers shown on reply card that correspond with numbers appearing beneath items scribed. If no circle number accompanies the article or advertisent, give page number (and advertiser's name) on line provided at ttom of the card.

Your requests for information will be forwarded promptly to the mpanies concerned.

NEW PRODUCT BRIEFS

ITIVE FUSE. A current-sensitive having a functional reliability of % is announced by Networks Elec- Corp. Glass-enclosed and hermet- sealed, the fuse is 100% humidity , and guaranteed to meet any ied resistance to atmospheric con- s. Unit has excellent environmental cteristics, withstanding tempera- from −100°F to +400°F . . . ion of 10 to 500 cps at 15 G's ium, and shock of 50 G's for 11 conds. Fuse is dimensioned to dis- heat produced by the maximum current under any special blowing and temperature conditions. Fast, m or slow burning-operating time vided. The slow-burning fuses have h time-lag, with standing heavy ; and instantaneous peaks, but g quickly in response to short cir- Units are filled with nitrogen or specified gases. Outside ends of rminals are flexible copper alloys straight cutoffs, or flattened-and- d lugs. Fuses can be designed and ged to customer specifications.

No. 245 on Subscriber Service Card.

OTEST CONSOLE. Solartron, Inc. a new console providing a con- t housing for selected items of est equipment, plus working sur- for use as a plotting desk or as d for units under test. The con- was designed to house Solartron nents such as its low frequency e oscillator, low frequency resolved onents indicator, Solarscope, con- s, sub-sonic power amplifier and nical reference generator. How- the manufacturer also suggests cer- ther instruments as being applic- n the servotest field.

No. 246 on Subscriber Service Card.

SDUCER. Astra Technical Instru- Corp., is now marketing a tung- resistance thermometer having a tless connector of 2 ounces. These possess the high accuracy and wide rature ranges characteristic °F to +2000°F) of the com- standard laboratory probes. lucers feature body rotation inde- nt of leads for ease of installation, re extremely rugged to withstand ibration and shock.

No. 248 on Subscriber Service Card.

PLANETARY MIXER-DISPERSER. A heavy-duty vertical planetary mixer, only 14 feet tall and powered with a four-speed, 20 horsepower, explosion-proof motor, has been produced by the Bramley Machinery Corps. Mixing is performed in the 250 gallon, stainless steel, mixing chamber by means of specially designed, wedge-proof paddles, one stationary paddle and one rotating paddle moving on its own axis in a planetary orbit. The paddles intermesh, thereby performing a continuous and quicker kneading and squeezing action between the paddles. The mixing chamber is jacketed around the periphery, including the bottom, for either cooling or heating, with an allowable internal working pressure of 50 PSI. A separate hydraulic system raises the mixing chamber and holds it to the head, to permit the mixing operation to be conducted under high vacuum.

Circle No. 249 on Subscriber Service Card.

DIFFERENTIAL. The Dynamic Gear Co. has introduced a miniature, precision three-gear differential for application in the fields of electronic computers and fire control systems. Designed, manufactured and available from stock, this differential has a backlash of only 8′ of arc and breakaway torque of .3 oz. in. Tumbling circle is 1.380″. Maximum recommended load at 2500 RPM is 75 oz. in. Featuring 6 precision bearings, this solid shaft differential is entirely constructed of 303 stainless steel—except the spider gear, which is 24 St aluminum. Overall length of the differential proper is 1.888 and shaft diameter is .1847. Shaft lengths are available up to 4″.

Circle No. 250 on Subscriber Service Card.

PROPELLANT TESTER. A "drop-weight tester" developed by the Olin Mathieson Chemical Corp. for impact testing liquid propellants and explosives is offered by Technoproducts Inc., exclusive licensee. The test method, developed by Olin Mathieson in a five year cooperative government and industry program aimed at standardization of propellant testing, has been accepted as a Recommended Test by the Joint Army-Navy-Air Force Panel on Liquid Propellant Test Methods.

Circle No. 251 on Subscriber Service Card.

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY CARD
First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

MISSILES and ROCKETS
20 EAST 46th STREET
NEW YORK 17, NEW YORK

SUBSCRIBER SERVICE DEPT.

POSTAGE WILL BE PAID BY ADDRESSEE

NAME_____
TITLE/POSITION_____
COMPANY_____
Product Mfg./Service Offered_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____
Card cannot be processed unless all information is given. Please limit requests to ten items.

MISSILES AND ROCKETS
August 10, 1959
Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers: _____

MISSILE LITERATURE

SURFACE COATINGS. A chart providing thermal, physical, chemical and electrical characteristics of HumiSeal protective surface coatings for electronics applications is now available from the Columbia Technical Corp. Prepared so that all characteristics can be seen at a glance on one side of the sheet, the chart covers the ten HumiSeal types broken down by the A.I.E.E. thermal classification as well as 47 other specific characteristics for each type. The reverse side has a selector table which enables the user to select the HumiSeal type best suited for the property most desired for his application.

Circle No. 200 on Subscriber Service Card.

A. C. TIMING MOTORS. The A. W. Haydon Company has released a Bulletin—AWH MO-807—describing a line of compact, reversible AC Timing Motors. These motors are supplied with built-in gear trains offering speeds from 450 RPM down to 1/4 RPM. Identified as the 26100 Series, these motors were designed specifically for applications where ease of reversing is the main requirement, and where small size and light weight is necessary. The synchronous characteristic of these hysteresis type motor assures an accuracy on the same order as the power source. Operation can be on single phase supplies, using a phase shift network supplied with one winding, or on two phase supplies. Reversing is accomplished rapidly and conveniently with a single-pole double throw switch.

Circle No. 201 on Subscriber Service Cord.

SENSITIVE DETECTOR. Technical bulletin no 91411 describes the theory and operation of a visual phase sensitive detector manufactured by Boonshaft and Fuchs Inc. This test instrument is used in the performance evaluation of a-c servo amplifiers and mechanisms. Other applications are also listed. Block diagrams, waveforms, and test setups are shown in the bulletin, as well as a chart illustrating the demodulation of various carrier signals of different phase relationships.

Circle No. 202 on Subscriber Service Cord.

TRANSFORMER. A "do-it-yourself" transformer, called the Flexiformer packaged transformer primary, which makes stocking of many fixed-ratio transformers unnecessary, is described in a bulletin released by the Superior Electric Co. Essentially, a Flexiformer is a self-contained toroidal primary coil consisting of a strip-wound silicon steel core having a coil of 400 turns of #24 B&S guage copper wire. When used as a source of a-c voltage, simply hand-thread the proper number of secondary winding turns through the center opening to obtain the desired output voltage. Input rating is 120 volts, 50/60 cycles, 1-phase and output is 150 VA. When used as a current transformer, the Flexiformer winding becomes the secondary winding with the current induced by a wire passing through the center opening. Used with a 0-1 ampere ammeter, currents up to 400 amperes can be measured with an accuracy of 1% at 60 cycles.

Circle No. 203 on Subscriber Service Cord.

GAS REGULATORS. A new line dustrial gas regulators without g is described in a data sheet now able from Linde Company, Divisi Union Carbide Corp. The new gau regulators eliminate the costly an noying problem of gauge breakag replacement. Designed for use wit gen, acetylene or propane on cyl or manifolds the new Oxweld regu are designated the R-550 (Oxyge 551 (Acetylene) and the R-552 pane). Complete specifications an erating data on the new large-ca single-stage regulators are includ the data sheet. The new regulato extremely valuable on jobs where lators are subject to rough handli switched from cylinder to cylinde quently. Use of an absolute mi number of parts in the gaugeless lators reduces the number of part ject to wear. It is rarely necessa replace parts other than the stem of diaphragm.

Circle No. 204 on Subscriber Servic

PUBLICATION. The first issue of D Tech Notes, a 4-page publication ing with analog computer tech and applications, is now available Donner Scientific Co. Subject of th issue is "How to Simulate a Non- Control System with an Analog puter". Diagrams of a typical system and plots showing respo the system at various points with ent parameters are included.

Circle No. 205 on Subscriber Servic

SPACE HANDBOOK. Those inclir brag of having "the world in pockets" should check Space Techi Laboratories, Inc. STL has manag effect, to shrink our solar system handy "pocket size." Produced form of a computer, the device matically computes time, distanc the earth's rotation in regard other planets. With minor position cardboard dials, the "Planetariur cates exact planet positions durir hour of the day, for all twelve of any year for the next ten yea

Circle No. 206 on Subscriber Servic

INTERNATIONAL INCH. Pratt & ney Company, Inc., announces th lication of a new booklet that dis on a practical commonsense bas various problems a manufacturer expected to encounter as a re America's change-over to the I tional Inch on July 1 of this year. "The New International Inch . . How It Will Affect Your Opera the booklet explains that a majo plants will not be affected to any ficant degree by the adoption new inch—but warns that each facturer should make a careful tion of his own machining and ing operations before deciding or not the 2-millionths-per-inch ence between the old and th measurements should be taken in count. To simplify the job of this necessary evaluation, Pratt & ney states that the boklet prov questions-and-answers section de to cover the more immediate poin will concern most manufacturers.

Circle No. 207 on Subscriber Servic

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY ADDRESSEE

BUSINESS REPLY CARD

First Class Permit No. 2455-R (Sec. 510 P.L.&R.) Washington, D. C.

MISSILES and ROCKETS

20 EAST 46th STREET

NEW YORK 17, NEW YORK

SUBSCRIBER SERVICE DEPT.

NAME_____

TITLE/POSITION_____

COMPANY_____

Product Mfg./Service Offered_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

Card cannot be processed unless all information is given. Please limit requests to ten items.

MISSILES AND ROCKETS

August 10, 1959

Expires Three Weeks After Above Date

CIRCLE NUMBERS BELOW FOR INFORMATION ON PRODUCTS, LITERATURE OR ADVERTISEMENTS

• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers: _____

B.F.Goodrich

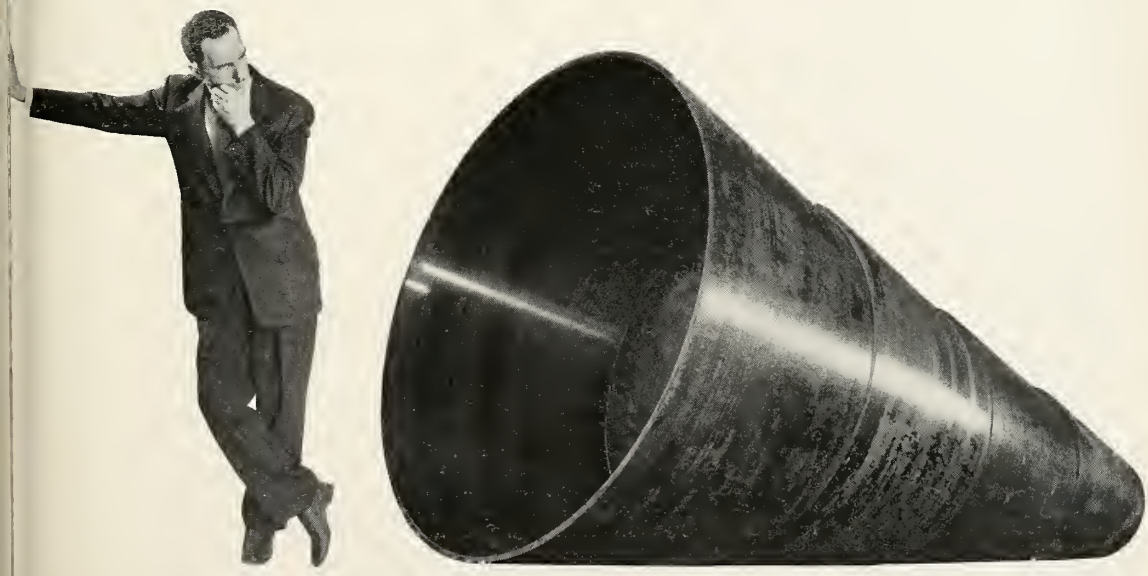
WHAT IS IT? Probably the biggest homogeneous void-free laminate ever built . . . a B. F. Goodrich ablation shield for an experimental re-entry vehicle designed and built by General Electric to be test flown on an Air Force Atlas ICBM.

Fabricated by a special B. F. Goodrich winding technique, the shield contains about five miles of high-temperature resin tape. This fabricating technique, which is also being used for many other specialized B. F. Goodrich products of various types and sizes, completely eliminates precision matched metal molds, cuts tooling costs by hundreds of thousands of dollars, and saves plenty of lead time. Autoclave curing replaces massive high pressure presses.

Throughout the construction of this re-entry vehicle shield, B. F. Goodrich maintains constant quality control of resin content and residual volatiles. Modern radiological facilities are used for final checking.

The fabrication and curing of such huge void-free parts illustrates the advances made by B. F. Goodrich in producing high-temperature, reinforced plastic products. So if you're up in the air and want down-to-earth answers on plastic laminate constructions, contact *B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. MR-89, Akron, Ohio.*

B.F.Goodrich *aviation products*



Circle No. 8 on Subscriber Service Card.

Electro Instruments Model A12 D.C. Amplifier

Totally transistorized—dissipates only 7 watts.
Long term drift less than 2 microvolts.
.01% linearity and stability.
100 megohms input impedance—40 milliohms output impedance
1 db DC to 10 KC.
Noise less than 10 microvolts wideband.
Single ended or differential input.
Operates to specifications from 0° to 50° C.
Self-contained power supply—operates on any line frequency from 50-400 cps.
Mil-type chopper gives unmatched reliability for the life of the instrument.
7" x 19" panel accommodates 8 instruments.

Plug-in attenuators of the A12 provide convenience, flexibility and economy. Special variations, gain settings, etc., can be tailored to your system at no extra cost.



FULLY TWO YEARS AHEAD of the FIELD!



Electro Instruments, Inc.

3540 AERO COURT
SAN DIEGO 11, CALIF.

Circle No. 9 on Subscriber Service Card.

AUGUST 17, 1959

AUG 1959
PUBLIC
LIBRARY
Houston Texas



'S EXPERIMENTAL
LAS NOSE CONE

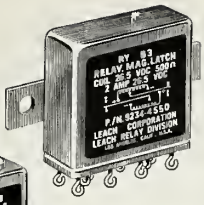
missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

ast Fights for Missile Dollars . . . 17
emands of Engine Controls . . . 23
PU's—Missile Muscles 31

AN AMERICAN AVIATION PUBLICATION

TYPE 9234-4550 2PDT, 2AMP, MAGNETIC LATCH RELAY



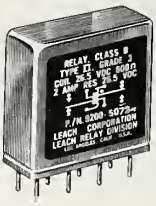
(BRACKET MOUNTING, SOLDER HOOK TERMINALS, HERMETICALLY SEALED)

TYPE 9200-5091 2PDT, 2AMP, RELAY



(STUD MOUNTING, SOLDER HOOK TERMINALS, HERMETICALLY SEALED)

TYPE 9200-5072 2PDT, 2AMP, RELAY



(PLUG-IN OR PRINTED CIRCUIT MOUNTING, HERMETICALLY SEALED)

LEACH SUBMINIATURE CRYSTAL CAN RELAYS

(SHOWN ABOVE...ACTUAL SIZ

torture-tested to perfection for big relay performance

These sensitive Leach subminiature relays deliver big relay performance . . . in a crystal can size that makes them ideal for use in missile control circuits in airborne or ground equipment and in computer and printed circuits.

Torture-tested to perfection in the Leach Production Reliability Center, these subminiatures are designed to meet the critical extremes of vibration, shock and other stringent environmental requirements in military and commercial applications.

They meet the specifications of both MIL-R-25018 and MIL-R-5757C—as well as MIL-R-6106C, *including the minimum current test requirements.*

Uniform contact pressure and overtravel are guaranteed for the life of these balanced-armature relays. They are available in a wide range of socket, stud and bracket mountings to meet specific customer requirements.

Write today for Leach Crystal Can Relay Brochure containing specifications, typical ratings and other information on these subminiatures! Or contact your nearest Leach sales representative to discuss your specific subminiature relay requirements.

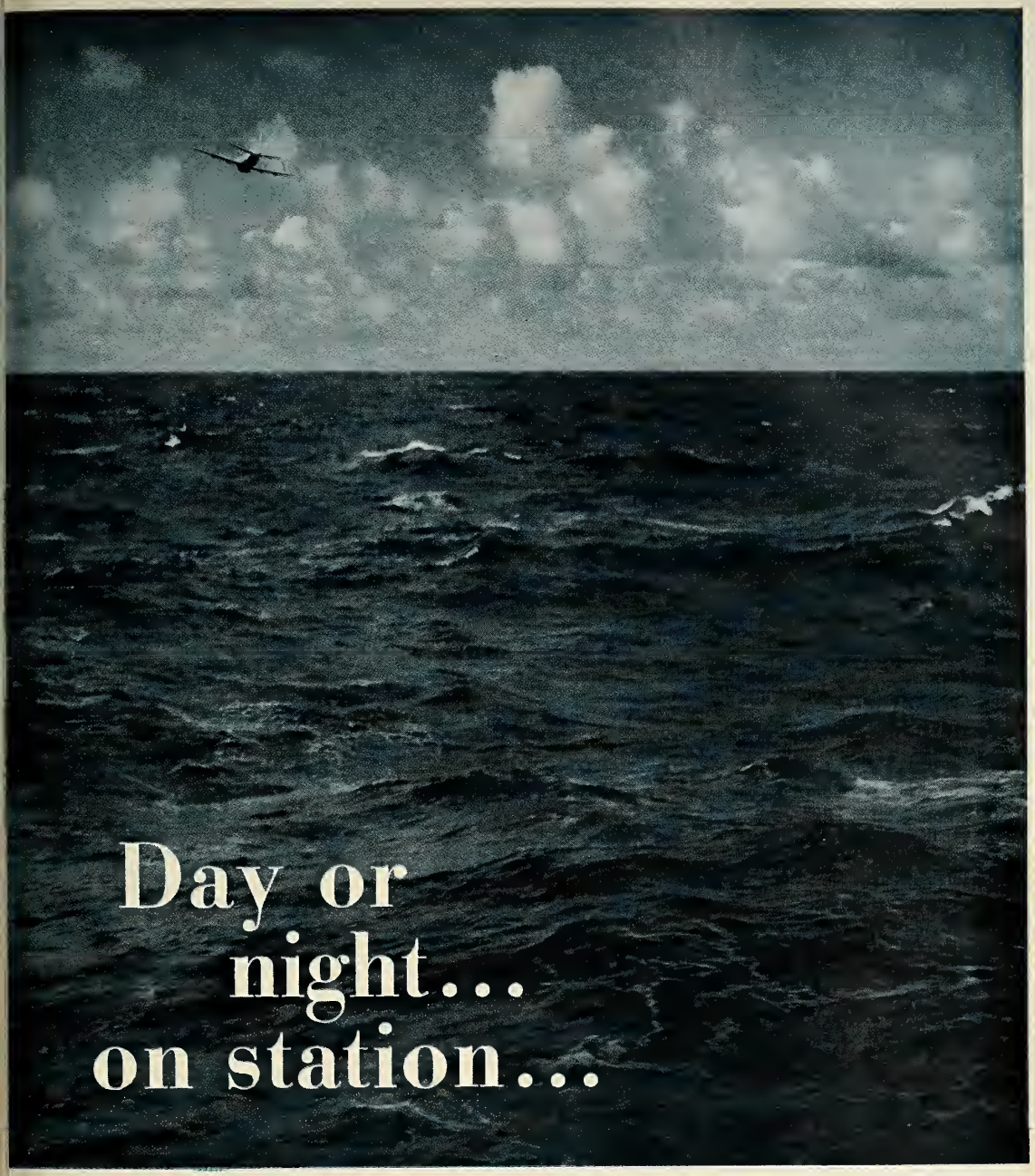
RELIABILITY

LOOK TO LEACH

RELAY DIVISION...LEACH CORPORATION

5915 AVALON BOULEVARD, LOS ANGELES 3

DISTRICT OFFICES AND FIELD REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA • EXPORT: LEACH CORP., INTERNATIONAL DIVISION



Somewhere at sea, crews of U.S. military patrol aircraft are intent on preventing a surprise attack by enemy bombers. Critical to the success of this patrol network is continuous knowledge of position and attitude.

For all missions of long flight times, Autonetics has developed and produced stellar-monitored inertial navigation systems of maximum accuracy and reliability. These systems make use of periodic starlight information... day or night... to correct for the gyro drift inherent in all pure inertial systems.

Autonetics stellar-inertial subsystems are now being produced for the advanced supersonic B-70 bomber, and to meet requirements for AEW... BMEW... reconnaissance... and tanker aircraft.

Stellar-Inertial navigation by Autonetics

A DIVISION OF NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA—REGIONAL OFFICES: WASHINGTON, D.C. AND DAYTON, OHIO

INERTIAL NAVIGATION / ARMAMENT CONTROL / FLIGHT CONTROL / COMPUTERS AND DATA PROCESSING

SPACE COMMUNICATION ANTENNAS



ANDREW

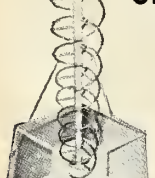
Quad-Helix antenna

tracks long and medium-range missiles

Telemetry circuits between missile (or satellite) and ground station are reliably maintained with the ANDREW Quad-Helix Array. This system offers low VSWR, high gain, and easy control.

Gain is 17.5 db at 265 mc, 14.5 db at 215 mc. VSWR is less than 2.0:1 across this range. Polarization is right hand circular; impedance 50 ohms. Counterbalanced rotator provides 180° elevation and 720° azimuth tracking at speeds from 0° to 30° per second.

Optional remote control unit regulates speed and direction.



OTHER ANDREW GROUND-AIR ANTENNAS

TRI-HELIX ANTENNA

880-990 MC 17.5 DB GAIN TYPE 81068

HELIX ANTENNAS

FREQUENCY	GAIN	TYPE NUMBER
108-132 mc	12 db	H 19110 A-1
215-265 mc	10.5 db	H 50140 A
215-265 mc	13 db	H 19110 A-2
260-320 mc	13 db	H 19110 A-3
320-400 mc	13 db	H 19110 A-4
400-500 mc	12 db	H 19110 A-5



DISCONE ANTENNAS

FREQUENCY	TYPE NUMBER
25-50 mc	50154
50-108 mc	51150
108-215 mc	19050-1
215-420 mc	19050-2
420-1000 mc	19050-3

VISIT WESCON BOOTH 2001

Andrew CORPORATION

363 EAST 75th STREET • CHICAGO 19

Offices: New York • Boston • Los Angeles Washington, D.C. • Toronto

For full information on these and other ANDREW ground-air antennas, write today for Bulletin 8456

Executive Editor .....CLARKE NEWL
Managing Editor ....DONALD E. PER

NEWS STAFF
News Editor .....REED BUI
Defense and Legislative .....BETTY OSW
JAMES B
West Coast .....RICHARD VAN OS
Copy Editor .....ERICA K
Editorial Assistant .....DAVID NEWM

ASTRIONICS
Guidance and Control ....CHARLES D. LAF
Support Equipment .....HAL GETTI

ASTRONAUTICS ENGINEERING
Chemistry & Propulsion .....JAY HOL
Astrodynamics .....PAUL ME

MISSILE SUPPORT
Installations and Equipment
East Coast .....WILLIAM E. HOW
West Coast .....FRANK McGU

BUREAUS
Los Angeles .....FRED HUN
Paris .....JEAN-MARIE RI
Geneva .....ANTHONY VAND

CONTRIBUTORS
British Astronautics .....G. V. E. THOMP
Propulsion .....MICHAEL LOREI
Industry .....JAMES J. HAGGERTY,
Soviet Affairs .....DR. ALBERT PA
Space Medicine .....DR. HUBERTUS STRUGH
Astrophysics .....DR. I. M. LE
Research .....HEYWARD CANNEY,

ADVISORY BOARD
DR. WERNHER VON BRAUN . ROBERT P. HAVIL
DR. PETER CASTRUCCIO DR. ARTHUR KANTROW
CONRAD H. HOEPPNER DR. EUGEN SAEN
R. F. GOMPERTZ ALEXANDER SA

PRODUCTION AND ART
Art Director .....WILLIAM MAR
Assistant Art Director .....BACIL GUI
Production Manager .....J. F. WA
Ass't Production Manager .....ELSIE G

BUSINESS STAFF
Publisher ..... E. D. MUHLF
Advertising Sales Manager .....W. E. BRO
Eastern Advtg. Manager ..... P. B. KIN
Circulation Director .....L. L. BRETT
Promotion Manager .....J. E. MULI
Advtg. Service Manager ..MRS. GLADYS BUSS

ADVERTISING OFFICES
New York .. (20 East 46th St.) P. N. ANDERS
A. B. SCHEFF
Detroit ...(201 Stephenson Bldg.) K. J. WI
Chicago .....(139 N. Clark St.) G. E. YO
Los Angeles .(8929 Wilshire Blvd.) J. W. CL
C. R. MARTZ,
Miami .....(208 Almeria Avenue) R. D. HA
Toronto (12 Richmond St. E.) ALLIN ASSOCIA
London .....(28 Bruton St.) NORALL & H
Paris .....11 Rue Condor
Geneva .....10 Rue Gre

Missiles and Rockets Volume 5 Number 3

Published each Monday by American Aviat Publications, Inc., 1001 Vermont Ave., N. Washington 5, D.C. Wayne W. Parrish, *Pr dent*; Leonard A. Eiserer, *Executive Vice Pr dent & General Manager*; A. H. Stackpole, F S. Hunter, Eric Bramley, Robert R. Parri *Vice Presidents.*

Printed at the Telegraph Press, Harrisburg, Second class postage paid at Washington, D and at additional mailing offices. Copyri 1959, American Aviation Publications, Inc.

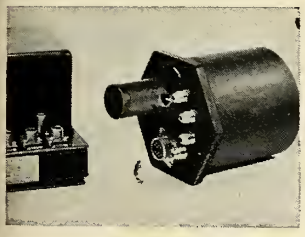
Subscription rates: U.S., Canada and Post Union Nations—1 year, $8.00; 2 years, $12.0 3 years, $14.00. Foreign—1 year, $10.00; years, $18.00; 3 years, $26.00. Single cop rate—$.75. Subscriptions are solicited onl from persons with identifiable commerci or professional interests in missiles an rockets. Subscription orders and changes address should be referred to Circulatio Fulfillment Mgr., M/R, 1001 Vermont Ave Washington 5, D.C. Please allow 4 week for change to become effective and enclos recent address label if possible.



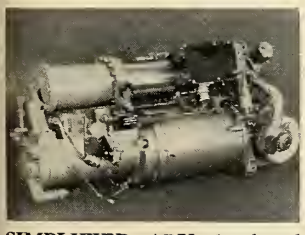
COVER: An Air Force experimental *Atlas* ICBM nose cone, which on July 21 became the largest re-entry vehicle recovered after intercontinental flight. Built by GE.



VACUUM-jacketed liquid hydrogen transfer line 2000 feet long connects Air Products' West Palm Beach, Fla., plant with a Pratt & Whitney test area. See report on liquid hydrogen, p. 21.



PART of propellant utilization control system produced by Servomechanisms, Inc., to provide for simultaneous depletion of missile engine fuel and oxidizer. See controls story, p. 23.



SIMPLIFIED APU developed by AiResearch uses only half the valves and parts of conventional units and can be modified for use with solid propellants. See APU story, p. 31.

missiles and rockets ®

MAGAZINE OF WORLD ASTRONAUTICS

AUGUST 17 HEADLINES

East Fights for Prime Missile Contracts
Business amounts to $1 billion a year in New York alone, but there's a dearth of prime contracts. First of a series on the Middle Atlantic States 17

Air Force Wants Added Billions and Authority
It stresses third generation ICBM, military satellites, maneuverable vehicles, *ALBM*, and moon bases. First of a series on Pentagon planning 19

Project *Tepee* May Undercut Need for BMEWS
But the new development will only supplement *Midas* 45

***Explorer VI* Gives NASA New Tracking Capability**
Solar-celled power unit slated for deep space probe 46

Cost, Handling Problems Knock Out Boron Program
Production curtailed after $200 million R&D expense 48

MISSILE SUPPORT
U.S. Reg. Pdg.

Nation's Liquid Hydrogen Output Rises
Industry-government cooperation is building large tonnage plants for the "ultimate" chemical fuel—until recently a laboratory curiosity 21

ASTRONAUTICS ENGINEERING
U.S. Reg. Pdg.

Engine Controls Are Demanding New Art
Environmental demands are running ahead of component improvements; much effort is given to improving servo loops 23

ASTRIONICS

APU's—An Oft-neglected $25 Million Business
Report shows that gas-turbines are first choice for missile auxiliary power units, with batteries close behind; exotic sources still in the future; crash programs make complications 31

THE MISSILE WEEK
U.S. Reg. Pdg.

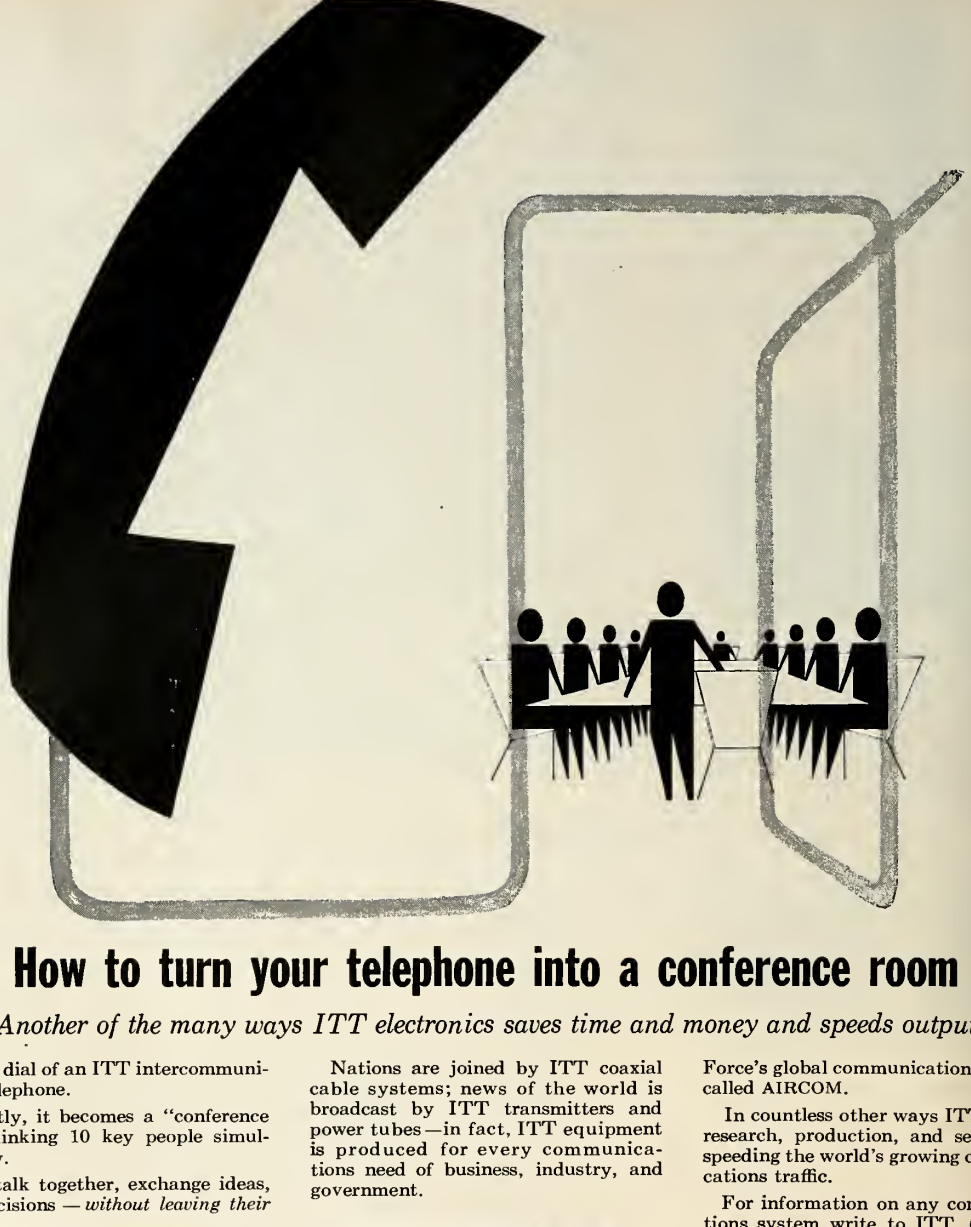
Washington Countdown 9
Industry Countdown 15, 40

DEPARTMENTS

Missile Business	36	Propulsion Engineering ..	44
Contracts	38	When and Where	49
People	42	Editorial	50

NEXT WEEK

Telemetry Receivers: A 'Coasting' Industry
Batteries Outlook for Space
Reds Research Lightning as Weapon



How to turn your telephone into a conference room

Another of the many ways ITT electronics saves time and money and speeds output

Flick the dial of an ITT intercommunication telephone.

Instantly, it becomes a "conference room"—linking 10 key people simultaneously.

They talk together, exchange ideas, reach decisions — *without leaving their desks!*

ITT electronics—a help for business

This ten-party conference telephone is one of hundreds of ideas developed by ITT's Kellogg Switchboard and Supply Company and other ITT units to help perform tasks—faster.

ITT supplies telephone systems for entire countries. It develops communications and guidance for missiles; radio aids for aircraft and ships; microwave systems that control the flow of oil, gas, and electric power.

Nations are joined by ITT coaxial cable systems; news of the world is broadcast by ITT transmitters and power tubes—in fact, ITT equipment is produced for every communications need of business, industry, and government.

Skills for international projects

ITT has decades of experience in operating nationwide telephone networks. ITT System commercial circuits—cables, radiotelephone, radiotelegraph, and marine radio—cover the earth.

An ITT System company operates and maintains the 3,000-mile DEW Line in the Arctic, the White Alice communication network in Alaska, and other vital lifelines of defense. ITT has the senior part in planning the modernization and extension of the Air Force's global communications conce called AIRCOM.

In countless other ways ITT Syst research, production, and service speeding the world's growing commu cations traffic.

For information on any communi tions system write to ITT, 67 Bro Street, New York 4, N.Y.

ITT

. . . the largest American-owned world-w electronic and telecommunication enterpri with 101 research and manufacturing units, operating companies and 130,000 employe

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION 67 Broad Street, New York 4, N.Y.

ITT COMPONENTS DIVISION • ITT FEDERAL DIVISION • ITT INDUSTRIAL PRODUCTS DIVISION • ITT LABORATORIES • INTELEX SYSTEMS INCORPORAT AIRMATIC SYSTEMS CORPORATION • KELLOGG SWITCHBOARD AND SUPPLY COMPANY • ROYAL ELECTRIC CORPORATION • AMERICAN CABLE & RAD CORPORATION • FEDERAL ELECTRIC CORPORATION • ITT COMMUNICATION SYSTEMS, INC. • INTERNATIONAL ELECTRIC CORPORATION • INTERNATION STANDARD ELECTRIC CORPORATION • LABORATORIES AND MANUFACTURING PLANTS IN 20 FREE-WORLD COUNTRIES



OUTPERFORMING all operational target missiles, Ryan's *transonic* Firebee has just set new world's records for altitude and duration-at-altitude.

...it flies *higher*—59,000 feet

...it flies *longer*—96.8 minutes *(77½ minutes above 50,000 feet!)*

...it flies *faster*—Mach .95

Now being produced for the Air Force (Q-2C version), Ryan's new *transonic* Firebee contains advanced, built-in auxiliary devices to better simulate enemy aircraft. It has the performance needed to challenge America's most advanced weapon systems under realistic combat conditions.

The *transonic* Firebee is the result of Ryan's unmatched ten years of design and operational experience in the jet target field.

In 1949, Ryan built the first jet target missile ... today more Firebees are in service—with the Air Force, Navy, Army, and Royal Canadian Air Force—than all other jet targets *combined*... and now, with this new *transonic* Firebee, Ryan gives proof again of its continued leadership in the design and development of jet targets.

RYAN OFFERS CHALLENGING OPPORTUNITIES TO ENGINEERS

RYAN BUILDS BETTER

AIRCRAFT · POWER PLANTS · ELECTRONICS

Ryan Aeronautical Company, San Diego, Calif.

COUNT DOWN

for the conquest of space



"MISSION ACCOMPLISHED: DEPARTING LUNA 2205 ZEBRA"

This message, flashed across a quarter-million miles to Washington, D.C., will be awaited anxiously by millions.

But even then our first expedition to the moon will still face its most crucial test—the journey home to earth.

The success of that trip will depend in large part on rocket propellants—fuels and oxidizers that will have been stored for days in the tanks of the expeditionary vehicle and yet will respond instantly when needed.

Storable liquid propellants is one of the fields in which Rocketdyne has anticipated the future. For more than ten years, its propellant chemists have been studying, engineering, and testing combinations of storable fuels and oxidizers for greater storability and higher energy.

Storability PLUS high energy

Rocketdyne has tested these combinations in all production and experimental engines. The results prove that today's storable fuels and oxidizers have these important capabilities:

(1) High performance, even after months or years of storage; (2) Stability over a wide temperature range, permitting storage in missile tanks without rigid environmental controls; (3) Dependable performance, predictable even at extremes of heat and cold; (4) Instant readiness for firing at any time during the storage period; (5) Energy yields equal to or higher than those of conventional propellant combinations.

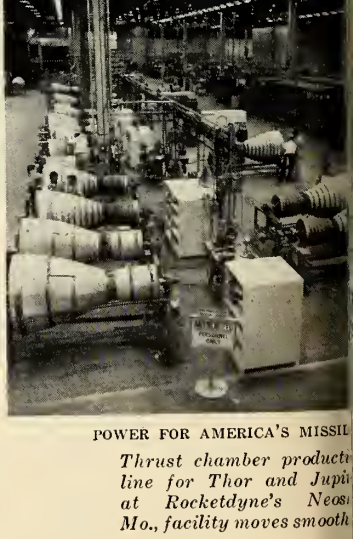
Second-generation missiles

The tests also prove that engines developed for conventional propellants can be converted to storable combinations rapidly and inexpensively—a significant consideration in the development of second and third gene tion strategic, tactical, and air fense missiles.

Significant, too, is the *potent* performance of storable combi tions. Research points to energy yie as high as 400 seconds of altitu specific impulse—performance 20 p cent higher than that of today's co binations. These high-energy yie will offer new capabilities and grea flexibility for America's scientific a military programs.

Stepping stones to Space

Rocketdyne has designed and bu much of today's operating hardwa in the high-thrust rocket field. E gines by Rocketdyne power most the military and scientific projec



POWER FOR AMERICA'S MISSIL

Thrust chamber producti line for Thor and Jupi at Rocketdyne's Neos Mo., facility moves smooth

sponsored by Air Force, Army, a NASA. This experience now becom the point-of-departure for tomorrow journeys into the unknown.

FIRST WITH POWER FOR OUTER SPACE

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

Washington Countdown

IN THE PENTAGON

Davy Crockett is seen . . .
more and more as the Army's limited war weapon par excellence. *Davy*—an in-house project at Rock Island, Ill.,—is reported to be designed to carry a nuclear warhead of sub-kiloton yield. The still secret missile will be fired by a GI from a bazooka tube.

• • •

The Navy is pushing . . .
for a joint space command to operate the vast military space and missile facilities on the West Coast. Of course, such a command would include the huge new Pacific Missile Range.

• • •

Lack of missile ranges . . .
in Western Europe will lead to the increasing use of U.S. ranges for the training of European NATO missile units. Suggestions that France open up its Sahara Missile Range south of Colomb Bechar for NATO training have received a very chilly reception in Paris.

• • •

The cut in B-58's . . .
from 40 to 32 for FY '60 is only a sign that the bombers cost more than anticipated—not a sign that manned bombers are being phased out in favor of missiles—at least so far. The Mach 2 B-58 price tag: about $15 million each.

• • •

The codeword *Agena* . . .
is ARPA's new name for the orbiting upper stage of its *Discoverer* vehicle. The **Lockheed** upper stage is powered by the **Bell** *Hustler* liquid engine.

• • •

The smart money . . .
now is on an early September launching of an operational **Convair** *Atlas* from Vandenberg AFB. The successful launching of an *Atlas* from Cape Canaveral Aug. 11 appeared to cinch the matter.

ON CAPITOL HILL

The last act . . .
of the Hébert Investigation may not come until shortly before Christmas. The House subcommittee probably will adjourn its investigation of the so-called "munitions lobby" when Congress quits for the year—sometime in the next few weeks. The hearings then would be resumed about early December for an airing of some specific cases.

Congressmen are worried . . .
over the possible development by Russia of poison gas missiles. Experts have told the House Space Committee that chemical warfare could be as dangerous an all-out threat as nuclear war . . . and more advantageous to the enemy.

AT NASA

NASA's deep space probe . . .
schedule this fall includes one moon orbit and one sun orbit. An attempt will be made to orbit the *Atlas Able IV* vehicle around the moon about Oct. 8—the date when the moon is farthest south. In December, NASA will attempt to send *Thor Able IV* to join *Mechta* and *Pioneer IV* as a miniature satellite of the sun, but with a transmitter which would send information to earth from as far away as 50 million miles.

• • •

Amateur hams and astronomers . . .
are furious over NASA's decision not to release the frequency of *Explorer VI's* big 40-watt transmitter. NASA contends that the frequency must be kept secret because it is one used by the military. The hams contend NASA released similar information on *Pioneer IV's* frequency. Among the protesters is a group of scientists at the Case Institute of Technology and **Standard Oil** in Cleveland. They have their own satellite tracking station and were one of the few western groups to track the Russian *Mechta*.

AROUND TOWN

Speculation is . . .
that the Soviets may try to strengthen the hand of Premier Krushchev on his U.S. visit by either orbiting the moon or sending man into space. The most favorable astronomical time for a moon shot would be a few days before the beginning of Krushchev's visit on Sept. 15. That would give the Soviets time to determine the success of the launching before the visit and "to time the announcement" with his arrival.

• • •

Sept. 5 is a likely time . . .
for the Russians to announce a manned space flight—simple ballistic trajectory. It's the birthday of Russian rocket pioneer Konstantin Ziolkovsky.

• • •

Shipments of *Nikes* . . .
will soon be heading for Denmark. The Danes are expected to be sent a total of 40 **Western** Electric *Nikes*—some *Ajax*, some *Hercules*.

VĀP-AIR'S YEARS OF EXPERIENCE CAN SAVE YOU HUNDREDS OF SPECIALIZED MAN-HOURS in solving critical thermal control problems

a case in point:

sophisticated problem:

AIR TEMP CONTROL IN MACH 2 MANNED CRAFT

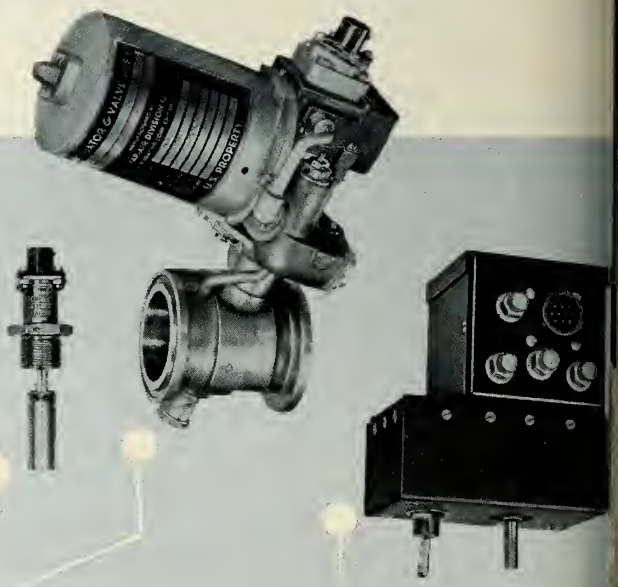
Needed:

absolute accuracy under severe G conditions, light weight, safety in case of electrical failure, sensitivity throughout a wide ambient temperature spectrum, low initial cost, simple maintenance, interchangeable parts for 3 complete air temp systems:

cabin temperature
pressure suit
electronic compartment



NAVY A3J Vigilante
Mach 2 aircraft



simple solution

VĀP-AIR ELECTRO-PNEUMATIC CONTROL SYSTEM

The 3 basic components shown at right, interconnected by VĀP-AIR designed electrical circuits met all these requirements...with response rates full open to full close of less than three seconds. Because all pick-ups and valves have the same resistance value, several systems for one craft can use the same parts!

DUCT TEMPERATURE SENSOR
One of many types made by Vapor, including thermistors, wire-wound resistance-temperature pick-ups, mercury contact thermostats, or the new MERCISTOR.

VALVE AND ACTUATOR
Two types: ON-OFF; or full-modulating, variable opening. Considerably lighter and smaller than electric valves, lighter than other pneumatic valves. Provides accurate hot and cold air proportioning. Other coaxial designs available for minimum envelope and rugged light weight.

CONTROLLER
Automatic or manual precision Magnetic Amplifier Power Controller acts as temperature controller, power converter, and transformer. Safe, simple, rugged, reliable!

CALL ON VĀP-AIR FOR SYSTEMS ENGINEERING AID WHENEVER A TEMPERATURE CONTROL PROBLEM ARISES:

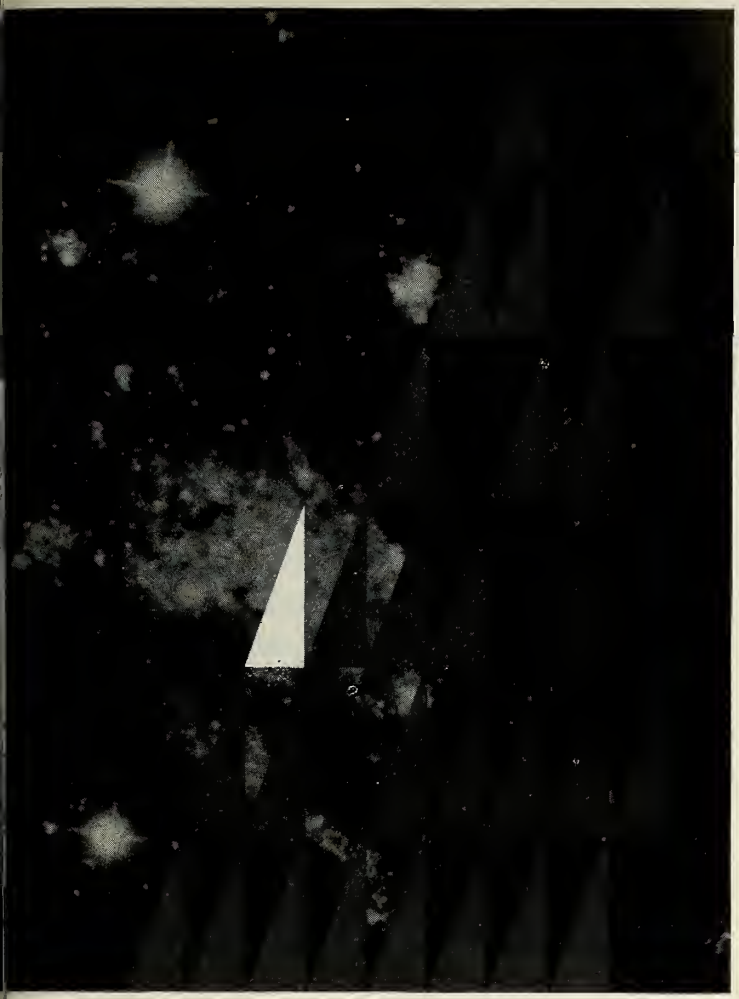
AIR TEMPERATURE: Instrument & electronic compartments, cabins, cockpits, windshield and wing anti-ice.

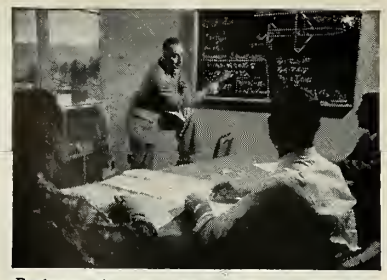
LIQUID TEMPERATURE: All liquids, including fuel systems, batteries, exotic rocket fuels, H_2O_2, acids.

SURFACE TEMPERATURE: Anti-icing, de-icing, nacelles, primary heat exchangers, generators, alternators, canopies, bearings, gyroscopes, accelerometers.

Detailed data and problem analysis for those who design for flight. Write on your letterhead, specify type of equipment or nature of problem.

VĀP-AIR
The Aeronautical Division of
VAPOR HEATING CORPORATION
80 E. Jackson Blvd., Chicago 4, Ill. Dept. 26-H.
Vapor Heating (Canada) Limited
3955 Courtrai Ave., Montreal 26, Quebec

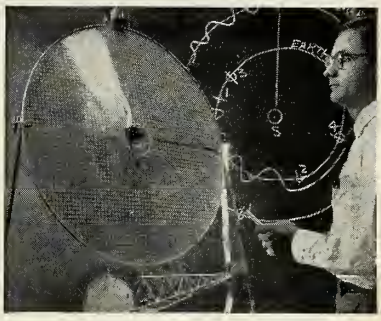




Boeing engineers work in small groups. Ability and initiative get plenty of visibility.



Test of ballistic missile propulsion system. Other tests cover space vehicle control units.



1/20th scale model of unmanned Martian reconnaissance vehicle, a Boeing study project.

Environment for Dynamic Career Growth

for Engineers and Scientists

Ability is important in getting ahead in engineering and science. But of almost equal importance is the environment in which you work. A dynamic environment that provides challenge and scope, unexcelled facilities, and plenty of room at the top, can accelerate your advance to higher levels of responsibility and income.

This is the kind of environment you'll find at Boeing... pictured and described in Boeing's new 24-page booklet, "Environment for Dynamic Career Growth."

The booklet, in addition, reports on engineering and science assignments in connection with current Boeing projects—from advanced military and commercial jet aircraft to space vehicles, guided missiles and intercontinental ballistic missiles. It also outlines Boeing research and development activities, and documents the dynamic Boeing environment that fosters career growth of engineers and scientists.

There are openings at Boeing, now, for engineers and scientists of all categories, all experience and educational levels. A Boeing assignment in Research, Design, Production or Service could be the answer to *your* future.



Mr. Stanley M. Little
Boeing Airplane Company
P. O. Box 3822-MIF
Seattle 24, Washington

Please send me a free copy of "Environment for Dynamic Career Growth."

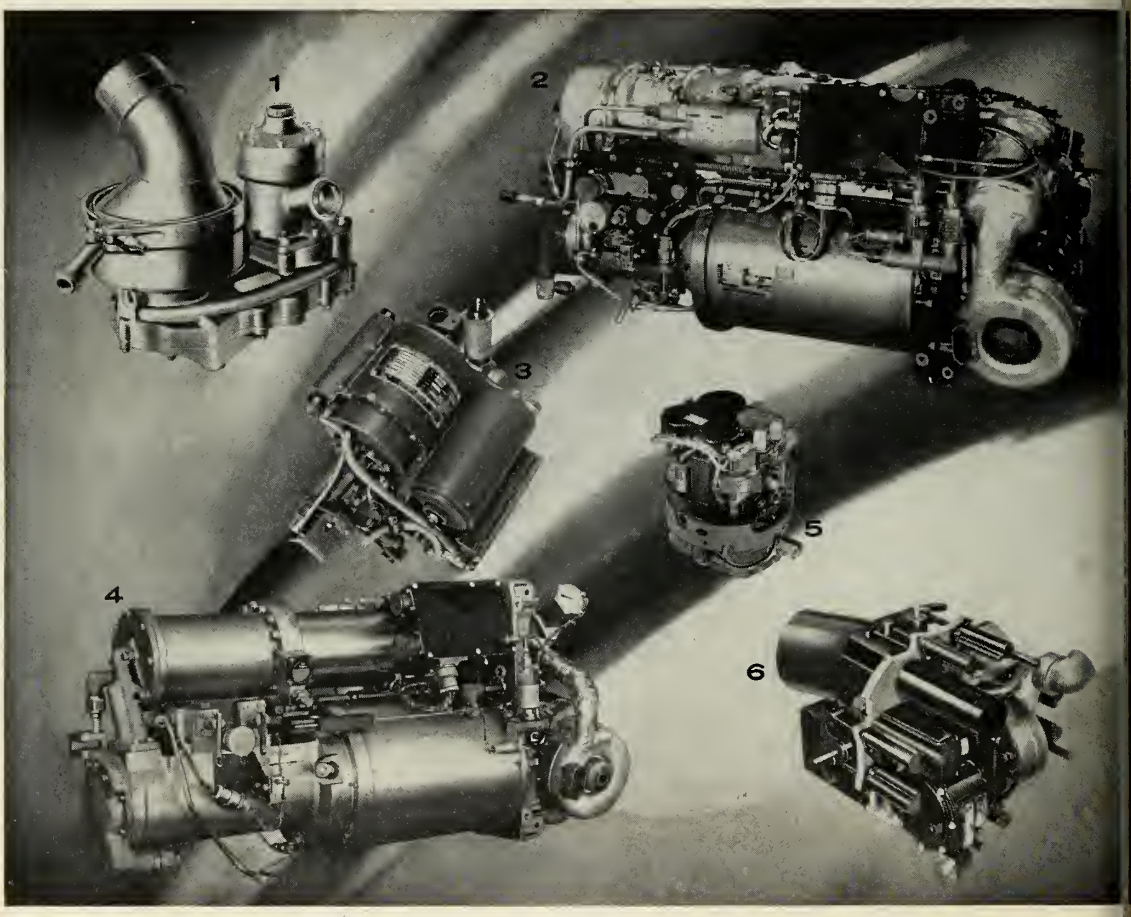
Name.....

Address.....City.....State.....

Degree(s).....

Field of Interest.....

DELIVERED—thousands of missile APUs



1. *Solid propellant—hydraulic output* 2. *Liquid propellant—hydraulic and electric output* 3. *Solid propellant—electric and mechanical drive out*
4. *Liquid propellant—hydraulic and electric output* 5. *Solid propellant—hydraulic and electric output*
6. *Solid propellant—hydraulic, electric and steering outputs*

AiResearch has designed, developed, manufactured and delivered thousands of missile accessory power units. Extremely reliable and lightweight, these various solid and liquid monopropellant APUs are completely self-sustaining within the missile system. Designed to minimum space and weight requirements, they are built to withstand high G loading and severe temperature extremes.

The several units pictured above provide hydraulic, electrical and/or steering surface control depending on the customer's requirement. Delivered horsepower ranges from 1.2 to 35 h.p. over hot gas operating durations from 30 seconds to 20 minutes. Electrical regulation is maintained as closely as ±½%. A significant advance in missile APUs is unit #6 pictured above. This package represents the first integrated hydraulic and electrical power unit providing a steering surface actuation syst

These tailored systems utilize extensive hardware experience complete laboratory, test and pro tion facilities of AiResearch nee for quick and efficient quan production of complex APU syste AiResearch is the world's largest most experienced manufacture lightweight turbomachinery — the component of its APU systems. Y inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIO

SYSTEM DEVELOPMENT CORPORATION

is currently seeking scientists and engineers in various skill areas. As part of this effort, I have been given the opportunity to tell you something about our organization.

Let me begin by giving you some general facts about the Corporation: SDC is a non-profit organization chartered to work in fields pertaining to public welfare, the advancement of science, and national defense. The Corporation's name implies its function—the development of systems. Specifically, we are concerned with large, complex information processing systems with a high degree of automation. Development of these systems is accomplished through the application of knowledge in the areas of applied mathematics, engineering, and psychology, to problems of over-all system design, data processing techniques and optimum man-machine relationships.

Our work is system-oriented, rather than concerned with the design or manufacture of hardware components. As a result of this type of specialization, we have assumed major responsibilities in the development of systems such as the SAGE (Semi-Automatic Ground Environment) Air Defense System and the world-wide Strategic Air Command Control System, and in the integration of the functional responsibilities of these systems with other military electronic support systems.

Because the scope of our activities is rapidly increasing, we are expanding our staff. In this message I am specifically addressing young engineers with advanced training and proved analytical ability in the areas of weapons system analysis, noise and information theory, ECM, electromagnetic intelligence and allied fields. If you are qualified, and our corporate activities sound interesting to you, we would like to hear from you. Address inquiries regarding our Santa Monica, California facility to Mr. R. W. Frost, 244 Colorado Avenue, Santa Monica, California. Inquiries regarding our Lodi, New Jersey facility should be addressed to Mr. R. L. Obrey, Box 2651, Grand Central Station, New York 17, N.Y. These gentlemen will see that your letter receives prompt attention and confidential treatment."

David Green

David Green, Assistant Director for Plans, Operations and Management Research Directorate



SDC

SYSTEM DEVELOPMENT CORPORATION

SANTA MONICA, CALIFORNIA · LODI, NEW JERSEY



AEROJET-GENERAL CORP®

THE GENERAL TIRE

A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPANY

(Plants at Azusa and near Sacramento, California; and Frederick, Maryland)

Engineers, scientists—investigate outstanding opportunities at Aerojet.

Industry Countdown

MANUFACTURING

Total of 6000 *Sidewinders* . . .
will be produced in Europe—5000 by **Bodenseewerk Perkin-Elmer** of Ueberlingen, Germany. The air-to-air missiles will go aboard **Lockheed** F-104G's, which are being bought in quantity by West German Air Force. *Nord* 5103 will be standard armament of **Fiat** G-91 lightweight fighters also being supplied to West Germany.

• • •

Still alive. . . .
transpiration cooling for re-entry. **General Electric's** Missile and Space Vehicle Department, Philadelphia, is devoting considerable research effort in this direction. Needed: proper materials.

• • •

All-out campaign . . .
for missile business is being cranked up by **Bethlehem Steel.** Despite late start, company figures it soon can equal and pass **U.S. Steel's** present lead in field of high-strength, high-temperature steels.

• • •

New Pacific press brake . . .
(with 500-ton push) is being used by **Boeing Airplane** to hasten developments in titanium and other high-temperature metal shaping.

• • •

Re-shaping *Titan* nose cone . . .
for faster re-entry is called for in $73 million Air Force contract awarded **Avco's** Research and advanced development division. Aim is to nullify enemy countermeasures. New design will require development of materials with greater heat tolerances.

PROPULSION

Multi-vehicle lunar . . .
expedition will have greater chance of success in the opinion of ABMA's Dr. Wernher von Braun. He proposes that instead of single vehicle, the operation include about six *Saturn* vehicles to serve as tankers for a seventh, which would carry a returnable payload.

• • •

Industry can solve . . .
orbital refueling problems, says von Braun, if it devotes all the engineering attention they require. The rocket expert says all three military services and NASA would have to pitch in together on logistical support of a moon mission—much like the all-out Navy support of Admiral Byrd's South Pole expedition.

ELECTRONICS

Inside word has it . . .
that both operational *Atlas* and *Titan* ICBM's originally scheduled for gas-turbine APU's will have to fall back on battery units. Reason: Inability to meet extreme design specs within development time allowed.

• • •

Difficulty in getting . . .
"on target" with narrow band (7°) radar is causing modification of Pacific Missile Range's FPS-16 tracking radar to incorporate optical acquisition.

• • •

DOD now is standardizing . . .
environmental requirements for electronic components. MIL-STD-446 sets forth eight "discrete levels" of environmental conditions applicable to equipment and component design. In the past, parts have been designed to withstand random conditions. Standard also is aimed at ultimate reduction of multitude of electronic items entering military supply channels.

WE HEAR THAT—

Latest wrinkle in . . .
hydraulic fluids is a metal with low melting point. Fluid would be held by metal seals perhaps at 1000°F and 6000 psi . . . Joint French-German research center at St. Louis, France, is being modernized. Facility dealing primarily with ballistic problems is 50-50 proposition with two chief execs—one German and the other a Frenchman . . . Although delivery isn't required until next year, **Bristol Aircraft Ltd.** has just supplied Sweden with the first of a batch of *Bloodhound* surface-to-air missiles to facilitate training program for initial unit to be located at Norrtälge . . . Need for working as well as equity capital brought on merger of **C. T. L. Inc.,** creator of first U.S. ablation re-entry nose cone (for *Jupiter),* with **Studebaker-Packard**—which is now diversifying into the missile industry . . . **General Electric's** Lamp Metals and Components Department, Cleveland, is offering pure molybdenum "HD" sheets with five times the room temperature ductility of ordinary moly . . .

• • •

Molybdenum has cut the price of consumable electrode "Climelt" pure moly and moly alloys from $9.85 a pound to $8.00. . . .

(Continued on page 40)

NEWS IS HAPPENING AT NORTHROP



Radioplane drones shown left to right: XQ-4B; RP-76; RP-77D; OQ-19; SD-1

RADIOPLANE CREATES FIRST FAMILY OF UNMANNED AIRCRAFT TO TRAIN MEN, EVALUATE WEAPON SYSTEMS, AND SURVEY ENEMY TERRITORY

Radioplane is the world's leading producer of drones and space age recovery systems. As live targets, drones perform as aircraft–then can be recovered by parachute. As evaluators, drones simulate the appearance of the enemy threat while they score our weapon systems' effectiveness. On surveillance missions, drones are zero-length launched, fly cameras, take photos, and return with information within minutes.

For 20 years Radioplane has led in the production of drones. Radioplane's leadership in the field typifies the years-ahead thinking that continues to produce design concepts for tomorrow, hardware for today–developed, produced, and delivered on time – at minimum cost to the taxpayer.

RADIOPLANE

Van Nuys, California, and El Paso, Texas
A Division of **NORTHROP CORPORATION**

irst of a Series

East Fights for Missile Dollar

Business booms in the New York industrial complex but area has yet to receive big prime missile contract— battle with California grows hotter in congress

by William E. Howard

NEW YORK—Inside the East oast's huge industrial complex sprawl- g from New York to Philadelphia, issiles today are big business. But ere are strident complaints that they ould be much bigger.

Missile manufacturing tops $1 bil- on a year in New York—yet the state oes not have a single major missile ime contractor. Some congressmen aim bitterly that California is getting r more than its rightful share. They e now fighting for legislation to roaden" geographical distribution of efense procurement. (California is ghting back.)

Over in New Jersey, despite the ck of a prime missile systems con- act, the picture is brighter. **Radio orporation of America** is prime con- acting BMEWS for an estimated 440 million and is heavily engaged radar, missile guidance and other ork, including test equipment for the rmy's anti-aircraft *Hawk*. And the ate generally is packed with missile omponent and electronic production.

At Philadelphia, **Philco Corp.** is co- ime with **General Electric,** Utica, .Y., on the Navy's air-to-air *Side- inder*. GE's Missile and Space Vehicle epartment in the "City of Brotherly ove" holds over $100 million in con- acts for *Atlas* and *Thor* nose cones nd the *Discoverer* satellite re-entry ehicle.

Throughout this industrial "heart- nd" there are scores of big and little rms hard at work on large missile sub- ontracts. Across Pennsylvania to ittsburgh, through "upstate" New ork to Buffalo and out on Long sland there are many more.

Defense Department procurement gures indicate that the total for all issile-related spending in the three- tate upper mid-Atlantic region is $3 illion or more.

• **New York slipping**—But industrialists and lawmakers fear that unless prime missile/space contracts are brought into the area, the industry will shrink. They point out that in 1961 missile appropriations very likely will equal the amount for manned aircraft, and after then, missiles will exceed aircraft spending.

One Long Island banker notes that during the Korean War, New York firms received 15.3% of the dollar value of prime contract awards, against 13.6% received by California firms. For fiscal 1958, New York slipped percentagewise to 11.6% while California climbed to 21.4%.

What does this mean in money? The banker says the shift in percentages when applied to huge missile programs translates into one billion dollars more for California than for New York.

Sen. Jacob K. Javits (R-N.Y.) puts it this way:

"At the present rate of acceleration, and with nearly $10 billion in prime missile contracts already awarded to California, New York can fall more than $3 billion behind California in defense procurement by 1961 . . ."

Javits is co-sponsor along with Sens. Kenneth B. Keating (R-N.Y.) and Clifford P. Case (R-N.J.) of S.1875, a competitive procurement act which they believe will have a scatter effect on future placement of missile contracts. At a Senate Armed Services subcommittee hearing last month on the measure, Javits declared that only $3.5 billion—15%—out of total defense procurement orders values at $23.8 billion is presently placed through competitive, formally advertised bids. And he added, "the proportion of negotiated contracts seems unusually high."

An aide of Sen. Javits commented to M/R this week that he had found the percentage of negotiated contracts "has increased with the number of retired military officers hired by defense contractors." He conceded: "This could be coincidence, of course."

• **Wants more open bids**—S.1875 spells out a Congressional directive to the Defense Department to replace negotiation with open bidding where there is no danger to national security. It would give prime consideration to small business; to concerns in labor surplus areas and to "eligible suppliers who have received the smallest share of business as well as being in different geographical areas of the nation."

Aerospace Industries Association opposes the Javits bill.

New York's congressional delegation touched off a transcontinental battle when they mounted a bi-partisan drive this year behind the competitive procurement bill. Californians retaliated in Congress. The Los Angeles Chamber of Commerce formed an "industrial task force to defend California's missile and aircraft defense business from further attacks by New York and other eastern legislators." The LA chamber has produced what New Yorkers call a "slick magazine presentation" detailing the state's "qualifications" for continued defense business. It is being distributed on Capitol Hill.

West Coast newspapers have added to the furor by implying the New York campaign is part of some strategy by Gov. Nelson Rockefeller to wrest the GOP presidential nomination from Vice President Richard M. Nixon, a Californian.

New Yorkers refuse to accept arguments that their state receives just as much missile business through subcontracts even though the prime is in California. They say subcontracting is erratic and that to build a stable missile industry New York should have prime systems contracts.

stubborn labor surplus . . .

• **Long Island growth**—While the verbal battle continues (no action is expected on S.1875 this session) New York industry is moving to snare a prime contract. **Grumman Aircraft Engineering Corp.,** principal subcontractor to the Navy *Eagle,* is in a $4 million expansion program. The firm is building a 55,000-square-foot center for complete avionics systems test, evaluation and development.

Recipient of military contracts exceeding $271 million in the past 12 months, Grumman's major production is aircraft for Navy anti-submarine warfare. It has created a small army of vendors in the state to which it paid $45 million last year.

Republic Aviation, the Island's other big aircraft company (F-105 interceptors) is constructing a $14 million R&D center and has under full steam a missile/space research program valued at $35 million. One Air Force project is trying to determine what vegetables will grow on the moon.

The state's two other aircraft concerns have hit rough going. **Fairchild Engine & Aircraft** sold a Long Island plant recently after cancellation of the Air Force *Goose* decoy missile. **Bell Aircraft** at Buffalo as a result of a cutback in military work has let go about half of its 12,000 employes in the past 18 months. Last week, however, the firm picked up three AF R&D contracts totalling $575,000, including one for developing a storable propellant flow system for rocket engines.

Sperry Rand Corp. is in the vanguard of Long Island's fast-expanding missile component industry. One division, **Sperry Gyroscope,** has been steadily enlarging facilities and its work force to produce SINS (ship's inertial navigation systems) for *Polaris* submarines; **Ford Instrument** is turning out computers for Navy *Talos, Tartar* and *Terrier* missiles and guidance controls for the Army *Jupiter.* In the past fiscal year Sperry has received defense awards exceeding $220 million.

Other vital missile systems and ASW devices are being developed and produced by **Hazeltine Corp.,** which has just purchased **Wheeler Laboratories** in New Jersey and which is now setting up a 50,000 square foot engineering laboratory on the Island.

Dynamic Gear, producer of miniature precision gears for missile guidance systems, is building a $200,000 plant at Amityville. At Westbury, **IMC Magnetics Corp.** (electro-mechanical missile components) is doubling its plant capacity. **American Bosch Arma,** Garden City, developer of missile fire control systems and space vehicles is one of the Island's leaders with $66 million in defense sales in the past year.

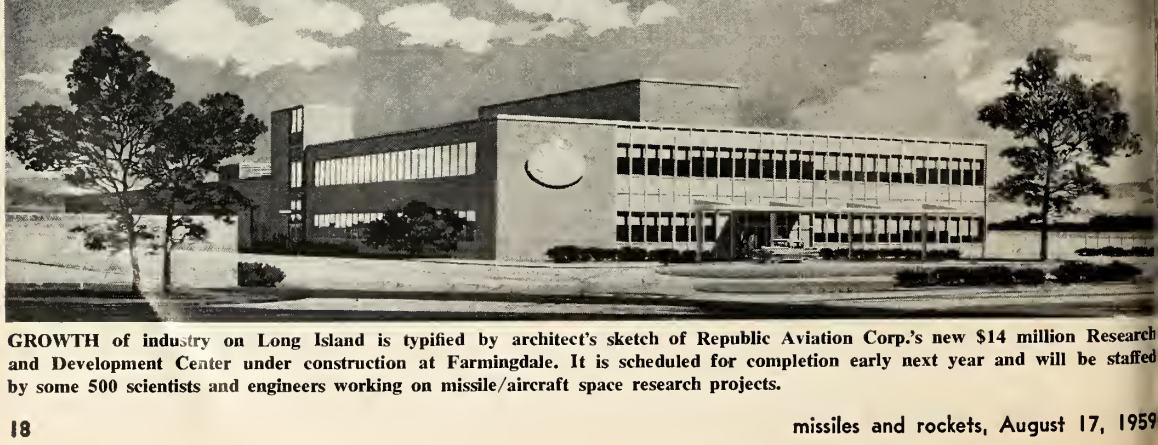
• **Missiles upstate**—There is considerable missile activity in metropolitan New York among such firms as **Yardney Electric,** which rolled up second quarter sales of $1.6 million with auxiliary power units (silver-zinc and silver-cadmium battery systems) for missiles, satellites and torpedoes. The company also is involved in ASW research and production. **Computer Systems Inc.** is developing tracking computers and plotters for the Pacif Missile Range, Point Mugu.

Just outside the city, **Stauff Chemical's** eastern research center Chauncey, N.Y., is working on mon propellants for the Navy; at Whi Plains **Chromalloy Corp.** is pushir explosive forming of refractory meta under a "substantial" Navy contra and **Polytechnic Institute of Brookly** is trying to come up with the answe for WADC as to why plastics crack i space environments.

Upstate at Poughkeepsie and King ton, **IBM** is making automatic dat processing machines and computer totalling some $140 million for mil tary customers.

In addition to its Utica *Sidewinde* operation, **General Electric** is makin high power acquisition radar for th improved *Nike-Hercules* and *Atla* guidance at its Syracuse plant. G New York plants have received cor tracts totalling some $160 million sinc July 1958. At Rochester, **Eastma Kodak** is fuzing and arming *Sidewinc ers* and *Sparrow III;* in nearby Corning **Corning Glass** is developing glass ceramic materials for nose cones. I the Buffalo area **American Machin & Foundry** is manufacturing *Titai* launchers and **Alco Products Inc.** i principal subcontractor of JATO meta parts for the Army's *Honest John.* An other Syracuse company, **Carrier Corp.** is a principal supplier of air condi tioners for missile systems.

There are hundreds more missil subcontractors all over the state. Bu officials say there are still surplus labo areas, notably around New York City This is why they are keeping up th battle to obtain some prime missil contracts.



GROWTH of industry on Long Island is typified by architect's sketch of Republic Aviation Corp.'s new $14 million Research and Development Center under construction at Farmingdale. It is scheduled for completion early next year and will be staffed by some 500 scientists and engineers working on missile/aircraft space research projects.

AF Wants Extra Billions for Space

It seeks to outstrip Soviets in third generation ICBM, military satellites, maneuverable spacecraft, ALBM and moon bases



SYMBOL of Air Force space effort is *Discoverer*, **the forerunner of the** *Sentry*.

Behind closed doors in the Pentagon, the nation's top military men are orking out the defense budget for FY 1961. Its effect on the nation's missile d space programs will be tremendous. Here is the first of a series of ticles on how the military men are thinking. NEXT WEEK: Navy planning.

by James Baar

WASHINGTON—The Air Force uld like to find two things in its cking this Christmas:

• An extra $5 to $7 billion for mis- e and space R&D.

• Much greater authority over the tion's space programs.

It won't get either. And it doesn't pect to get them. But both are ex- mely important to bear in mind. ey are strongly felt needs. And they m the parameters within which Air rce missile and space planning for e early 1960's is taking place.

Many Air Force officials see the xt several years as a great second nping off point in the East-West race r missile and space leadership.

They feel that R&D work done—not done—in these years could well termine the fate of the United States the late 1960's and early 1970's. herefore, they feel that the Air Force ould be permitted to push forward the job vigorously and unstintingly.

Here are some of the key missile d space systems that a number of r Force experts believe must be deloped as rapidly as possible:

• Reconnaissance, early-warning d communications satellites.

• The *ALBM*, the air-launched ballistic missile—and its strategic partner, a nuclear-powered bomber.

• A third generation *ICBM* to succeed the **Boeing** *Minuteman*.

• A maneuverable, recoverable space vehicle.

• A space vehicle capable of rendezvousing with another vehicle or pieces of equipment in space.

• Establishment of bases in space and on the moon.

Early types of all three of the satellites are already being developed under the direction of ARPA. The Air Force is developing *Midas* and *Sentry*. The Army is developing *Courier*.

Lockheed's *Sentry* will evolve from the *Discoverer* series of satellites. It is being designed as a long-life, unattended reconnaissance satellite.

Lockheed's *Midas* would provide early warning of *ICBM* attack. The satellite, through use of infrared sensors, would be capable of reporting the launching of an *ICBM* before it left the launching pad.

Courier, primarily an in-house project, is the first of a series of communications satellites. It will be a delayed repeater system. Later, active repeater satellites are planned for stationing in 24-hour orbits.

Douglas Aircraft is still working on design studies for the *ALBM*. However, it is hoped that development can begin moving forward by the end of the year.

• **Delays in** *ALBM*—Many Air Force experts regard the *ALBM* as one of the top weapons of the mid-1960's—particularly when placed on nuclear-powered bombers.

The bombers, armed with possibly eight *ALBM's*, would be placed on station for long periods, much like *Polaris* submarines. *ALBM's* could be launched 1000 to 1500 miles from their targets.

New delays in the nuclear-powered plane program have forced the Air Force to shelve this strategic idea indefinitely. Meantime, the *ALBM* is being designed for launching from Mach 2 B-58's and Mach 3 B-70's.

The *ALBM* also is seen as the progenitor of the space-launched missile. Such a weapon would be launched from either a maneuverable space craft or a satellite.

• **Shape of third generation**—The Air Force has yet to decide on the specific requirements for a third generation *ICBM*. They probably will be written within the next six months or a year. However, the general nature of these requirements is clear.

The Air Force candidate for successor to *Minuteman* will ideally be lighter and somewhat smaller. It will have extremely accurate guidance. It will be easier to control and may be capable of changing course. It will pack bigger warheads.

money is the prime problem . . .

The solid *Minuteman*—expected to be operational about early 1963—is about a third the size of the huge liquid **Martin** *Titan* and **Convair** *Atlas*.

It is designed to be fired from hardened underground sites where it can be kept for long periods. It also will be designed for firing from railroad cars and large vans.

However, *Minuteman* packs a much smaller warhead than *Atlas* or *Titan*. And although its guidance will be improved it will be able to fly only a predictable ballistic path like its predecessors.

The third generation *ICBM* will be a far deadlier and trickier weapon.

Its guidance will enable it to score a direct hit on any hardened site. U.S. experts agree that not even a hardened site can withstand a direct hit by a nuclear warhead.

Its ability to maneuver will enable it to avoid attempts to stop it with an anti-missile missile. Its improved control system will enable launchers to direct it to a variety of targets while it is in flight.

Its relative lightness and size will greatly increase its mobility. Its bigger warhead would eliminate the need for continued maintenance of the first generation missiles in the nation's strategic arsenal.

Finally, the development of such a weapon probably would lead eventually to abandonment of fixed, hardened *ICBM* sites.

Presumably Russia by this time also would have improved its guidance systems to a point where any known hardened site could not survive an attack.

• **Toward rendezvous**—*Dyna-soar I* is the Air Force program aimed at development of a maneuverable space vehicle. However, it is not in itself aimed at development of a weapon system. Rather, it is a research program.

Dyna-soar I, estimated to cost possibly $1 billion, would test out the concept of launching a space craft from the earth into orbit and returning it into the atmosphere at will and landing it.

Dyna-soar II, also known as *Mrs. V*, would be the true weapon system: A maneuverable, recoverable space bomber. It also would lead to a vehicle capable of rendezvousing in space.

Air Force officials feel that the ability to rendezvous in space will become essential in not too many years.

Unknown satellites will have to be identified. U.S. satellites will have to be repaired and re-equipped. Space stations will have to be built. And, finally, the stations will probably be used as staging areas for space exploration.

A number of Air Force officials feel that such stations also could serve as military bases in space. On the other hand, some feel that moon bases would be more efficient.

• **Robbing Peter**—All of these programs are running into the major obstacle of money.

The Air Force feeling is that as much as $5 to $7 billion more is needed each year. At the same time, the Administration has made clear that the Defense Department's budget for FY '61 will be the same as this year if not lower.

This means that much of the money needed for missiles and space must be found in other programs or not at all. For example, the Air Force might have to decide to drop development of the B-70—possibly a $10 billion program—in order to press ahead with development of *Dyna-Soar* and other space projects.

Or, the Air Force could be faced with losing a project like the B-70 anyway so that money can be found by the Defense Department to press on with new Army and Navy space and missile projects.

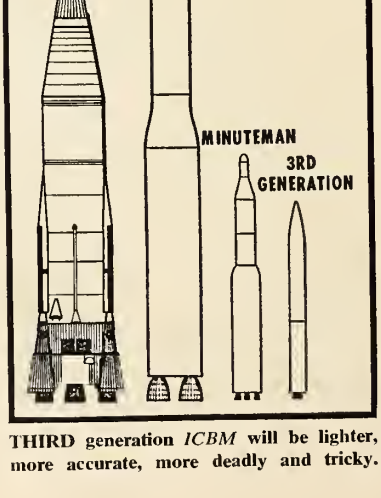
• **Private preserves?**—This raises what the Air Force sees as another major obstacle in the path of its space programs: Division of authority.

The Air Force feels that space is not divisable; that the Army and Na are encroaching on space and in eff impeding progress; and that the res is a net gain for Russia.

As one Air Force officer has put "Space is not a new ocean for Navy and it is not an artillery ra for the Army. There are too da many cooks."

The Air Force feels that beca the Army and Navy do not have same needs as the junior service, t will not push essential space progra as hard as the Air Force would.

Needless to say, both the Army a Navy have stiff counter arguments.



THIRD generation *ICBM* will be lighter, more accurate, more deadly and tricky.

NASA Official Proposes Outer Space Definition

WASHINGTON—How high does space extend, and where does ou space begin?

Dr. Robert Jastrow of the Natio Aeronautics and Space Administrati suggests that this important legal qu tion be settled by reference to or characteristics of a typical satellite.

Jastrow, chief of NASA's theore cal division, proposes that outer spa should be defined legally as the regi traversed by vehicles that have be placed in orbit about the earth, or t have escaped from the gravitatio attraction of the earth.

At low altitudes, a satellite quickly destroyed by atmospheric fr tion. To be considered an orbiting sat lite, Jastrow says, it should make least one circuit of the earth. Thus, suggests that air space be defined as t altitude at which the density of atm sphere is sufficiently low to permit c circuit.

"Our calculations of satellite li times indicate that this critical altitu is 100 miles for a satellite of a typi weight and dimensions, i.e., a weig of one ton and a cross-sectional area 30 square feet," he says.

New Compound Excels as Corrosion Inhibitor

COLUMBUS, OHIO—Ammonium h afluorophosphate is better than hyd fluoric for inhibiting the attack of fu ing nitric acid on several metal alk over an extended storage period.

Three **Bell Aircraft Corp.** searchers made this report recently a paper read at the American Roc Society conference on propellant th modynamics and handling.

Sam A. Long, William H. Bergd and Edward J. Kinsley tested 70 co pounds suggested as possible corrosi inhibitors. The tests ran for 30 days 120°F in liquid and vapor-phase con tions.

U.S. Liquid Hydrogen Stream Swells

Industry and government cooperate in building large tonnage plants to make 'ultimate' chemical fuel more than a laboratory curiosity

by Jay Holmes

WASHINGTON—Hydrogen, in the m of an odorless, colorless, frigid id—the lightest there is—has pro-ssed in seven years from a labora-y curiosity to the product of a good-ed industry.

Rocket fuel and research needs for liquid—which boils at –423°F—ve created a multi-million-dollar rket. And with increasing use of drogen as fuel for big rockets—be-nd *Centaur*—now in the thinking ge, the market is bound to increase.

Seven years ago, the largest instal-ions produced less than 15 pounds liquid hydrogen per hour. Today, daily production is measured in s. By next spring, the figure may doubled.

At the moment, three companies in the business of making liquid drogen on a large scale. **Air Products** . has built and operates a large nt for the Air Force at West Palm ach, Fla., and a moderate-sized nt at Painesville, Ohio. **Stearns-ger Manufacturing Co.** operates a derate-capacity plant at Bakersfield, lif. And **Linde Co. Division of ion Carbide** is building a large plant t will begin operation at Torrance, lif., next spring.

Production and cost figures on the Products and Stearns-Roger opera-ns are classified. The Air Force feels t revealing them would give a po-tial enemy valuable information on erica's war potential.

This creates an amusing paradox. r the Linde product will be sold to SA, the civilian space agency. Pro-ction and cost figures for this plant—ut as large as the Air Products ility in West Palm Beach—are a tter of public record. An Air Force kesman says classification of such rmation is under constant review l some of its hydrogen figures may released soon.

The creation of this new industry is an example of industry-government cooperation. Because it boils at 70°F above absolute zero, large-scale storage of the liquid has been a poser. Scientists of the Atomic Energy Commission and the National Bureau of Standards discovered principles underlying a process for storing the liquid without undue loss. Based on the scientific breakthrough, Air Products, Stearns-Roger and Linde developed mass-production methods. And **Pratt & Whitney Division of United Aircraft** has learned to handle the fluid in preparation for use as rocket fuel.

• **"Ultimate" chemical fuel**—The interest in hydrogen is mainly the result of its role as the ultimate chemical fuel. More specific impulse is provided by burning hydrogen than any other fuel—whether in oxygen, fluorine or any other oxidizer. The reason is elementary chemistry. Hydrogen, the lightest element, has one electron per atom available for chemical reaction. Since its atomic weight is 1, hydrogen has one reaction electron available for each unit of atomic weight.

When heavier atoms are used as fuel, there is no proportionate increase in the number of reaction electrons. Nor is there a proportionate decrease in the binding energy of the electrons, which would increase their reactivity.

Liquid hydrogen also has a role in *Project Rover*, NASA's nuclear propulsion development. Because of its light weight, hydrogen is best suited for use as a propellant gas to be heated by the *Rover* space-borne nuclear reactor.

The first plant with a capacity of more than 15 pounds per hour was put in operation by the Bureau of Standards at Boulder, Colo., in 1952. The liquid produced was kept in high-vacuum insulated, refrigerated dewars holding about 500 gallons (300 pounds). The refrigeration was necessary because the hydrogen molecule exists in two forms: one in which the two atoms are spinning in the same direction (orthohydrogen) and one in which they are spinning in opposite directions (parahydrogen).

Gaseous hydrogen at room temperature contains about 75% orthohydrogen and about 25% parahydrogen. But when cooled to the boiling point of –423°F, this mixture is unstable. At this temperature the two forms do not reach equilibrium until 99.8% of the molecules shift from ortho to para form. The diagrams on page 22 illustrate the transformation.

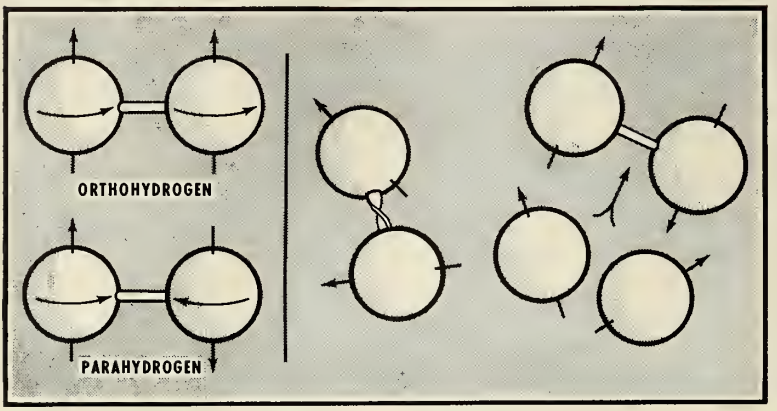
• **Long time transformation**—But the transformation from ortho to para requires a long time under ordinary conditions. It takes about a month for 25% para to convert itself to 90%. The conversion releases heat, because parahydrogen is in a lower energy state than ortho. It is more stable. This might be compared to some types of twin-engine airplanes in which the engines spin in opposite directions to make the plane more stable in flight by equalizing torque.

Because of this continuous release of heat, liquid hydrogen produced by older methods needed to be continually refrigerated. Even so, it was constantly boiling off. Many scientists searched for catalysts that would speed up the conversion, so that the product would be more stable.

The first major break came in 1953, when workers at the **Los Alamos Scientific Laboratory** succeeded in modifying a small hydrogen liquefier for the regular production of 85% para liquid at a rate of 25 liters (3 pounds) per hour. A short time later, the hydrogen liquefier at Boulder was modified to produce 240 liters per hour of 90-95% parahydrogen.

Meanwhile, under Atomic Energy Commission sponsorship, the Cryogenic Engineering Laboratory at Boulder began a catalysts research program directed by D. H. Weitzel. The most effective catalyst, they discovered, is hydrous ferric oxide. Its high conversion efficiency makes it possible to design ortho-para converters about 1/40

handling hazards are minimized . . .



HYDROGEN molecule exists in two forms shown at left: ortho, with spins of atoms parallel, and para, with spins in opposite directions. At right is sequence showing change of ortho molecule to the more stable para form.

the size of those used in the early work at Los Alamos and Boulder. This makes it possible to hold to manageable size the converters for the very large scale new plants.

• **12,000 pounds a day**—The Linde plant at Torrance, Calif., due to be completed next April, will have the capacity of producing 12,000 pounds per day. Linde, which is putting its own money into the venture, won't say how much the plant will cost. NASA has agreed to buy from Linde as needed on a sliding scale beginning at 70 cents a pound. If as much as 10,000 pounds a day are purchased, the price will average about 50 cents a pound, a Linde spokesman said.

Air Products Inc. began operating the first plant for continuous production of liquid hydrogen at Painesville, Ohio, in the summer of 1957. Stearns-Roger started up another plant the following winter at Bakersfield, Calif.

Part of the much larger Air Products facility at West Palm Beach went into operation in the fall of 1957 and the complete plant became operational early this year. It is the first plant with on-site generation of the gas used for liquefaction. As for production, the Air Force will say only that it is several tons per day.

Since the Air Force owns the plant and merely pays Air Products an operating fee, it would be difficult to give the cost of liquid hydrogen even if the figures were released. One officer has said that, depending on how you calculate, the cost is somewhere between $1.50 and $5 per pound. The Air Products contract for building and operating the plant is reported to be in the neighborhood of $20 million.

• **Vacuum-jacketed line**—A 2000' vacuum-jacketed pipeline connects the Air Products plant to an area where Pratt & Whitney tests the liquid hydrogen-lox engine that will be the second stage of the *Centaur* space vehicle. The pipeline is capable of transferring up to 400 gallons per minute (14,400 pounds per hour). Presumably, this transfer capacity is much greater than the Air Products plant's production. The line is used to supply pump test stands where 50,000 gallons (30,000 pounds) of liquid hydrogen may be consumed in one test.

The plant storage system consists of 28,000-gallon tanks (the number of these is classified). Vacuum-insulated trailers also are available for transporting 6000-gallon loads of hydrogen by highway to points in California and elsewhere.

The cold liquid, once thought to be extremely hazardous, now is considered only a moderate danger. Precautions are necessary but Air Products' safety director, Franklin Himmelberger, says it is less flammable than propane, commonly stored in tanks in rural homes.

P. C. Vander Arend, Air Products' chief scientist, has given this outline of the safety assumptions made in design of the plant: All equipment containing hydrogen gas or liquid, except for the compressor building six stories high and a quarter-mile long, is located outside, where leaking lightweight hydrogen will dissipate rapidly upward. All equipment containing hydrogen gas or liquid is kept at a pressure above atmospheric, to avoid contamination with oxidants. The same is true of cold boxes containing heat exchangers, adsorbers and liquid baths.

A rather extensive alarm syst tells when pressures drop below s limits and shuts down the compress if the conditions are not corrected. operator in a central control room a continuous visual and instrum check on plant operation. And entire liquefier and storage system closed. Under normal conditions, li hydrogen gas escapes into the atr sphere. Safety relief valves are pi into tall stacks, which are tigh covered except when the excess is ing vented.

• **Not too hazardous**—Engine working with liquid hydrogen ag that spills are not dangerous so l as there is no source of ignition. few gallons spilled will evaporate mediately. When hundreds of gall are spilled, the ground freezes, the liquifies and a cloud of ice crys and water vapor forms. Althou warm hydrogen is much lighter tl air, a large mass of very cold gas n have about the same density as and lie along the ground until it pi up heat. However, the adjacent outside the cloud has less than 0. hydrogen. Thus any explosion and will be confined to the volume of cloud.

A spill that is ignited immediat will burn smoothly in air without ploding. The fire creates an extrem strong updraft, so that damage usually confined to material direc overhead. Thus, C. D. Robin of P & Whitney advises, test stands sho be designed with no important equ ment overhead.

Leaks in a liquid hydrogen syst can usually be detected by the cl of ice crystals and water vapor arou it. But if the leaking hydrogen is bu ing, it may be harder to detect. hydrogen flame is invisible in daylig

Air Products recently invited engineers to its Allentown, Pa., he quarters for a series of lectures a demonstrations on safe handling cryogenics. Himmelberger told conference the three chief dangers handling liquid hydrogen are conta nation by oxidants, spills, and leaks the vent system. He recommended st preventive measures as periodic purg of vessels and pipes with inert gas, c stant monitoring of all equipment a powerful fans for quick evacuation all air from any room or building i which hydrogen may leak.

A constant alert is necessary, course, against the danger from spar flames and lightning. Hydrogen mal an explosive mixture with air when concentration is anywhere from 4 74%. "No smoking" must be the r anywhere near hydrogen equipment.

Engine Controls Demand A New Art

Components are improving too slowly to keep pace with new environmental demands; efforts to simplify servo loops underway

by Frank G. McGuire

Los Angeles—"The controls field s gone about as far as it can go h the materials and skills it has to rk with today—and we've pushed transducer and sensor business as rd as anybody." These words by ger M. DiJulio, Chief Engineer at **rvomechanisms, Inc.**, about sums up state of things in the field of engine ntrols, as seen by a number of comnies.

Components are being slowly but ely improved in reliability, performce, etc., but the problem is that they being improved *too* slowly. In ee years, say the controls people, 'll need much more performance an we have now in our control sysns. "But," they complain, "we'll be ked to make a system to operate at nus 400° F, and the same system ll have to operate at over 1000° F.

Other companies, specifically **Mardt Corp.** and **Bendix-Pacific Division,** are not trying to achieve seven-league steps as much as they are incrementally improving reliability and performance of present, proven components and loops.

Even though the performance and reliability have improved, there is a continuing effort to simplify the servo loops that make up a system for missile control. This is difficult mainly because of the basic nature of operating components. Many smaller items, such as a capacitor or two, have been deleted and some circuits have been simplified, but on the whole, no large-scale elimination or consolidation has occurred.

Certain important features have, of course, been designed into recent control systems, including that of **Aerojet's** *Titan* engine, which will continue operation even if the missile's hydraulic system suffers a complete failure.

Additionally, *Titan* is held to the launcher for a pre-determined period after full thrust is achieved, insuring that any malfunctions which occur immediately after ignition will automatically cause the engine to be shut off. The hold-down period, believed to be over five seconds, has been credited with saving at least one vehicle that was prevented from leaving the launcher at the last second, then was later flown successfully.

The unit is what might be termed a ground-based engine control, and is composed of a sequencer which compares the parameters of the engine operation with optimum parameters previously fed into it. If the actual engine operation does not fall within tolerable limits, the sequencer shuts off the engine before the missile leaves the ground. If all is well, explosive bolts are actuated, which free the missile for flight. The device's function is based on the premise that most mission-aborting malfunctions occur soon after ignition.

• **Thrust control**—In this area, the usual method is to sample chamber pressure through a transducer, and feed the error voltage through the control system into the servo loop, which regulates the turbopumps that either increase or decrease fuel and oxidizer flow until chamber pressure matches the pre-set level on the potentiometer of an electrical reference device.

Other methods of controlling thrust through propellant flow to the gas generator vary in complexity from a drilled orifice involving no moving parts, to the other extreme, with many electronic and mechanical devices in the system. Parametric requirements of the vehicle, calling for an accuracy between 0.1 and 5.0%, usually decide the method selected for thrust control.

With an open loop system, as normally used, each component must be made and tested to great accuracies, which is often uneconomical. If a closed system is used, the tolerances are more liberal, since the control sys-

Instrumentation Better Than Computation

"At this time, our instrumentation is much better than the computational art, and a lot better than circuits themselves. To be more specific, we can detect the motion of the sensing element in a transducer up to the limit of its internal hysteresis, where the properties of the material itself suddenly become a severe limitation. This is well below the confidence which you can place in things like precision gears, bearings and machined parts, synchros, and that sort of thing.

"We've developed some sophisticated and tricky methods to compensate for things like temperature and accelerations. But there's still a broad band of uncertainty that you can't trim out.

"This begins to suggest that a new art might be required here. This new art will be computation to higher accuracies. The first thing that comes to mind is digital computation . . . but the sensing of basic phenomena is an analog thing—and there isn't an acceptable transducer on the market today that will sense this analog physical quantity and put out a usable digital signal.

"Something basically new and different is required. It will not come necessarily from the controls people or the computer people, but will probably come from some physicist who studies the very nature of matter itself."

Roger M. DiJulio
Chief Engineer
Servomechanisms, Inc.

control for guidance accuracy . . .

tem can then account for any deviations. Since October 1953, when it was first proven possible by flight test, the thrust-controller has added considerable effectiveness to the missile.

With this thrust controller, which permits pre-planned trajectories to be actually flown in practice, the Army's *Redstone* has repeatedly followed the pre-programmed trajectories with a cutoff point within 100 milliseconds of its predetermined 110-second flight time. Accuracy in this case is within 0.1%.

One of the prime reasons for thrust control is accuracy of guidance, not merely for engine considerations of running at rated thrust. A great simplification of guidance problems results from closer control of thrust. The missile is programmed on a time basis, and the timing comes out right only when a precise trajectory can be flown as previously planned. If the thrust varies from the plotted ideal, the timing is off, and thus the angle is off and the vehicle's position in space is different than required for the mission—therefore the end-point of the warhead or other payload is not as planned.

In order to correct for these variations, a much greater complexity of guidance systems would be required than is now needed for a closed loop thrust-control system where engine output is constantly monitored for compliance to the plotted level. It is therefore easier to make this a function of the propulsion system rather than the guidance system.

In solid propellant rocketry, there is not as much application for thrust-control devices as yet. The problems in this area rest mainly within the propulsion field, rather than the controls field. **Grand Central Rocket Company** has work in progress on a hybrid system that would control thrust levels by regulating the liquid oxidizer as it enters the combustion chamber with the solid fuel. **Thiokol Chemical Corp.** has indicated the possibility of introducing a combustion-modulating chemical that would disturb combustion to a controllable extent. Lowering of chamber pressure through escape ports at the side of the motor casing would also provide some means of thrust control.

Whatever the method used to actually raise or lower the thrust level in a rocket engine, the controls people indicate that present methods of exercising control and determining the amount needed would still be used.

• **Propellant utilization**—One of the most difficult problems confronting the engine controls people today is that of propellant utilization (PU) and liquid-level control. The difficulty lies in the accuracies needed, the environmental conditions encountered and the tactical requirements. Liquid-level control is a relatively old subject, but when applied to the measurement of rocket fuel/oxidizer levels, it becomes an entirely new field of endeavor.

Usually, the fuel/oxidizer combustion is done through stoichiometric requirements, so, that the PU system must insure that they are being consumed at an equally proportional rate. The most important consideration, therefore, is that the fuel/oxidizer must deplete simultaneously. Otherwise, combustion stops when the missile is lightest and near the end of powered flight, throwing the guidance system way off. It is therefore essential that both tanks empty precisely simultaneously.

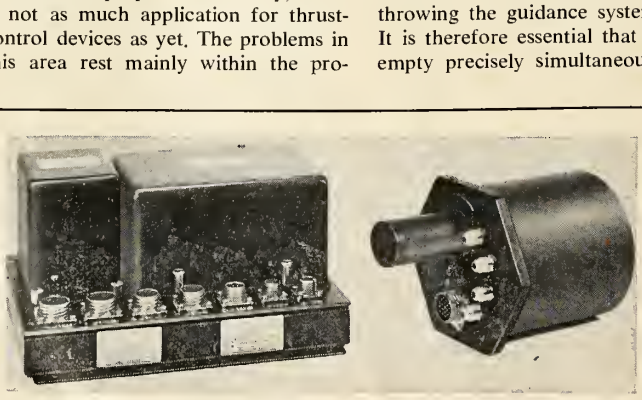
The problem: continuous, pre
control and measurement of two l
masses of liquids, with great term
accuracy, in a vehicle travelling
12,000 mph and under terrific accel
tions, vibrations and temperature
tremes, and noise levels in excess
100 db. So, there are several sch
of thought on how it should be h
dled.

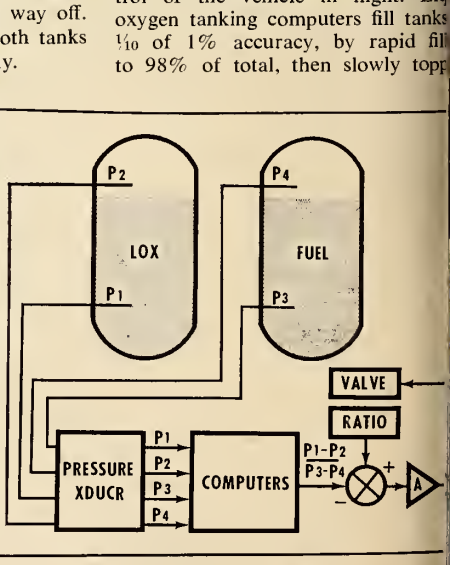
Some systems employ dip-stick t
approaches where a capacitive pr
or resistance probe is put into the ta
Other systems use the difference
pressure between top and bottom
the tanks, but this is merely an i
cation of the weight of the colu
There are difficulties in transla
column weight to significant data
total fluids.

Variations in tank diameter due
manufacturing tolerances are such
even if the weight of a given colu
is known, there's no guarantee that
total amount is known. In addition
knowing the ratio of weight/volu
it is necessary to know where the l
is, so that in a variable-diameter tan
corrected ratio can be used.

Servomechanisms, Inc. is at w
on a method of computing the mas
not the cubage or pressure differenc
then translating this information i
control signals which operate a pu
or valve to control flow of one of
constituents. Some missiles require
type of control and some do no
those that don't usually being the sh
range missiles that can be "tuned"
tests to deplete fairly uniformly;
open loop method. Long-range vehi
not only have to be tuned, but
controlled.

The other end of the PU spectr
is the loading of propellant aboard
missile. This can easily affect the c
trol of the vehicle in flight. Liq
oxygen tanking computers fill tanks
1/10 of 1% accuracy, by rapid fil
to 98% of total, then slowly topp



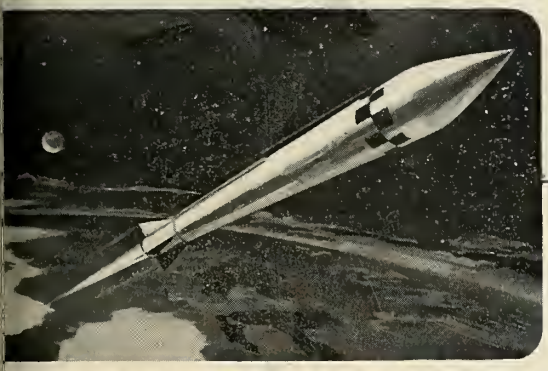


ABOVE: Servomechanisms' Type AQC 600 propellant utilization control system assures that the fuel and oxidizer are depleted simultaneously. This system measures the pressure ratio remaining in the tanks and controls flow. RIGHT: Schematic of the system.

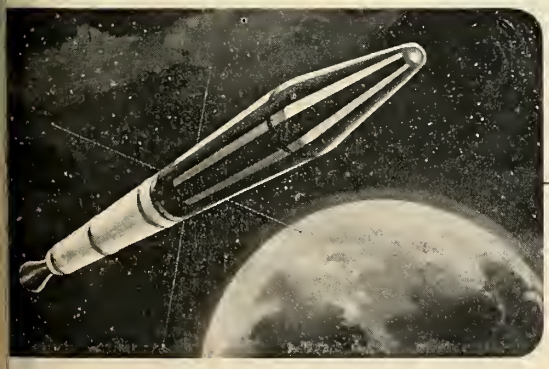
Historical Achievements at JPL



JATO UNITS... The nation's first successful jet-assisted takeoff (JATO) units were originated and developed in 1941 at the Jet Propulsion Laboratory, and sparked the development of future rocket vehicles.



THE CORPORAL... this country's first ballistic surface-to-surface guided missile, now an operational weapon of the U.S. Army, was pioneered and developed by the Jet Propulsion Laboratory.



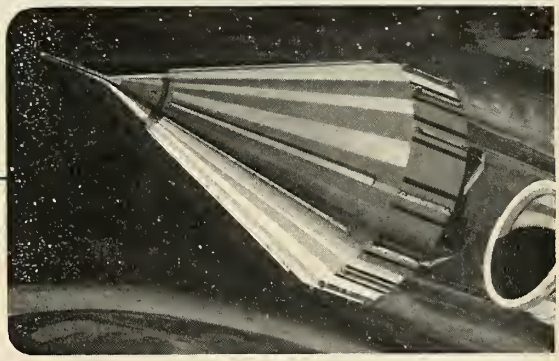
EXPLORER I... The United States' first successful earth satellite, launched January 31, 1958, was developed by JPL in collaboration with the Army Ballistic Missile Agency.



THE WAC-CORPORAL... fired in flight from a V-2 rocket, established a world's altitude record of 250 miles in 1949. The combination was known as the Bumper-Wac.



THE SERGEANT... A second-generation solid propellant missile developed by JPL for the U.S. Army. The SERGEANT is now being readied for production.



PIONEER IV... America's first successful moon-space probe, launched March 3, 1959, was developed by the Jet Propulsion Laboratory in collaboration with the Army Ballistic Missile Agency and the National Aeronautics and Space Administration.

CALIFORNIA INSTITUTE OF TECHNOLOGY

JET PROPULSION LABORATORY

A Research Facility operated for the National Aeronautics and Space Administration

PASADENA, CALIFORNIA

Employment opportunities for Engineers and Scientists interested in basic and applied research in these fields:

INFRA-RED, OPTICS, MICROWAVE, SERVOMECHANISMS, COMPUTERS, LIQUID AND SOLID PROPULSION, STRUCTURES, CHEMISTRY, INSTRUMENTATION, MATHEMATICS, AND SOLID STATE PHYSICS

Send professional resume, with full qualifications and experience, for our immediate consideration

HOW SAC's "HOUND DOG" SCENTS ITS TARGET



The crew of the B-52G starts up the jet engine of the sharp-nosed GAM-77 Hou Dog missile hung under its wing... gives its inertial autonavigator the location of the targ

On a "for-real" mission, the Hound Dog would leap toward its target at supersonic spe —very likely a ground-defense center hundreds of miles away. Its guidance system can't jammed... can't be decoyed.

Purpose of the GAM-77 air-to-ground jet-powered guided missile is to increase the striki power of Boeing's B-52. Sling a pair of Hound Dogs under the wings of the new B-52G—a you have what amounts to a brand-new weapon system.

The GAM-77 program was started in August, 1957. The missile has been put into accelerat development. It already is in its early flight test phase... will be deployed by 1960.

Weapon system contractor: the Missile Division of North American Aviation.

MISSILE DIVISION NORTH AMERICAN AVIATION, INC., DOWNEY, CALIFORNIA

new system to do two jobs . . .

off and maintaining the desired level in face of evaporation. At launch, this computer is dropped to the pad and reused.

Servomechanisms is currently at work on a system which will do both jobs: control ground fueling and also airborne depletion of fuel/oxidizer tanks. The airborne device will gain negligibly in weight, since most of the changes from present equipment involve only wiring.

These systems are small and light and are basically independent of the type of liquids being used in the missile, because there is no direct contact between the sensor and the tank contents.

Complications in loading occur similarly as in utilization: tank diameter changes, fuel densities with varying temperatures, and varying densities between fuel and oxidizers. Even different batches of the same fuel have slightly different densities.

Then there is the problem of sheer size in the plumbing that must handle vast amounts of liquid. How can a vehicle like *Saturn* be adequately and accurately calibrated for fuel loading? The first stage alone holds three million pounds of propellants. There will be at least three, and possibly five, different fuels and oxidizers used in the vehicle.

The accessory requirements are just as stringent. Vibration requirements for transducers on *Saturn* first-stage are over 125 g. This is in addition to the temperature requirements needed for a vehicle using eight engines in the first stage.

• **Hydraulics or pneumatics?**—The use of hydraulics or pneumatics in a system, depends, of course, on the requirements involved. Principal advantage of hydraulics being their good response characteristics, while their disadvantages lie mostly in temperature and nuclear radiation limitations. Gases suffer from a lack of response characteristics, but have few temperature or radiation worries.

The application of hot-gas pneumatic servos is getting considerable attention from Bendix-Pacific, which is using "clean fuels" as a hot-gas source. Company engineers feel that solid propellant gas generators, while having many advantages, introduce contamination to delicate systems. "Although solid-propellant people maintain their gas generators are very clean, and this is true in most senses, we find just enough contamination in them to justify using bottled cold gas where possible," explained a Bendix engineer. In reliability, also, Bendix sees the bottled gas as an advantage. It is viewed as competitive weight-wise with hot-gas systems, even for explorations as far as Mars. "It depends on how much you want to run the thing," says Bendix, "because cold-gas is superior to hot-gas up to about 1000 I_{sp}. Beyond that, the hot-gas systems seem to be favorable, except that they are not easily used in an on/off/on situation."

Response characteristics favor hydraulic systems, which perform at about 270 cps in an arrangement whose equivalent pneumatic system would perform at about one to five cps. Adding some sophisticated feedback to the pneumatic system would raise response to about ten cps, says Bendix, indicating that a factor of 25 to 30 makes the difference quite broad.

Marquardt Corporation, working mostly with pneumatics, has achieved responses of 18 cps, for example, then connected the system with external RC-type networks that reduced response to 3 cps. The change results from looking at the loop response or the complete system response. In contrast with Bendix, Marquardt has used hot-gas sources from either liquid-propellant or solid-propellant gas generators, but is not currently utilizing cold-gas bottled supplies to any great extent.

Work in the pneumatic system field is concerned mostly with improving "stiffness" of the system response, performance of individual components, and the old bugaboo, reliability. Few companies admitted to a search for one great stride or "breakthrough" in the field of controls.

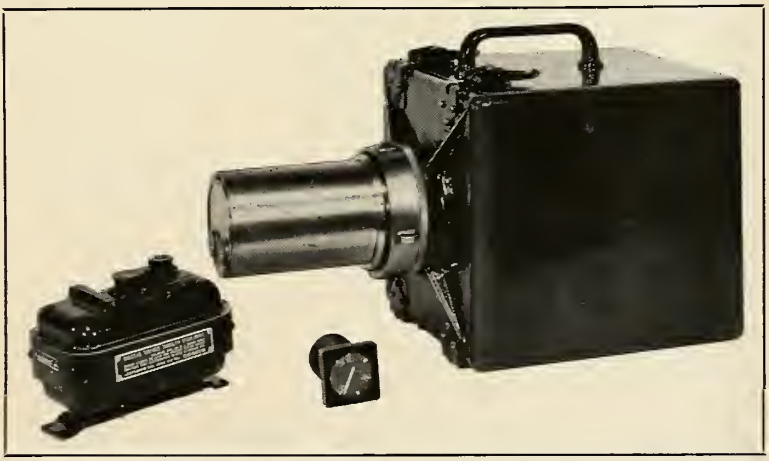
Marquardt is working on the adaptation of new principles in gas systems, as well as component and loop improvements. Advanced work at Bendix is also in gas controls, although company spokesmen feel that hydraulics are adequate for anything now or in the future, ". . . but to stay competitive, we have to reduce size and weight and increase performance."

• **Pressure switch**—An example of individual component improvement is that afforded by Servomechanisms, Inc.'s new pressure switch; devices which have been the bane of design engineers' existence. They've been notoriously unreliable, unpredictable, hard to make, environment-sensitive, etc.

The switch recently designed by SMI operates on a novel principle which does not depend on the storage of energy, the release of energy, or the triggering of mechanisms. It depends on a very discreet electrical phenomena which is either black or white. The switching takes place over an extremely narrow range of pressure change, and with extreme rapidity.

The unit is very reliable and rugged, as illustrated by the description of one of its tests: "We can set it to within a fraction of a psi of the switch point, hammer nails with it, and the circuit will not switch . . . go up on the other side of the range, set it again to within one psi of a switch point, hammer some more nails, and the circuit still will not switch."

The accelerations and shocks are in the thousands of g's, but the unit still detects motions in the pressure element down to tens of micro-inches. The logic is all electronic, solid state, and the unit is encapsulated into a capsule about 1½" diameter and 2" long. One part has an elastic motion,



MAIN BUILDING block in obtaining a competely automatic propellant loading system is the LOX tanking computer system.

NEW PROGRAM

Raytheon enters new weapons systems program and offers advancement opportunities for both Junior and Senior electronics engineers with experience in the following fields:

- Microwave engineers—component and antenna design
- Communications systems
- Guidance systems
- Computer systems
- Radar systems
- Inertial reference systems
- Feed-back control
- Auto-pilot
- Ground support
- Electronic packaging engineers
- Radar systems engineers (project management)
- Electromechanical engineer for missile control and auto-pilot design (project management)
- Mechanical engineer experienced in ground handling of large missile systems (project management)

You and your family will enjoy the many advantages of living in the metropolitan Boston area. Relocation assistance and modern benefits.

Please forward resume to:

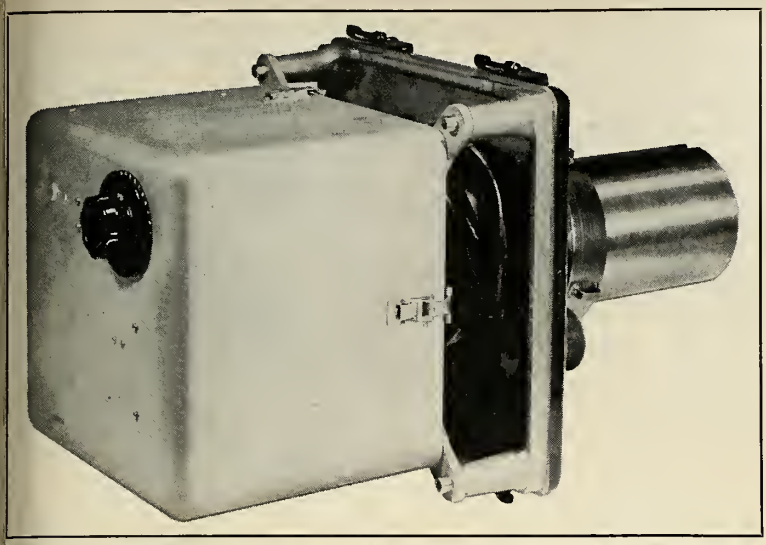
Mr. W. F. O'Melia
Employment Manager
Raytheon Manufacturing Co.
Bedford, Mass.

or call collect:

Crestview 4-7100
Extension 473

RAYTHEON MISSILE SYSTEMS DIVISION

Excellence in Electronics



SERVOMECHANISMS' SMI Type AC 2019 computer with protective cover removed.

but there are no other moving parts. Operating with an on/off differential of 0.1% (it has achieved 0.03 of 1%), the switch will be used on the *Saturn* vehicle to sample chamber pressure in each of the first stage's eight engines, then signal a black box to release the vehicle if pressure is as planned. Otherwise, engine-cutoff devices will be actuated. As in most devices of this nature, fabrication of the devices is but a fraction of the time and cost involved in quality inspection, testing, and calibration.

• **Testing and accuracy**—Candidate for the title of most frustrating problem is that of proving just how accurate or reliable a device is. The standards are limiting, and there is a major obstacle in determining absolute accuracy. As phrased by one frustrated engineer: "We're talking about accuracies of 1/10 mm of mercury or less. We'd love to have a couple of hundredths of a millimeter, but we just can't get it." The problem is industry-wide . . . and is not just a technical problem. It has become necessary to organize the entire company, from front door to shipping dock, to handle that kind of accuracy. Sloppiness cannot be tolerated anywhere in the process.

Astronomical increases in performance will be required in the near future. Some of them can't be met right now. Frequently, say industry spokesmen, the specifications are written against what can be done, rather than what the requirement is.

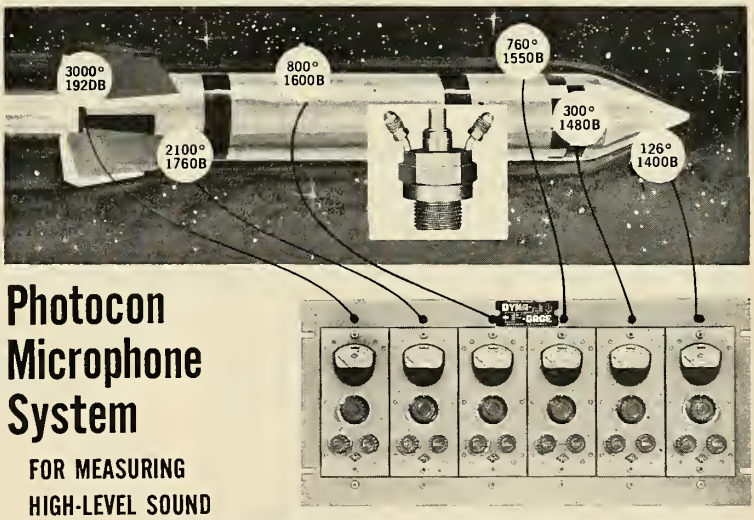
One firm indicated that customers frequently come and say: "We need a gizmo to do this . . ." and is told; "You can't get it." "Then, we add a little increment to what is possible right now, and this makes us run for it."

It is estimated that systems managers could use another order or two of magnitude in the accuracy of propellant utilization, thrust control, and other segments of the controls field. The belief, however, is that the rest of the missile system is not that accurate, so the additional money we put into fantastically accurate devices is sometimes wasted. Tanks are not perfectly cylindrical, guidance is not precise enough, etc.

Then there is the argument that tolerances of a missile's components add up to a total probable reliability. Too many sloppy components, and the system will not perform. Therefore, each component must be much more accurate than the overall vehicle must be.

"It is sometimes necessary," said one Bendix engineer, "to compromise the design of one component to offset the weakness of another. In other words, you don't design the best servo valve, you design the best servo loop."

Complained SMI's DiJulio: "Everything we do now has a basic limitation . . . 'How accurately can we machine things?' 'How accurately can we measure them when they're made?' 'How stable are they?' 'Will they stay put until the vehicle gets there?' 'Can we get a production organization to make it?' and 'Can we get a production organization to determine that they've been made correctly?' So this problem backs up until you're down to the last girl on the production line . . . who never heard of the things you're talking about."



Photocon Microphone System

FOR MEASURING HIGH-LEVEL SOUND

—WITHSTANDS SEVERE ENVIRONMENT

—high temperature—high sound levels—high vibration

Static calibrations and wide frequency response. Remote operation. Write for complete data. Bulletin 1163

PHOTOCON RESEARCH PRODUCTS

421 NORTH ALTADENA DRIVE, PASADENA, CALIF.

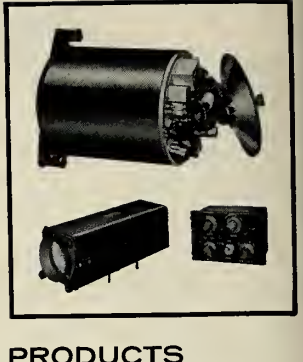
Pressure, Microphone, Proximity & Displacement Transducers, Dynagage Readout Instruments.
See our display at WESCON SHOW booths #3307-3309.

AIRBORNE RADAR...

The APS-67 Airborne Radar . . . designed and developed by *The Magnavox Company* in conjunction with the Navy Department, gives eyes that see by both day and night to the Crusader.

The APS-67 delivers the utmost in performance and reliability for this Navy Fighter . . . clearly demonstrating *The Magnavox Company's* ability to produce and work as prime contractor on a complex electronics project.

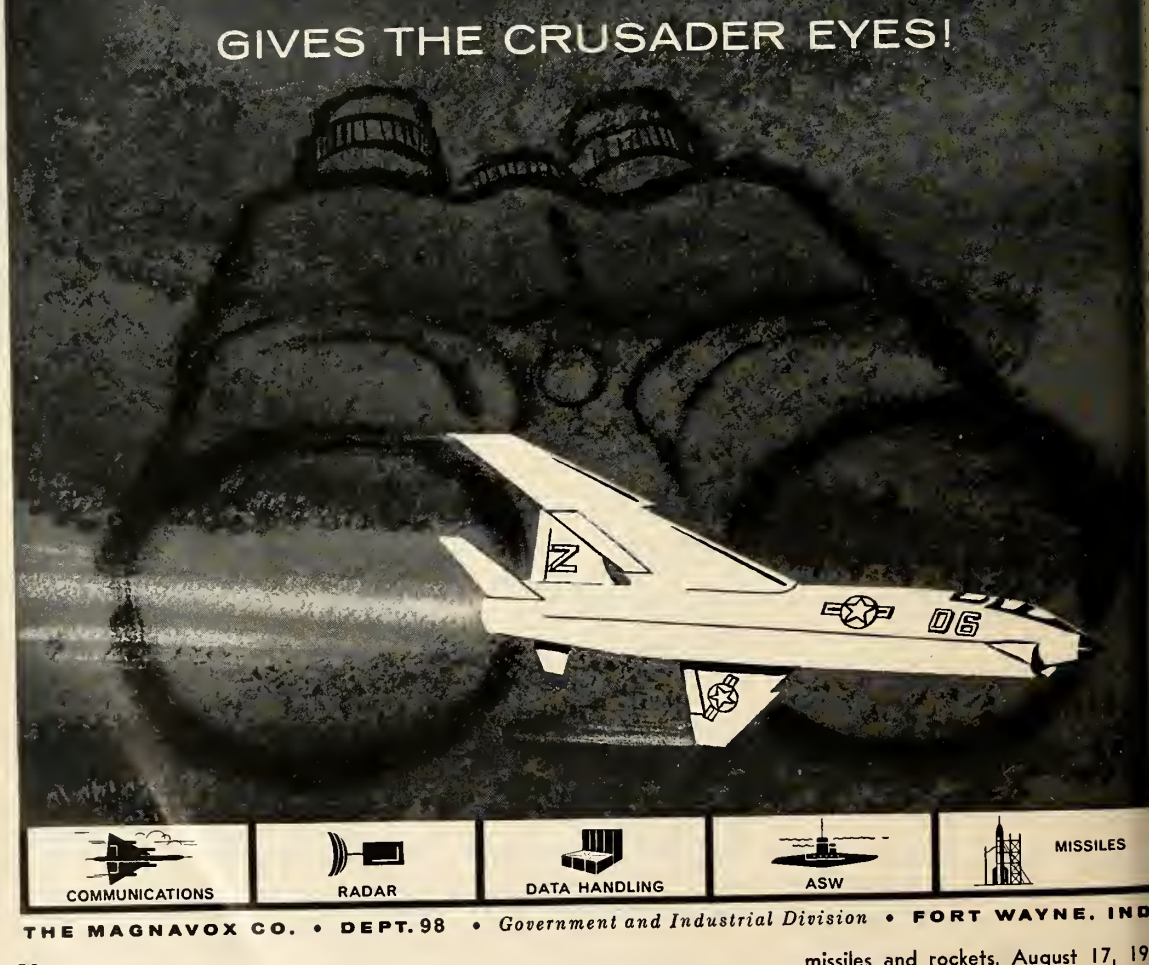
MAGNAVOX capabilities are in The Fields Of Airborne Radar, ASW, Communications, Navigation Equipments, Fusing and Data Handling . . . your inquiries are invited.



PRODUCTS THAT SEE BY THEMSELVES

Magnavox

GIVES THE CRUSADER EYES!



THE MAGNAVOX CO. • DEPT. 98 • *Government and Industrial Division* • FORT WAYNE, IND

APU's—the Muscles for Missiles

Gas-turbines are first choice for missile auxiliary power units; batteries are a strong second; exotic sources still are some years away from reality

by Hal Gettings

WASHINGTON—A vital, but often neglected, part of a missile system is its auxiliary power unit (APU). These units supply electrical, hydraulic—and sometimes mechanical and pneumatic—power to the various operating mechanisms of the missile. They drive control surfaces, energize transducers, guidance, telemetering, and other accessory equipment. Their development and production is presently a $25 million business.

Differentiated from primary power—the missile's propulsion system—the auxiliaries perform a function just as vital to the mission's success. Whether a test vehicle or an operational type, each missile and space vehicle must carry a separate internal power source. This source may take one of several forms. It may be a fuel cell, thermoelectric generator, nuclear unit, or some other exotic form of power.

At present, however, two less glamorous sources are carrying the bulk of practical applications: gas-turbine APU's and batteries.

• **Gas-turbine**—The gas-turbine unit claims several advantages over the battery. Most important, it is more efficient in size and weight per unit of power output. Batteries have undergone a steady improvement, however, and they find use in many missile applications. A comprehensive report on their development and important place in the missile business will be covered in next week's issue of m/r.

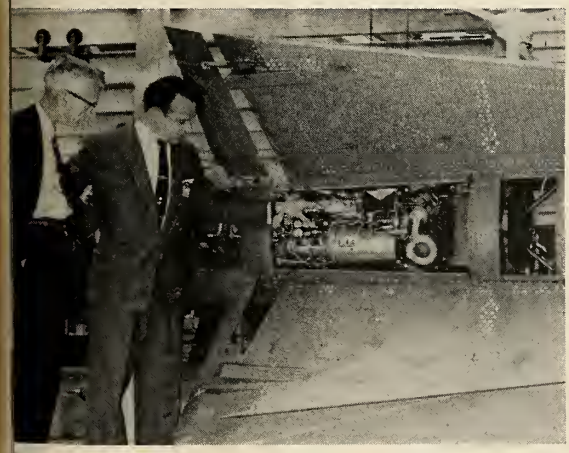
Gas-turbine APU's use both solid and liquid propellants as a hot-gas source. Both have their advantages and limitations and, at present, neither is considered sufficiently superior to make it universal.

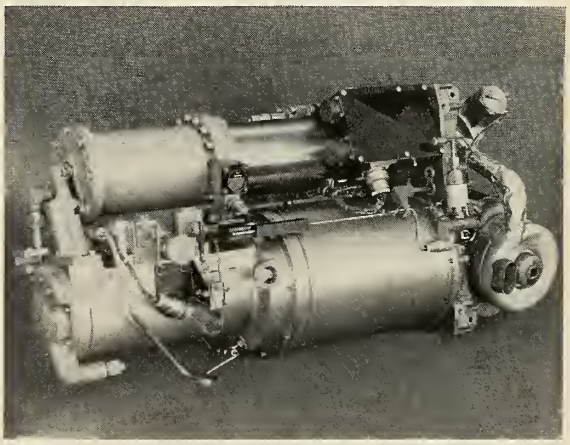
Current production of short-duration APU's is dominated by solids for their ease of handling and storage capability. For run durations of over two minutes, liquids are expected to dominate production for the next year.

Current research and development is aimed at solid-propellant units for over 30 hp and durations of up to 20 min.

According to an **AiResearch** spokesman, APU's can be expected to become more elaborate with each passing year. Power requirements and durations will continue to increase. He predicts that liquid propellants will be able to fill the need for units running for six months or more. Beyond one year, solar and nuclear-powered APU's will have to fill the need.

Generally, the liquid units are bulkier, more complex, and less reliable than the solids. On the other hand, their packaging design is more flexible and they are more controllable. Progress has been made in sealing the liquid container so that fueled units may be stored for two years and possibly longer.





LEFT: installation of APU in *Nike-Hercules*. RIGHT: new and simplified APU developed by AiResearch uses only half the valves and parts of conventional units. Operating on either ethylene oxide or hydrazine, the unit can be modified for use with solid propellants. Designed as an approach to a standard power source, the current model weighs 85 pounds and produces five horsepower for 7.5 minutes.

trouble with crash programs . . .

• **No emphasis**—Some auxiliary power manufacturers feel that proper emphasis has not been placed on this phase of missile development. They contend that the APU should be a part of the overall system design and not just packed into the missile frame somewhere along the line. Conversely, both **Thompson Ramo Wooldridge** and AiResearch—and possibly others—have made steps toward developing a line of standard units that would fit a large percentage of applications.

Since missile development is usually pushing the state-of-the-art, APU designers often find themselves working on a crash basis to build a unit for a particular missile. Consequently, new and unproven units are often pushed into production, or a missile development may have to wait for the APU.

Ideally, the APU development should go through an orderly process of feasibility study, research and development, breadboard, test and evaluation, and production. Such a logical time-consuming process would, of course, produce a good power unit for a now-obsolete missile.

This dilemma can be solved to an extent, however, by looking ahead to requirements for one to two years from now and doing the necessary research. In other words, start sooner. The problem here, naturally, is financing. Much could be accomplished by government backup of institute research programs in components and critical areas.

• **Areas of investigation**—Some of the areas to be investigated for improvement include evaluation of propellant characteristics, turbine reliability and efficiency, comparison of relative merits of various types of APU's versus application, materials for high-speed high temperature use, and standardization of environmental test requirements.

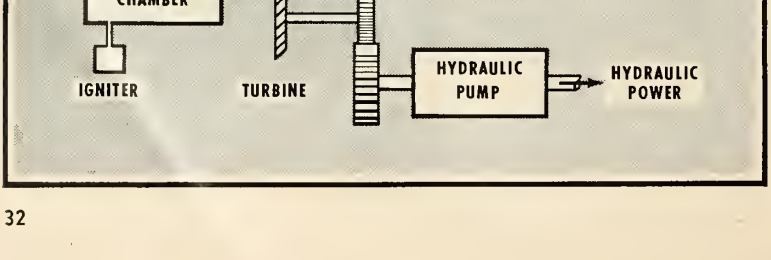
Many factors affect the design of gas-turbine APU's: type of control, outputs, run duration, package and space requirements, porting location, and others. They must be extremely rugged and reliable and be storable for an extended time. The primary problem of course, is the precise control of power output. Pressures, frequencies, power level are all critical.

Strangely enough, most units are not designed for high turbine efficiencies. Usual figures run in the range of 30-50%. Better design could easily raise these to 70-80%. The output of one air-to-air missile APU was recently experimentally modified to produce more than double its previous output by a simply nozzle design change. NASA engineers at Lewis Research Center recently conducted an investigation of a 4.5″ two-stage turbine for APU use and obtained efficiencies of 65% and better.

Efficiency is usually sacrified, however, for reliability considerations. The smaller, more efficient, nozzle is more critical and subject to erosion and clogging. Especially in short-duration operation units, the gain in efficiency is usually not worth the cost. For long-duration operation (over 10 minutes) more attention is paid to higher-efficiency design.

Some work has been done on using primary propulsion gases to drive the power generators. Big problem here, however, is the difficulty in handling the extreme temperatures involved. At least one such system has successfully operated; others may possibly be in use.

Research has also gone into the possible use of hot-gas servos—a system whereby direct use is made of energy from a secondary or primary propellant. Such a system could be used in place of hydraulic power but would be no substitute where electrical energy is needed.



Claiming to be the largest manufacturer of APU's in the business, **Garrett Corporation's AiResearch Manufacturing Division** started work in the field in 1950. Current work includes units for *Terrier, Falcon, Nike-Hercules, Nike-Zeus, Polaris, Quail,* and an unspecified Navy missile. They are working on two WADC contracts for advanced space APU's—one using solar energy source and the other nuclear unit.

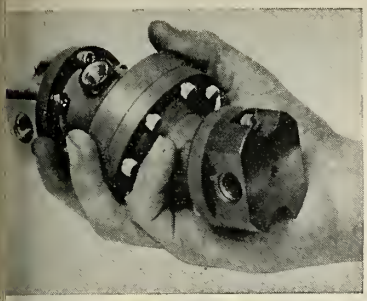
Thompson Ramo Wooldridge has several units now in operational missiles and others under development. They are producing a solid-propellant unit for the advanced *Terrier* BT- which is actually a double system. The hydraulic side produces approximately seven horsepower and the other about one kilowatt.

• **Hydrazine APU**—Their long-duration hydrazine APU for the *Bomarc* produces approximately 40 horsepower hydraulic and eight kilowatts electrical. This unit features completely sealed fuel tanks which can be stored upwards of two years. TRW last week introduced the first in a proposed series of solid-propellant multi-output electrical units which can be stored for as long as five years. They have also produced a solid-propellant turbo hydraulic pump, capable of about 1 horsepower output, for an unspecified missile. About half of TRW's units use solid and the other half liquid propellants.

Vickers Incorporated, in an extension of their work on hydraulic equipment, has just developed a unique hot-gas driven motor pump for use as an APU. This unit operates at moderate rotational speeds (6500-18,200 rpm) and produces ½ hp at 1500 psi and up to 66 hp at 3000 psi. The motor has reportedly been successfully tested using a hydrogen-oxygen fuel with combustion temperatures of over 5000°F. Because of its high temperature capability, the unit may be run from either propellant-generated gases or directly from the prime propulsion system.

The *X-15* manned missile uses two 40 hp hydrogen peroxide APU's which produce both hydraulic and electrical power. These units, built by **General Electric,** have an operation cycle up to 30 minutes and a designed life of 150 hours. Turbine speed is 51,200 rpm. Hydraulic pad speed is 3925 rpm and alternator pad speed 12,000 rpm.

Aerojet-General's Turbomachinery



VICKERS hot-gas motorpump. Unit shown, smallest in series, is capable of 3.9 hp and weighs only 2.5 pounds.

Division, devoted entirely to APU work, has produced a hydrazine-fueled unit which develops approximately 30 hp. This unit, scheduled for the *Titan*, holds frequency and voltage variations to 0.25%. It has been test run for periods up to 1¼ hours.

A different type of APU used for extremely short-duration maximum-force power in many missile applications is the cartridge-actuated device (CAD). This device, which uses the controlled power of an explosion, can produce 50-100,000 ft-lbs per lb of weight. They are actuated mechanically (by a firing pin) or by heavy currents (two amps or more). They are used to activate batteries, engage and disengage gear trains, open and close switches and valves, separate components, shear cables and membranes, and unlatch aircraft missile launchers.

Other firms important in APU business include **Hughes, Raytheon,** and **Sundstrand.**

BIAX Units Expected to Replace Semiconductors

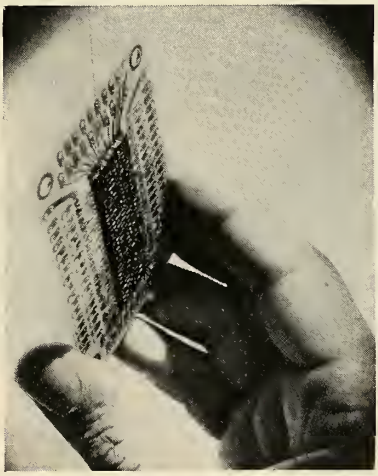
LOS ANGELES—A new microminiature computer element capable of operational speeds up to 20 megacycles per second has been developed here by **Aeronutronic Division** of **Ford Motor Company.** So small that more than 5000 can be held in a man's hand, the elements are expected to result in faster, smaller, and cheaper computing equipment.

Called the BIAX, the units are small (50 x 50 x 85 mils) bars of ferrite magnetic material presently being produced as memory elements and logic devices.

Several advantages are claimed for the BIAX elements over the semiconductor devices they reportedly will replace in the next generation of computers. They operate over a wide temperature range—from below freezing to 125°C. They have low thermal conductivity and are not affected by radiation. Units are relatively inexpensive to produce and reduce the number of solder connections in a typical computer by a factor of 10-100 and the number of connectors by a factor of ten or more. According to the company, an extremely high packing density may be achieved with the tiny units: 200 flip-flops and 3000 gates—the equivalent of 15-20,000 semiconductors—in one-tenth cubic foot.

The basic concept of BIAX is that of flux interference between orthogonal magnetic fields. This is accomplished by means of two 20-mil orthogonal holes through the elements. The flux interference takes place in the magnetic material between the holes. Because of the orthogonality, no normal magnetic coupling occurs between conductors associated with the two holes.

The spacing between the holes determines whether the flux interference is destructive or nondestructive. Nondestructive elements are used in memory applications and the destructive element in logic circuitry. In the memory elements, one of the holes acts as the storage axis while the other acts as the nondestructive interrogate axis. The logical element uses the same hole technique except that the holes are extremely close together.



TYPICAL BIAX array for an electronic digital computer memory unit, this printed circuit card contains more than 300 BIAX elements.

In memory element applications, BIAX provides a very rapid random access memory unit. Elements have been interrogated over 100 billion times at a ten mc rate with no loss in output signal.

Aeronutronic has five military contracts for equipment using the BIAX technique. Work is classified and no details are available.

Expanding the Frontiers of Space Technology in

RECONNAISSANCE

■ Lockheed Missiles and Space Division activities in reconnaissance are among the most advanced in industry. They include such areas as radar, optics, infrared and television. Work in the fields of radar and data link is concerned with research, design and development of systems and equipment for missile tracking, command guidance, detection and relay of information. Noise modulation techniques are under study as part of statistical communication theory and implementation of automatic space communication systems. Of special significance is the development of a radar firing error indicator that measures the intercept trajectory between target and attacking missile.

Solid state work in infrared embraces the development of new systems and subsystems for long range infrared communications, surveillance, range findings and target tracking. Considerable work is being conducted in optical devices and systems employing optics. Capability in this area also extends to scanners, encoders, detectors, read-out devices, and analytics of information processing.

ENGINEERS AND SCIENTISTS

Lockheed's programs reach far into the future and deal with unknown and stimulating environments. If you are experienced in work related to the above areas, you are invited to share in the future of a company that has an outstanding record of achievement and make an important individual contribution to your country's progress in the race for space. Write: Research and Development Staff, Dept. H-2-29, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed

MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM, DISCOVERER SATELLITE, Army KINGFISHER, Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO • HAWAII



missiles and rockets

2nd ANNUAL MISSILE SUPPORT ISSUE

SEPTEMBER 21, 1959

From the magazine which is first and best in Missile Support—the most accurate picture available of the tremendous Missile Support field, which takes a big slice of every missile dollar. Penetrating articles and reports by recognized experts and experienced M/R staff members help you reach the heart of this multi-billion dollar market . . . through the pages of the technical/news weekly of the missile/space industry. Contact your *missiles and rockets* representative today, and find out how you can put your sales message before the men who make the important decisions concerning Support System equipment and capability.

NEW YORK CITY: 20 East 46th Street YUkon 6-3900 • DETROIT: 201 Stephenson Bldg. TRinity 5-2555 • CHICAGO: 139 N. Clark Street CEntral 6-5804 • LOS ANGELES: 8929 Wilshire Blvd. OLeander 5-9161 • MIAMI: 208 Almeria Avenue HIghland 4-8326 • TORONTO: 12 Richmond Street E. EMpire 4-2001 • LONDON: 28 Bruton Street GRosvenor 8356 • PARIS: 11 Rue Condorcet Tru 15-39 • GENEVA: 10 Rue Grenus 34 66 73

ADVERTISING FORMS CLOSE SEPTEMBER 1, 1959

M/R

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

tanford Plans to Build 42-Ft. Radar Dish Antenna

PALO ALTO, CALIF.—Stanford Uni-ersity and the Stanford Research In-itute will build a radar dish antenna tall as a 15-story building for studies the cosmos.

The 142-foot antenna will be the rgest of its type in this country and cond in the world only to the 250-ot dish at Jodrell Bank, England, e university announced last week. he Air Force Cambridge Research enter is providing financial support r the 1½-million-dollar project.

A million-watt radio transmitter—rgest ever built in the 20-60 cycle equency band—will be capable of uncing signals off the Sun and Mars. he gigantic research tool will be used make accurate measurements of anetary distances, explore the sur-ces of the Sun, Moon and planets d measure the rotation speed of enus.

lovel Technique May lass-Produce Transistors

BALTIMORE—A new technique de-loped by **Westinghouse** may pave the ay toward completely automatic mass-oduction of transistors and other miconductor devices.

Using long thin crystals of ger-anium, the devices are formed as a ntinuous series of dots along the sur-ce of the crystal. After electrical nnections are made, the strip is then t into sections, forming individual miconductor units. These are then aled in plastic or metal containers.

Westinghouse believes the entire ocess can be done automatically by achine at high speed and with highly liable results.





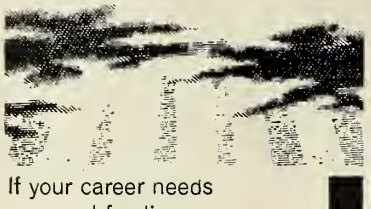
The Atlantic Ocean is the office of the Pan Am Engineer. Our Guided Missiles Range Division assists the Air Force in management, operation and maintenance of the Atlantic Missile Range. From our Division Headquarters at Cocoa Beach, Florida, to Cape Canaveral, the Bahamas, Ascension Island and beyond, members of our technical staff work and live by the sea.

Other creative engineers and scientists will find unique opportunities for professional achievement by the Atlantic Ocean with Pan Am. Address Mr. J. B. APPLEDORN, *Director of Technical Employment*, Dept. B-10.

PAN AM

Guided Missiles Range Division
Patrick Air Force Base, Florida





If your career needs care and feeding...

DOUGLAS AIRCRAFT COMPANY
MISSILES AND SPACE SYSTEMS

has immediate openings in the following fields—

Electrical and Electronics:
Control System Analysis & Design
Antenna & Radome Design
Radar System Analysis and Design
Instrumentation
Equipment Installation
Test Procedures
Logic Design
Power System Design

Mechanical Engineering—
Analysis and Design of the following:
Servo Units
Hydraulic Power Systems
Air Conditioning Systems
Missile Launcher Systems
Propulsion Units and Systems
Auxiliary Power Supplies

Aeronautical Engineering:
Aerodynamic Design
Advanced Aerodynamic Study
Aerodynamic Heating
Structural Analysis
Strength Testing
Dynamic Analysis of Flutter and Vibration
Aeroelasticity
Design of Complex Structure
Trajectory Analysis
Space Mechanics
Welding
Metallurgy

Physics and Mathematics:
Experimental Thermodynamics
General Advanced Analysis in all fields
Computer Application Analysis
Computer Programming and Analysis
Mathematical Analysis

For full information write to:

Mr. C. C. LaVene
Box 620-R
Douglas Aircraft Company, Inc.
Santa Monica, Calif.

missile business . . .

By WILLIAM E. HOWARD

It won't happen overnight, but the Army holds promise of becoming a considerably bigger market for basic and applied research work. Chief agitator for broadening industrial participation is Lt. Gen. Arthur C. Trudeau, chief of Army R&D. For some time now Trudeau has been calling for a step-up in basic research, which presently is funded to the tune of 5% of the Army's $9 billion budget. Applied R&D gets 45%.

In anticipation of a bigger program . . .
Trudeau's office is now in the process of preparing—for industry—a classified document detailing long-range Army research goals and problem areas, in which private research is needed. This document won't be ready for several months—perhaps not until next year. However, it should be an extremely useful guide when it appears—and well worth ordering in advance.

Even if Army research funding is not increased . . .
industry's share of the total may be greater. The Army is showing a tendency to break more and more research out of government arsenals. Maj. Gen. August Schomberg, deputy Chief of Ordnance, says that today his agency is spending about 20% of its money in-house, with 80% going to industrial plants and non-profit institutions.

Areas in which Trudeau sees a real need . . .
include "unexplored" alloys—to find those that will be stronger, more heat-resistant and lighter—and electronics. The Army is looking for surveillance drones to penetrate enemy air space and be capable of sending back information via infrared, radar, photographic film or television. And it is re-emphasizing aircraft that are "low and slow" and can take off like a helicopter. This area may be wide open for propulsion techniques that are being developed for rockets.

Just off the press is a new Air Force booklet . . .
telling about the broad applied research interests of the Air Research and Development Command—and how individual companies can go after contracts. The booklet (obtainable from ARDC at Andrews AFB) is called: "Applied Research Planning Document Release Program." As the title implies, this publication is a reference guide to applied research areas and contains applications for getting planning documents in specific areas such as propulsion, electronics, and metals.

These documents—like the Army's—are classified . . .
and companies must show a "need-to-know" to get them. This may present a problem for firms seeking to break into the defense research field. The documents are classified because they actually define the military problems involved and why the particular service wants to solve them. As such, they are a fair indicator of our technological progress and would be useful to Moscow.

Small business vs. big business over defense contracts . . .
is heading for a showdown in the next session of Congress. The tussle will come over S. 2487 introduced by Sen. George Smathers (D-Fla.), chairman of the Senate Small Business Procurement Subcommittee which investigated "abuses" by large contractors. Smathers contends several large contractors are guilty of pirating engineering know-how from small firms and are making more and more components themselves, rather than subcontracting items.

Coming up before Senate Armed Services Committee . . .
Smathers' bill would provide for more careful screening and contract review by the Small Business Administration of agreements letting private industry use government-owned production equipment; require a fair market rental on such facilities; keep SBA fully informed of major contracts for subcontract opportunities; limit prime contractor profit on subcontracts to actual work performed; and require breakout of components and large segments of weapon systems from prime contracts into open competition. Biggest objector to this proposal very likely will be the Defense Department. It may be an interesting battle.



The care and feeding of a missile system



It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Some immediate openings are described on the facing page. Please read it carefully.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of DOUGLAS

SSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT

MISCELLANEOUS

$1,000,000—**Giannini Controls Corp.**, Pasadena, for precision free and rate gyroscopes. (Two contracts, one from **Bendix Products Div.**, Mishawaka, Ind., and from **The Martin Co.**)

NAVY

$71,237—**The Aro Equipment Corp.**, Bryan, Ohio, for MD-1 and MD-2 oxygen regulators.

AIR FORCE

$73,360—**Avco Corp.**, Research and Advanced Development Div., for research and development of an advanced design re-entry vehicle nose cone for the *Titan* ICBM.

$4,500,000—**Kearfott Co., Inc.**, Little Falls, N.J., subsidiary of **General Precision Equipment Corp.**, for production of attitude Coordinate Converter Systems and related equipment used to provide the *Bomarc* Interceptor with directional control signals. (Subcontract from **Boeing Airplane Co.**, Pilotless Aircraft Division, Seattle.)

$980,680—**McDonnell Aircraft Corp.**, for design and fabrication of an airframe part made of refractory metals to withstand space travel temperatures.

$500,000—**Coleman Engineering Co.**, Torrance, Calif., for GAM-77 *Hound Dog* engineering, tooling and production of positioning and transportation trailers and associated hardware.

$225,000—**Eitel McCullough, Inc.**, San Carlos, Calif., for transmitting tirode electron tubes.

$78,868—**General Electric Co.**, Utica, N.Y., for study of disturbances in radio reception associated with passage of orbital bodies.

$57,200—**Sonotone Corp.**, Elmsford, N.Y., for various electron tubes.

$50,000—**Leach Corp.**, Compton, Calif., for development of instrumentation system to help probe the earth's upper atmosphere.

$30,075—**Telechrome Mfg. Corp.**, Amityville, N.Y., for telemetering transmitters.

$25,256—**Westinghouse Electric Corp.**, Elmira, N.Y., for electron tubes.

ARMY

$3,989,999—**Kaiser Steel Corp.**, Los Angeles, for construction of 305-foot self-propelled tower for erecting and servicing *Saturn* missiles.

$3,641,280—**H. B. Zachry Co.**, San Antonio, Tex., for range instrumentation facilities, White Sands Missile Range.

$2,512,495—**John H. Sellen Construction Co.**, Seattle, for construction of *Bomarc* facilities at Paine AFB.

$2,496,759—**Donald M. Drake**, Portland, Ore., for construction of *Bomarc* facility at Adams AFB.

$2,456,792—**Montgomery, Ross & Fisher**, Los Angeles, for construction of a *Bomarc* facility at Vandenberg AFB, Calif.

$1,952,873—**Lawless and Alford**, Austin, Tex. for construction of *Nike-Hercules* facilities at Bergstrom AFB.

$1,674,830—**Browning Construction Co.**, San Antonio, Texas, for construction of *Nike-Hercules* facilities at Dyess AFB.

$1,657,000—**George A. Rutherford, Inc.**, Albuquerque, N.M., for construction of a *Nike-Hercules* facility at Walker AFB, Roswell, N.M.

$450,000—**Telecomputing Corporation**, Los Angeles, for the manufacture of nuclear warhead testers.

$198,271—**Sperry Utah Lab. Div., Sperry Rand Corp.**, N.Y., for radar set.

$104,806—**Western Electric Co., Inc.**, N.Y. for electron tubes.

$84,037—**Radioplane, Div. of Northrop Corp.**, Van Nuys, for drone system, low-speed.

$75,000—**General Electric Co.**, Syracuse, N.Y., for research and development leading to the establishment of designs for solid state reciprocal and non-reciprocal filters, transformers and delay lines and the fabrication samples.

$72,713—**McCullough, Inc.**, San Carlos, Calif., for electron tubes.

$67,095—**Radio Corp. of America, Electron Tube Div.**, Harrison, N.J., for electron tubes.

$55,249—**General Electric Co.**, Schenectady, N.Y., for electron tubes.

BENDIX SR RACK AND PANEL CONNECTOR

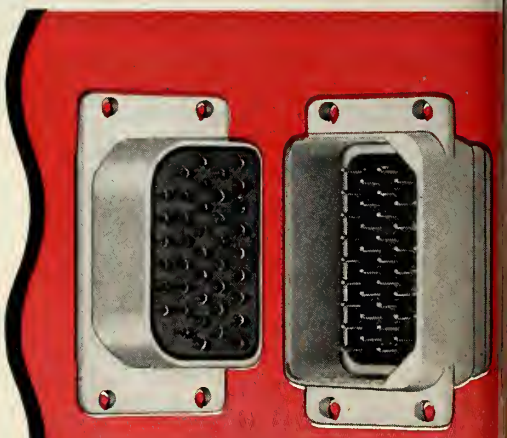
with outstanding resistance to vibration

The Bendix type SR rack and panel electrical connector provides exceptional resistance to vibration. The low engagement force gives it a decided advantage over existing connectors of this type.

Adding to the efficiency of this rack and panel connector is the performance-proven Bendix "clip-type" closed entry socket. Insert patterns are available to mate with existing equipment in the field.

Available in general duty, pressurized or potted types, each with temperature range of −67°F to +257°F.

Here, indeed, is another outstanding Bendix product that should be your first choice in rack and panel connectors.



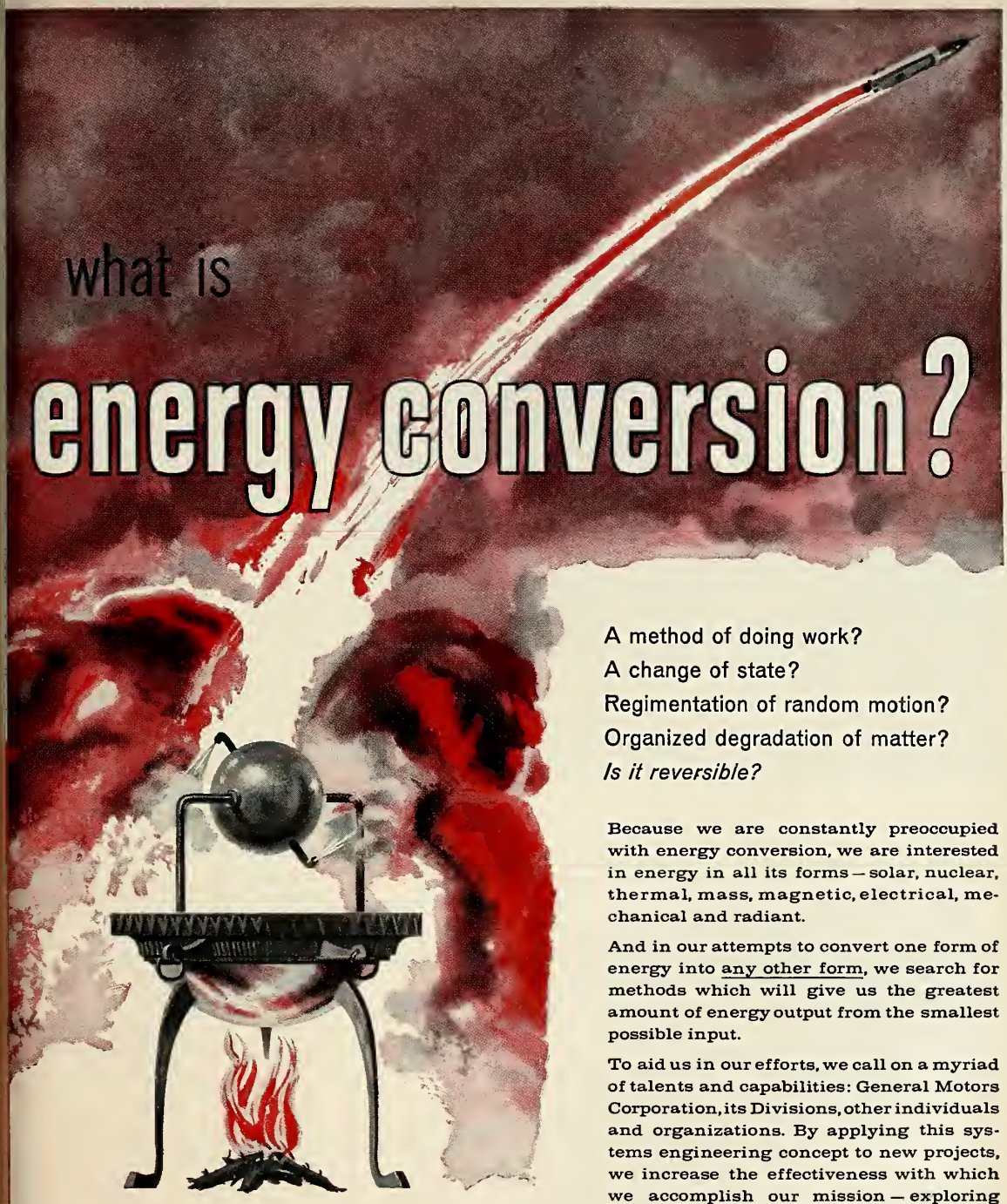
FEATURES:

Resilient Insert • Solid Shell Construction • Low Engagement Forces • Closed Entry Sockets • Positive Contact Alignment Contacts—heavily gold plated Codmium Plate—clear irridite finish • Easily Pressurized to latest MIL Specifications.

SCINTILLA DIVISION
SIDNEY, NEW YORK

Bendix
AVIATION CORPORATION

Expart Sales and Service: Bendix International Div., 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliates: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.
Factory Branch Offices: Burbank, Calif.; Orlando, Florida; Chicago, Illinois; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.



A method of doing work?
A change of state?
Regimentation of random motion?
Organized degradation of matter?
Is it reversible?

Because we are constantly preoccupied with energy conversion, we are interested in energy in all its forms — solar, nuclear, thermal, mass, magnetic, electrical, mechanical and radiant.

And in our attempts to convert one form of energy into any other form, we search for methods which will give us the greatest amount of energy output from the smallest possible input.

To aid us in our efforts, we call on a myriad of talents and capabilities: General Motors Corporation, its Divisions, other individuals and organizations. By applying this systems engineering concept to new projects, we increase the effectiveness with which we accomplish our mission — exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business

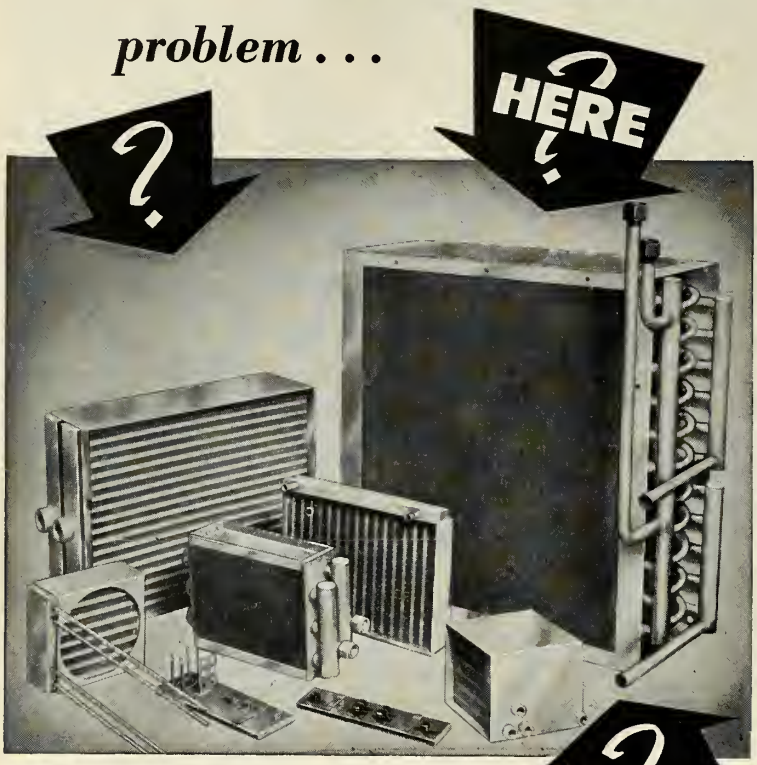
ALLISON

Division of General Motors, Indianapolis, Indiana

Is the answer to your

HEAT EXCHANGER

problem . . .



THE photographic compilation above is important to you.

It is concrete evidence that among Dunham-Bush Inner-Fin Heat Exchanger equipment you will find the unit which best meets your particular design and performance demands, whether for airborne, ground support, lubricant, missile, computer, or air conditioning system cooling.

Patented Inner-Fin coils make the vital space-saving difference. They reduce a unit's coil size by as much as 60%, yet they maintain the same air and liquid pressure drops through the coil as does a standard finned tube coil which needs much more space.

The answer to your heat transfer problem . . . critical or common . . . is available to you from Dunham-Bush, where product precision and engineering insight combine to satisfy the air conditioning, refrigeration, and heating needs of our growing space-age industry.

AIR CONDITIONING · HEATING · DUNHAM-BUSH · REFRIGERATION · HEAT TRANSFER

Dunham-Bush, Inc.

WEST HARTFORD 10, • CONNECTICUT, • U. S. A.

SALES OFFICES LOCATED IN PRINCIPAL CITIES

(continued from page 15)

E. I. du Pont de Nemours Co. Inc. i planning to give major attention t high-temperature metals at its new re search center now a-building at Balti more . . . At St. Louis, **Monsant Chemical** is starting construction of plant to produce ultra-pure silicon—fo semiconductors . . . Solid-state physics theory of metal binds, the structure o plastics and other research will be ex panded into a new facility being erecte by **Union Carbide Research Institut** near Tarrytown, N.Y. It will be read late next year . . . **Avco** has come u with a small plasma generator for flam spraying ceramics at 15,000°F. Prod uct is similar to devices developed b **General Electric's** Rocket Engine Sec tion and by **Giannini Plasmadyn Corp.,** which developed the first pro duction plasma sprayer.

AF, Navy Cutting Off Boron Fuel Production

Production of boron-type fuel appears to be all but dead. The Ai Force has cancelled the schedule opening next month of a $45 millio plant at Model City, N.Y., wher **Olin Mathieson Chemical Corp.** wa getting ready to produce high energ fuels developed at a cost of $55 millior

The Navy also is ready to shu down its $37 million **Callery Chemica** plant at Muskogee, Okla., the onl other DOD plant concerned with high energy compounds. Earlier this summe the Navy cancelled a boron prograr with **Metal Hydrides,** Beverly, Mas The AF also cancelled the **Gener Electric Co.** J93-5 boron-fueled je engine being developed for the B-7 at a cost of $10 million. B-70, whic may be scratched, will now use cor ventional fuels. (See story on p. 48.)

Actual cents-per-hour wage in creases to be sought jointly by th IAM-UAW in the missile/aircraft ir dustry next year will be decided at "price tag" conference of the tw unions later this year. A 15-cent pe hour hike may be under consideratior

Latest scientific apparatus to b subjected to miniaturization—the mas spectrometer—will make a truly sig nificant transition. A unit being de signed for a 35-inch satellite by **Con solidated Systems Corp.** will occup only one-half cubic foot and weigh 1 pounds. Standard spectrometers use in oil refineries weigh four tons an require an entire small room. Th smallest previous model was a desk type unit weighing 115 pounds. Tw of the new spectrometers will b orbited in a NASA satellite to gain a accurate analysis and measurement o the exosphere between 150 and 60

miles above the earth. Launching is scheduled for 1961.

Army's new satellite-tracking station, atop Madkin Mountain at Redstone Arsenal, went into operation last week. The installation will track ABMA satellites launched under the direction of NASA.

Antennas include two 108 mc colinear arrays, a steerable 20 mc beam yagi, and three simple dipoles. The 108 mc units measure 20 x 20 feet and stand 27 feet high. One is polarized horizontally and the other vertically.

The station also includes receiving and recording equipment, digitizers, automatic teletypewriter to transmit tracking data to the ABMA Computation Laboratory, and an automatic graphic recorder. The antennas, from their 1250-foot mountaintop site, can track satellites anywhere above one-degree elevation.

Two *Minuteman* Silos Being Built at Cape

Launching facilities for **Boeing** *Minuteman*—including two underground silos—will be built at Cape Canaveral during the next nine months under a $5.3 million contract.

The reinforced concrete silos will be approximately 90 feet deep and 26 feet in diameter. Both launching complexes will also include domed blockhouses, instrumentation and launch support buildings, underground checkout and transformer rooms and two 1480-foot service tower tracks.

In addition there will be assembly facilities consisting of one inspection and assembly support building, two missile assembly buildings and two engine receiving and inspection buildings. Specs also call for two engine storage and one missile storage building, some hangar alterations and extensive exterior electrical work. Contractor for the Corps of Engineers is the **George A. Fuller Co.**, Atlanta.

Bendix *Eagle* Team

Contractor lineup for the Navy's long-range air-to-air *Eagle* missile now includes in addition to **Bendix Aviation,** the prime: **Grumman Aircraft Engineering Corp.,** Bethpage, L.I. (major sub for airframe, propulsion system, launching and support equipment); **Sanders Associates,** Nashua, N.H. (seeker); **Litton Industries,** Beverly Hills, Calif. (tactical computer); **Air Arm Division, Westinghouse Corp.,** Baltimore (airborne intercept radar). Bendix's Research Laboratories Division, Detroit, will develop electronic guidance and its Pacific Division, North Hollywood, Calif., will design and produce subsystems and perform missile assembly and tests.

THE GRAND CENTRAL REPORT

Mr. Customer is always the most important visitor to Grand Central Rocket Co.; his first question is most pertinent.

"How is my problem to be handled by your company?"

We have a to-the-point answer:

The day Mr. Customer sends his letter of intent, a full-time Project Manager is assigned.

He reviews the proposal, makes a budget study, sets a work schedule, directs preparation of a contract and assembles a staff.

He reaches into Engineering for the most experience in Mr. Customer's type project. He searches R & D, Manufacturing and Test for precisely the right people for all jobs.

By the time the Customer's contract is here, our Project Manager is in business. He is ready and equipped to be Mr. Grand Central Rocket to Mr. Customer. Throughout the plant, he is respected as Mr. Customer himself.

Thus, our customer deals with a single-point contact who reports at vice president level. Mr. Customer never has to wait for a decision on his project.

Management instructions to the Project Manager are unique: Provide your customer with the *intent of his requirements—within legal limitations!*

We are proud of this position at Grand Central. It is a distinct advantage to our customer when contrasted with a common method of operation—rigid adherence to legal language as the prime requisite while secondarily fulfilling the customer's needs.

Recently we have added new strength to an already strong Project Management staff. Grand Central Rocket's Project Managers are men with the highest technical ability, veteran experience in solid motors and propellants—men of integrity.

We know you will find Grand Central Rocket's streamlined Project Management system a time-saver, a money-saver and an incentive to permanent customer relationships.

John J. Crowley, Vice President
Project Management and Marketing

(If you have the qualifications that a fast-moving space propulsion team needs, contact our Director, Personnel. Openings now for chemists and engineers.)

Grand Central Rocket Co.

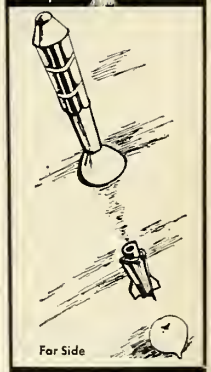
An Affiliate of Tennessee Gas Transmission Company
And Food Machinery and Chemical Corporation

P. O. Box 111 Telephone: PYramid 3-2211
REDLANDS, CALIFORNIA


Mercury

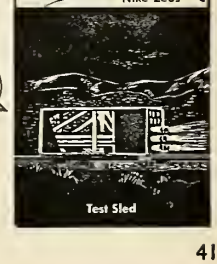

Terminal Stage, NASA


Explorer III and IV


For Side


Vanguard


Nike-Zeus


Test Sled

Engineering and management opportunities in...

RCA SYSTEMS SUPPORT PROJECTS

RCA offers expanding opportunities in Weapon Systems Support projects. This work involves program planning, advanced operations analysis, systems analysis, equipment development and design, and systems integration. Experience is desired in the many areas of systems support—checkout and test equipment, logistics, and training.

Exceptionally fine professional and management positions are available to EE's, ME's, Mathematicians, and Physicists with at least five years of experience.

Salaries are excellent; opportunities for advancement, unlimited. Benefits are among the best in the industry.
Several current Systems Support Project areas are:

Aircraft electronics systems

Military and civil digital communications systems

Missile systems

Space vehicles and space stations

FOR INTERVIEW WITH ENGINEERING MANAGEMENT:

Please send complete résumé to:

Mr. C. B. Gordon
RCA, Box Z-22HA
Professional Employment
Building 10-1
Camden 2, N.J.

RADIO CORPORATION OF AMERICA
Defense Electronic Products

people

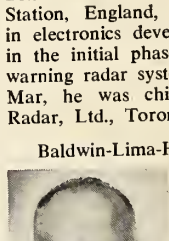


JACKSON

Packard Bell Computer Corp. ha named **Kenneth F Jackson** technic assistant to the d rector. Jackson, wh holds several patent for missile autc pilot devices, form erly was special a sistant to the pres dent of the Waug Engineering Co.

William O. Boschen has been ap pointed to the Board of Directors c Avien, Inc. Boschen also is vice pres dent and general manager of Avien. Be fore joining Avien in 1954, Bosche was eastern regional manager Minnea polis-Honeywell's Aeronautical Divisio and manager of Aircraft Export, Av quipo, Inc., New York.

Douglas Aircraft Co. has appointe three *Nike* Systems project engineers t missile testing activities, **W. J. Binghan** project aerodynamicist on the *Nike He cules*, has been named *Nike* proje engineer (field station testing); **J. L. Cub** chairman of the *Nike Hercules* and *Nik Zeus* test planning and evaluation con mittee, named *Nike* project engineer White Sands missile range; and **L. I Marshall,** test planning coordinator fc the overall *Nike Zeus* field test progran has been appointed *Nike* project enginee at Point Mugu to work out details c future *Nike Zeus* tests on Pacific Missil Range.



SANCTUARY

Cliff Sanctuary, a member of th original radar r search team unde **Sir Robert Watso Watt,** "father c radar," has joine Del Mar Enginee ing Laboratories assistant chief e gineer for ele tronics. Sanctuar served with th British Air Ministry at Bawdsey Researc Station, England, where he participate in electronics development programs an in the initial phases of the British earl warning radar system. Before joining D Mar, he was chief engineer of Decc Radar, Ltd., Toronto, Canada.



FIELDER

Baldwin-Lima-Hamilton Corp., Phil delphia, has a nounced election **Frederick A. Field** as vice presider and general manag of the corpor tion's Loewy-Hydr press Division, Ne York City. Gener sales manager an assistant gener manager of the d vision since 1955, Fielder succeeds th late **Erwin Loewy.**

Control Data Corp. has announced promotions of the following men who were among the founders of the company when it was established in 1957. **Seymour R. Cray,** formerly associate director of engineering becomes engineering director of the Computer Division. **William R. Keye** has been elected vice president for Research and Engineering. Prior to joining CDC, he held engineering positions with Radio Corp. of America, Airborne Instruments Laboratory, Inc., Engineering Research Associates, and Remington Rand Univac where he was director of Product Design for commercial computer programs.



ROSA

Gilbert N. Rosa has been elected a member of the board of directors of Statham Instruments Inc., Los Angeles manufacturer of transducers. Rosa's elevation to a directorship, according to the company, is part of a long-range expansion plan.



COPLEN

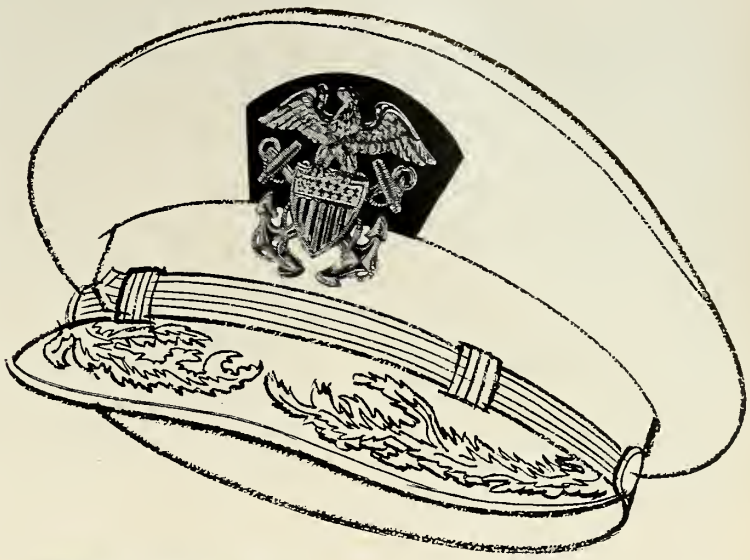
Aerojet-General Corp.'s Liquid Rocket Plant, has announced that **Herman L. Coplen, Jr.,** left the Systems and Control Department which he headed to join the Advanced Research Projects Agency in Washington, D.C. He will specialize in space research and in ballistic missile evaluation. Coplen, 43, joined the company in 1943 in Azusa, was active in the development of liquid fuel assist take off rockets for the Air Force F-84 and the B-47 and pioneered many programs now vital to the Space Age.

Andrew C. Bayle has been elected vice-president—Engineering by the directors of the Waltham Precision Instrument Co. (formerly Waltham Watch). Before joining Waltham Precision Bayle spent several years at Vectron, Inc. where he was chief engineer and assistant to the president.



HURST

Appointment of **William F. Hurst** as Director of Quality Control at the Leach Corp. Compton facilities has been announced. Hurst will be responsible for all quality control activities at the Inet and Special Products Division, including the development and management of a total quality control plan. He was formerly director of Quality Control at Hallamore Electronics Co.



EAGLE

. . . an advanced system program for better professional personnel

As the symbol of our Navy's air-to-air advanced weapon system concept, the Eagle presents a new challenge to senior professional personnel in technical and management fields.

Bendix Aviation Corporation will develop the Eagle long-range missile system. The Bendix Systems Division of Ann Arbor, Michigan with laboratories also in Van Nuys, California holds the prime system management and engineering responsibility.

Specifically, Bendix Systems Division has opportunities for the following personnel in Michigan and California—project supervisors and engineers in:

- **missile guidance and control**
- **countermeasures**
- **weights and aerodynamics**
- **displays and human factors**
- **airborne radar and computers**
- **systems analysis**

Working with top men in these fields at Bendix Systems Division, you will find conditions ideal for personal achievement and pleasant living. If you are interested and qualified, please write Bendix Systems Division, Department K8-17, Ann Arbor, Michigan, or Van Nuys, California.

Bendix Systems Division
ANN ARBOR, MICHIGAN
VAN NUYS, CALIFORNIA

Bendix
AVIATION CORPORATION

NEW VOUGHT PROJECTS OFFER CAREER APPEAL TO CREATIVE MEN

Space, ASW, and weapon system work at Vought requires continuous R & D in methods and materials, structures and design. These projects have prompted exploratory work in the following areas:

Structures (Supersonic and Hypersonic)
Heat transfer, thermal stress and deflection analysis, and stress analysis using high-speed computers.

Manufacturing R & D
Welding and brazing of super alloys and exotics; advanced forming and cutting studies; prediction of metal fabricability.

Industrial Engineering
Project estimating, work sampling, line load and balance, and packaging and installation of new procedures.

Antisubmarine Warfare
Studies of detection and classification techniques involving Acoustics, Geomagnetism, Geophysics, Electromagnetics, Electrochemistry, Math.

Engineering Planning
Man-hour and budget forecasting, and project planning and scheduling.

Product Design
Automatic escape devices, atmospherically sound cockpits and advanced instrument displays for space pilot, crew.

Flight Test Instrumentation
R & D in new techniques for electronic gathering and reducing of flight test data.

Aerodynamics
Wind tunnel and model work employing Vought's 3,800-mph high-speed wind tunnel and new "high-temperature" laboratory.

Qualified applicants are invited to write:

J. W. Larson
Ass't Chief Engineer, Administrative Dept. P-15

CHANCE VOUGHT
DALLAS, TEXAS

propulsion engineering . . .

By M/R STAFF

Suppress combustion instability . . .

in solid propellant motors by one of these three methods: Damping, acoustic interference, additives. This is the gist of a paper by E. W. Price, presented at the 9th International Astronautics Congress. Price discusses the three most effective and practicable methods of suppressing instability. "Damping" refers to viscous damping and temperature damping. "Acoustic interference" makes use of geometries that preclude easy excitation of natural modes of the combustion chamber. "Additives" considered by Price are suppressants such as aluminum oxide or carbon which block excitations.

The paper also discusses . . .

the various ways in which combustion instability shows itself and the conditions under which it occurs. Price also discusses the mechanism of combustion instability, the phase relations that permit excitation and methods for detecting instability.

European hydrogen peroxide capacity . . .

expands with the announcement of an addition to **Elfa, Ltd., Electrochemical Works** at Aarau, Switzerland. The new facilities are "Americanized" in that they incorporate designs and techniques used by **Food Machinery and Chemical Corporation's Becco Chemical Division** plants at Buffalo, N.Y., and Vancouver, Wash. It is an electrolytic process. Elfa does not have European missile industry or U.S. missile bases in mind as immediate markets—output will go to the textile, paper, and chemical industries for use as a bleach, plasticizer and chemical process intermediate. Output will be far below the 90%+ H_2O_2 needed for missiles, but the capability will be there if needed.

Synthetic lubricants . . .

for use at high temperatures are among the potential uses that **Union Carbide Corporation** sees for its new *iso*-decanoic acid—a mixture of isomers. Other potential applications are as a plasticizer, defoamer or corrosion inhibitor. Its boiling point (760 mm) is 254°C. It sets to a glass below –60°C. Price right now is 32¢ per pound in tank car lots.

Metallic lithium and derivatives . . .

formerly shipped from **Lithium Corporation's** Minneapolis plant will be shipped from Bessemer City, N.C., beginning in January. Lithium Corp. plans to save $500,000 to $1 million a year by moving everything to its North Carolina facility. The Bessemer City unit, now valued at $7 million, will be expanded; research labs and pilot plants will be added.

Investigating boron?

Boron derivatives are not entirely out of the fuels picture and some firms are either continuing their investigations or starting new ones in the hope of finding a way to salvage work already done. The Oak Ridge National Laboratory makes new types of fundamental studies possible by releasing research quantities of boron containing 92% B^{10} which can be traced through reactions. ORNL also announces availability of special boron compounds made up with B-10.

Russian missile industry chemists . . .

have the same interests and are working on the same projects as are U.S. missile chemists. Examples: T.V. Antipina and E.N. Avdonina are studying the influence of boron fluoride on the catalytic activity of aluminum oxide and alumosilicates. N.A. Slavinskaia, S.A. Kamenetskaia, and S. Ia. Pshezhetskii are studying the effect of ozone on combustion of hydrocarbons.



RELIABILITY

is what determines the success or failure of any weapon system at launch and during flight. Here at the Missile Division of North American Aviation, we are constantly striving to improve this most vital state of the art through analysis and evaluation of environmental criteria, system design analysis, statistical test programs, and other advanced reliability techniques. Engineers and statisticians with a minimum of five years full time related experience in aircraft or missile engineering will find this a most stimulating career in present and future efforts under development.

Write or send resume to:

B. H. Cunningham, Mgr.
Employment Services
12214 Lakewood Blvd.
Downey, California

MISSILE DIVISION
North American Aviation, Inc.

Project *Tepee* May Cost Less, Outperform BMEWS

WASHINGTON—Project *Tepee*—the Navy's missile warning system—could make the vast multimillion-dollar BMEWS system obsolete.

However, it would not necessarily eliminate the need for *Midas*—the early-warning satellite.

Tepee, now under R&D, is considered capable of detecting the firing of Soviet missiles seconds after launching. That would give about 30 minutes warning time.

BMEWS will be able to detect oncoming ICBM's when they are about 2500 miles away. That will mean about 15 minutes warning.

At best, therefore, BMEWS would only provide a back stop for an operational *Tepee*.

RCA's BMEWS is expected to cost more than $1 billion. It probably will be operational in about two years.

The Navy estimates that *Tepee* is comparatively much cheaper and far smaller than BMEWS. It possibly could be operational in less than three years.

Tepee—A development of Dr. William J. Thaler of the Naval Research Laboratory—is based on the use of ionospheric backscatter from high-frequency radar transmitters.

Navy scientists found that backscatter comes not only from the ground but also from plasma clouds resulting from the launching of a missile or nuclear explosions.

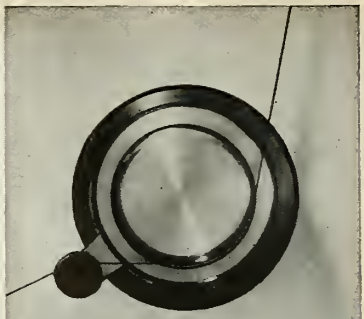
• **Success reported**—Thaler and his associates already have detected missile launchings and nuclear explosions over intercontinental ranges by using breadboard equipment.

Moreover, the Navy has strongly indicated that it has detected Soviet missile launchings with *Tepee*. However, it stresses that the entire program is only in the R&D stage.

Thaler says that no breakthroughs are needed to perfect his system. He said the work ahead is mainly in the field of improving the quantity and quality of the information that can be obtained through the use of *Tepee* so that ICBM's can be tracked.

Scientists at Stanford and Yale Universities, **ACF Industries** and several other laboratories have joined in the research work. So far only about $2.7 million has been spent or budgeted for the program.

Tepee does not necessarily affect the attractiveness of **Lockheed's** *Midas* because the use of a satellite for early warning also provides a possible launching platform for trying to intercept a missile once it is launched.



AMPEX: turning point for tape

Magnetic recording has reached the point where a better tape, by itself, can significantly improve the performance of your equipment. Anticipating this, Ampex has developed its Instrumentation Tape to assure the highest capability that the state of the art requires.

Precision tape reliability comes principally from the properties of its coating. And Ampex combines oxide preparation and careful coating techniques with the exclusive Ferro-Sheen process to produce the smoothest, most cohesive, most uniform of precision tapes. The result is measurably higher signal-to-noise ratios, and much less tape wear.

This, with its squared-up hysteresis curve, makes Ampex Instrumentation Tape ideal for all recording systems: direct, FM-carrier, PDM, and NRZ-digital.

Ampex Instrumentation Tape is available on hubs, NAB-type or die-cast magnesium - alloy Precision Reels. Widths of ¼", ½" and 1" are standard on either Mylar* or acetate base, in the following lengths, reel diameters, and base thicknesses:

AMPEX STANDARD TAPE LENGTHS (feet)

REEL DIAMETER	BASE THICKNESS (mils) 1.0	1.5
7"	1800	1250
10½"	3600	2500
14"	7200	5000

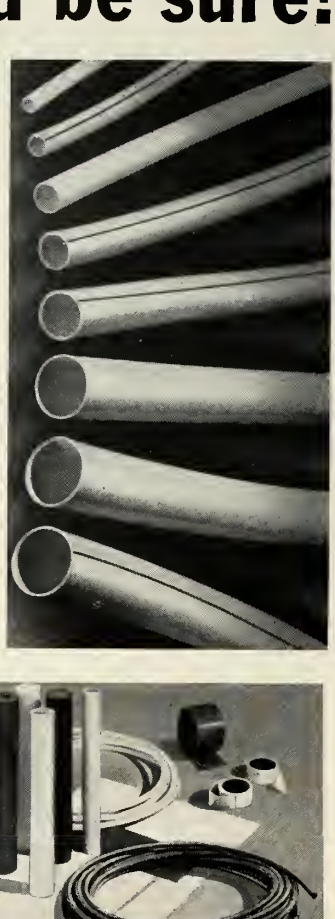
*DU PONT TRADEMARK

For complete specifications or additional tape literature, write

AMPEX MAGNETIC TAPE
934 CHARTER STREET, REDWOOD CITY, CALIF.

If the job calls for TEFLON* use R/M and be sure!

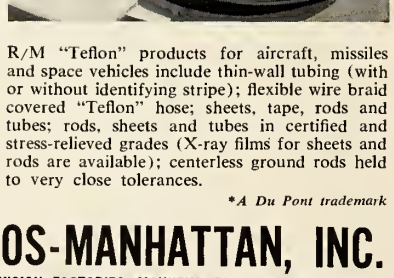




Minimize the risk of failure of a "Teflon" part or component at a critical point by getting it from Raybestos-Manhattan.

R/M has been in the forefront of "Teflon" development from the beginning. Our engineers *know* "Teflon" . . . its unique characteristics, its vast potentialities, how it can best serve the needs of a particular industry. Our production men have the know-how and complete plant facilities to follow through. You specify it; they fabricate it.

We understand the complexities of your problems—friction, extremes of temperature, the corrosive action of exotic fuels, etc.—and will give you all possible aid in designing, molding or machining the R/M parts or components you need. Make R/M your headquarters for all the "Teflon" products you need. Call upon your nearest R/M district office for the cooperation you require—or contact us direct.



R/M "Teflon" products for aircraft, missiles and space vehicles include thin-wall tubing (with or without identifying stripe); flexible wire braid covered "Teflon" hose; sheets, tape, rods and tubes; rods, sheets and tubes in certified and stress-relieved grades (X-ray films for sheets and rods are available); centerless ground rods held to very close tolerances.

*A Du Pont trademark

RM

RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION FACTORIES: MANHEIM, PA.; PARAMOUNT, CALIF.

Contact your nearest R/M district office listed below for more information or write to Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

BIRMINGHAM 1 • CHICAGO 31 • CLEVELAND 16 • DALLAS 26 • DENVER 16 • DETROIT 2 • HOUSTON 1
LOS ANGELES 58 • MINNEAPOLIS 16 • NEW ORLEANS 17 • PASSAIC • PHILADELPHIA 3
PITTSBURGH 22 • SAN FRANCISCO 5 • SEATTLE 4 • PETERBOROUGH, ONTARIO, CANADA

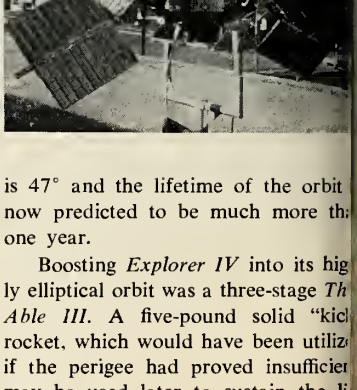
RAYBESTOS-MANHATTAN, INC., Engineered Plastics • Asbestos Textiles • Mechanical Packings • Industrial Rubber Sintered Metal Products • Rubber Covered Equipment • Abrasive and Diamond Wheels • Brake Linings Brake Blocks • Clutch Facings • Laundry Pads and Covers • Industrial Adhesives • Bowling Balls

Explorer VI Gives NASA New Tracking Capability

WASHINGTON—The successful c eration of *Explorer VI*'s 8000 sol celled power system gives NASA t capability of tracking deep space prob over 50 million-mile distances.

A fall launching of *Atlas Able* is now scheduled as the first attem to utilize the Space Technology Labor tories' power unit on a deep space m sion.

Early data established *Explorer V* 142 lb. payload's apogee to be 26,4 statute miles, and its perigee 156 s tute miles. The period of orbit is hrs., 46 min., during which the satell so far has travelled a total of 91,1 miles. The orbit's angle of inclinati



is 47° and the lifetime of the orbit now predicted to be much more th one year.

Boosting *Explorer IV* into its hig ly elliptical orbit was a three-stage *Th Able III*. A five-pound solid "kic rocket, which would have been utiliz if the perigee had proved insufficie may be used later to sustain the li of the orbit.

The payload, developed under t direction of STL, carried 15 major e periments designed to tell scientis about the environment encounter over the long orbit, and to test prop gation techniques over long distanc in space. Of particular interest was 2½ lb. scanning device designed relay a crude picture of the earth cloud cover.

Companies contributing researc and hardware to the *Explorer VI* e periment, as listed by STL, included t **Atlantic Research Corp., Engineer Magnetics, Gilfillan Bros., Hallamo Electronics Co., Hoffman Electroni Inc., Motorola Inc., Radiation In Rantec Inc., Space Electronics Cor Stanford University, University of Ch cago, and the University of Minneso**



WESTERN GEAR CAN SUPPLY THE SOLUTIONS

PRECISION PRODUCTS DIVISION

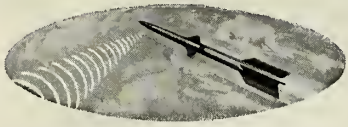
To insure the reliability of the missile, its positioning must be accurately and cautiously handled. No matter what mode of transportation, truck, rail, air or water, there are Western Gear precision drives and related equipment engaged in the touchy and delicate task of handling the mighty "birds." Moreover, Western Gear's extensive experience and facilities enable the company to effectively handle your system requirements.

For complete information on our capabilities and facilities, write on your letterhead for Bulletin 5900.

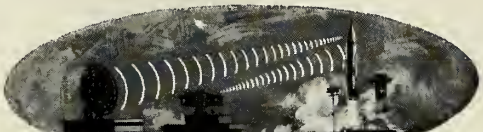
WESTERN GEAR CORPORATION
Precision Products Division, P.O. Box 192, Lynwood, California

5921

Interested in Systems Engineering?



There are systems



...and systems

...and TOTAL systems in which the big bird and support equipment may rank only as a component.

This difference between systems can make a big difference in your career

IF YOU ARE QUALIFIED and interested in contributing to programs of "total" scope, it will be of value to you to investigate current opportunities with General Electric's DEFENSE SYSTEMS DEPT., whose work lies primarily in providing *total* solutions to large scale defense problems of the next 5, 10 and 20 years.

The work here lies almost entirely in the areas of systems engineering and systems management.

Inquire about these positions:

Guidance Equation Engineers
Systems Logistics Engineers
Electronic Systems Management Engineers
Operations Analysis Engineers
Systems Program Engineers
Data Processing Engineers
Systems Test Evaluation Engineers
Engineering Psychologists
Radar Equipment Engineers
Weapons Analysis Engineers
Weapons Systems Integration Engineers
Engineering Writers

Forward your confidential resume at an early date.

Whereas the growth potential is evident — both for DSD and the engineers who join us — the positions we fill during these early months will carry significant "ground-floor" benefits.

Write fully to Mr. E. A. Smith, Room 8-G.

DSD DEFENSE SYSTEMS DEPARTMENT
A Department of the Defense Electronics Division

GENERAL ELECTRIC

300 South Geddes Street, Syracuse, N. Y.

Pentagon Calls Halt to HE Boron Fuels Program

WASHINGTON—Research and deve opment work will be continued i high-energy boron type fuels despi a decision by the Defense Departme to abandon plans for quantity produ tion. However, indications are th this work will be dropped when cu rent contracts run out.

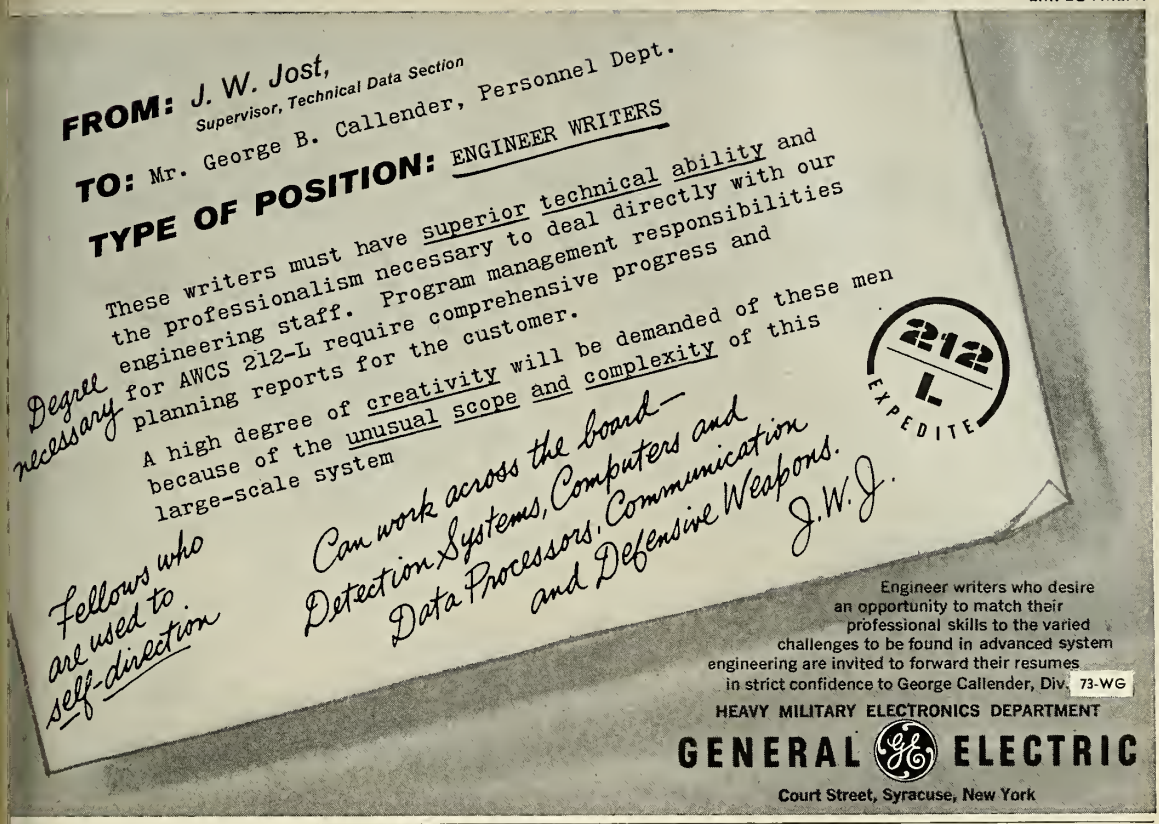
The Air Force has research an development contracts which are co tinuing with **Olin-Mathieson Chemic Corp., Callery Chemical Corp.; AF Corp.,** a corporation owned by **Ame ican Potash Company; Food Machi ery & Chemical Corp.** and **Nation Distillers;** and **Aerojet-Stauffer Chen ical Co.**

The difficulty with the fuel, a cording to informed sources, is that is literally too hot and too expensiv to handle. Original plans called f using it first in aircraft and later i ballistic missiles. As matters no stand, improvements in hydrocarbo fuels—and in chemical fuels producir a higher energy which are less crank to handle—have resulted in by-passir boron—at least for the time being.

As a result, the Air Force will n permit Olin-Mathieson to open i newly completed Model City, N.Y plant which cost about $45 millio Similarly, the Navy will not allow th almost-completed Callery Chemic plant in Muskogee, Okla., to ope The Callery plant cost the Navy f land, plant and equipment abo $35,355;000. Since 1955, the Air For has spent about about $55 million develop boron-type fuels. The Nav estimates its costs for research and d velopment, which started in 1952, about $122 million. The Navy's figur include plant and equipment. How th AF and Navy plants will be use hasn't been decided.

• **Changing Signals**—Pentagon o ficials are using the boron story illustrate the current difficulty in pr viding firm research programs. Abo eight months ago, President Eisenhow in a message to Congress cited th boron high-energy fuel program as major importance. He said the pr gram had a top national priority. No at least for the foreseeable futur there will be no quantity production the fuel.

The big question is why more tha $200 million was spent before the d cision came to write production o Answers may finally be forthcomi when a report now being prepared b **Arthur D. Little Company** for th Secretary of Defense is made publ in mid-September.



Advertisers' Index

erojet-General Corp., Sub.-General Tire & Rubber Co. 14
Agency—D'Arcy Adv. Co.
iResearch Mfg. Co., Div.-The Garrett Corp. 12
Agency—J. Walter Thompson Co.
llison Div.-General Motors Corp. 39
Agency—Kudner Agency, Inc.
mpex Corp. 45
Agency—McCann-Erickson, Inc.
ndrew Corp. 4
Agency—Frank C. Nahser, Inc.
ndix Aviation Corp., Bendix Systems Div. 43
Scintilla Div. 38
Agency—MacManus, John & Adams, Inc.
eing Airplane Co. 11
Agency—Calkins & Holden, Inc.
hance Vought Aircraft, Inc. 44
Agency—Tracy-Locke Co., Inc.
uglas Aircraft Co., Inc. 36, 37
Agency—J. Walter Thompson Co.
nham-Bush, Inc. 40
Agency—William Schaller Co.
rand Central Rocket Co. 41
Agency—Jakobsen Adv. Agency
ughes Aircraft Co. 52
Agency—Foote, Cone & Belding
ternational Telephone & Telegraph Corp. 6
Agency—J. M. Mathes, Inc.
t Propulsion Laboratory, Calif. Institute of Technology 25
Agency—Stebbins & Cochran
ach Corp., Relay Div. & Inet Div. .. 2
Agency—Hixson & Jorgensen, Inc.
ckheed Aircraft Corp., Missile System Div. 33
Agency—Hal Stebbins, Inc.
Magnavox Co., The, Government & Industrial Div. 30
Agency—Rothbardt & Haas Adv., Inc.
Melpar, Inc. 51
Agency—Larrabee Associates Adv.
North American Aviation, Inc.,
Autonetics Div. 3
Missile Development Div. 26, 45
Rocketdyne Div. 8
Agency—Batten, Barton, Durstine & Osborn, Inc.
Northrop Corp. 16
Agency—Edwin Wasey, Ruthrauff & Ryan, Inc.
Pan American World Airways, Inc. .. 35
Agency—Willard E. Botts Adv., Inc.
Photocon Research Products 29
Agency—Balsam Adv., Inc.
Radio Corp. of America 42
Agency—Al Paul Lefton Co., Inc.
Raybestos-Manhattan, Inc. 46
Agency—Gray & Rogers
Raytheon Mfg. Co. 28
Agency—Donahue & Coe, Inc.
Ryan Aeronautical Co. 7
Agency—Batten, Barton, Durstine & Osborn, Inc.
System Development Corp. 13
Agency—Stromberger, LaVene, McKenzie
Vapor Heating Corp. 10
Agency—William Hart Adler, Inc.
Western Gear Corp. 47
Agency—Adams & Keyes, Inc.

EMPLOYMENT SECTION

General Electric Co. 48, 49
Agency—Deutsch & Shea, Inc.

when and where

AUGUST

Institute of Radio Engineers, Western Electronic Show and Convention, Cow Palace, San Francisco, Aug. 18-21.

AFOSR/Propulsion Research Division, Directorate of Aeronautical Sciences Office of Naval Research, Office of Ordnance Research and National Aeronautics and Space Administration, Symposium on "The Dynamics of Ionized Cases," Northwestern University, Evanston, Ill., Aug. 24-25.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare, (classified), San Diego, Calif., Aug. 24-26.

USAF's Ballistic Missile Division; Space Technology Laboratories Inc., Fourth Symposium on Ballistic Missile and Space Technology, Los Angeles, Calif., Aug. 24-27.

International Commonwealth Spaceflight Symposium, Church House, Westminster, London, England, Aug. 27-29.

The Benevolent Tyranny of Congress

There must be a moral involved in the recent bill passed by both houses of Congress, a bill which requires Congressional authorization *by program* for procurement of missiles, rockets and aircraft. The moral is a little elusive but it probably concerns itself with the fact that Congress in its own way exercises a benevolent tyranny over the Army, Navy and Air Force. Congress giveth and Congress taketh away. And when an indulgent tyrant is goaded to exasperation his benevolence more often than not turns a little sour in hunting a remedy.

The Armed Services are still shuddering over the one-vote margin which defeated a nonsensical bill that would have prohibited any retired officer from being employed by a defense industry. What legislation will eventually be enacted to cover some fairly loose military-industry practices in that area is still in doubt.

But on the missiles, rockets and aircraft front the military is now faced with a vertical financial envelopment which is going to make previous budget troubles—by comparison—seem like capturing Piccadilly Circus on a sunny Sunday afternoon.

For years the Armed Services Committees of both houses have been complaining about the reprograming activities of the services. In so many words, this reprograming means getting money for one thing and spending it for another. There are, of course, restrictions. The Army cannot, for instance, take money for tactical missiles and spend it on reconnaissance aircraft. But they can take the money appropriated for one tactical missile and spend it on another. Just as the Air Force or the Navy can, for example, cut back one program and extend another—within the same category, say missiles or aircraft. Money cannot be shifted out of Research and Development—but it can be moved all over the lot within R&D.

Now by the insidious and dangerous practice of enacting a rider to the Military Construction bill—dangerous because it is almost always done in haste and without proper consideration—Congress has enacted a measure designed to prevent such shifting by requiring a program presentation of missiles, rockets and aircraft production and procurement each year.

How will this work out? Under almost any arrangement it seems certain to double the time spent by the military and defense officials who defend the budget annually before the Congress.

Heretofore the Department of Defense has appeared before two committees in defense of its budget—the Appropriations Committees of the House and the Senate. Now DOD and the Services must first appear before the Armed Service Committees of each house, get an approved program and then, in effect, take this program to the two Appropriations Committees to get the money.

This procedure has long been required for the military construction program because military construction takes place in some congressman's district, an event near and dear to his heart. Congress imposed the same restriction on the National Aeronautics and Space Administration. Each of these, however, involves a much smaller program with infinitely less detail than the multibillion-dollar missiles, rockets and aircraft program with all its complexities.

The exact procedures have not been spelled out and probably will not be until after December 31 when the Army, Navy and Air Force have been directed to tell the House and Senate Armed Service Committees what their programs are and how much each will cost. It is likely also that the actual effect of the new law will not be felt until the 1962 budget. Then the Pentagon will be faced with these difficulties, among others:

The sending up of a budget asking for a specific number of missile, rocket and aircraft wings, groups, squadrons, companies or perhaps flotillas, for a given period. How detailed this must be—no one knows for sure.

The problem of modernization and spares, since they require long lead time.

The fact that the President's budget would then cover only that part of the program to be financed that one year.

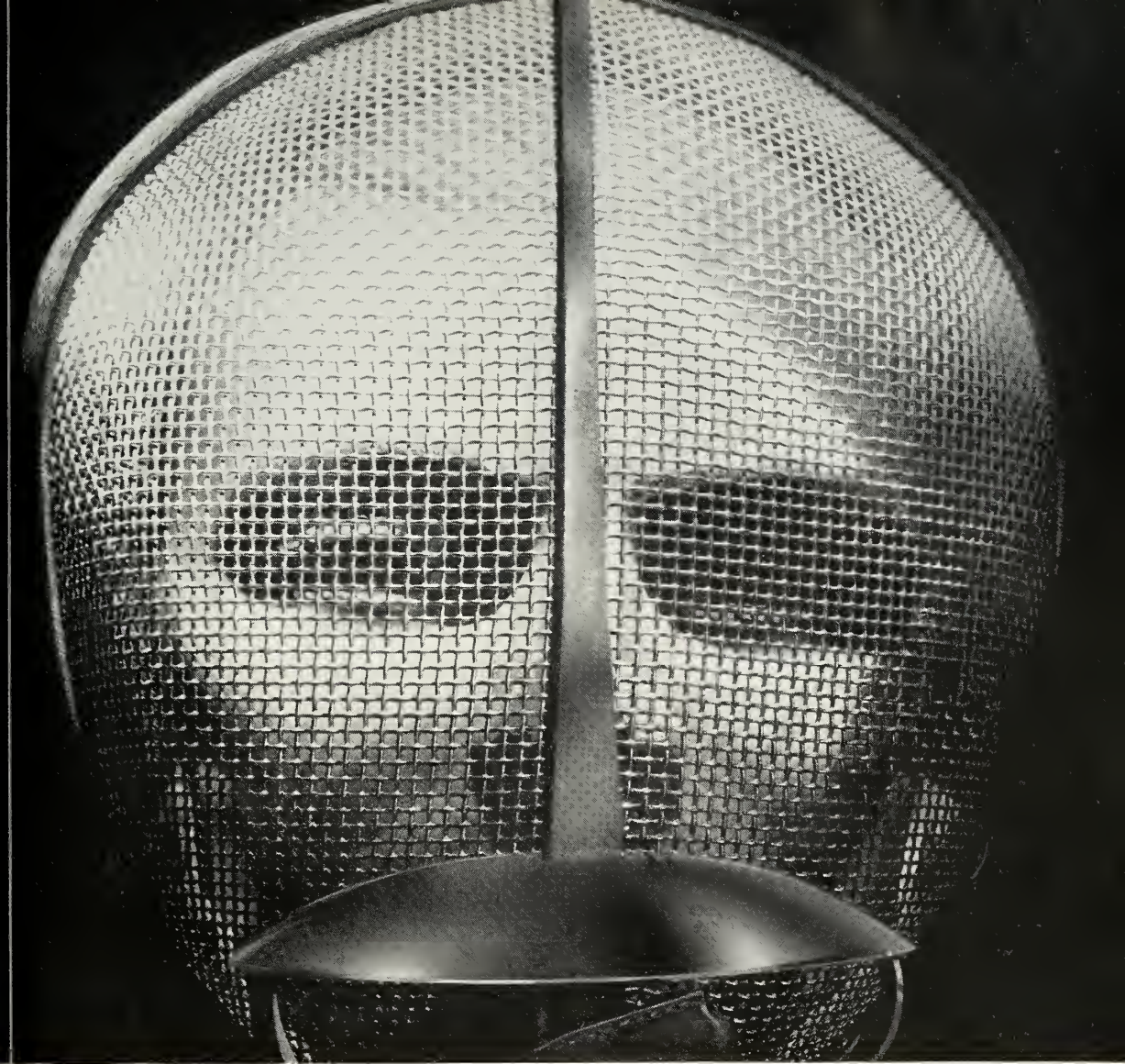
The problem of timing, because the program must be authorized before money can be appropriated; otherwise the money will be eliminated as "out of order," as it recently was in the NASA program.

Applying pressure to get the authorization bill out before the end of the fiscal year—because otherwise the continuing resolutions which allow the Pentagon to continue to operate might not be legal without the authorization.

Trying to figure what changes in budget format will be necessary because the rider covers only production and procurement—not development. However, development testing is now included in P & P funding.

What is to be gained from all this? It's a little like the moral involved—somewhat unclear. Certainly it adds time and another complexity to an already unbelievably drawn-out and complex missile, rockets and aircraft procurement and production program.

CLARKE NEWLON



En Garde!

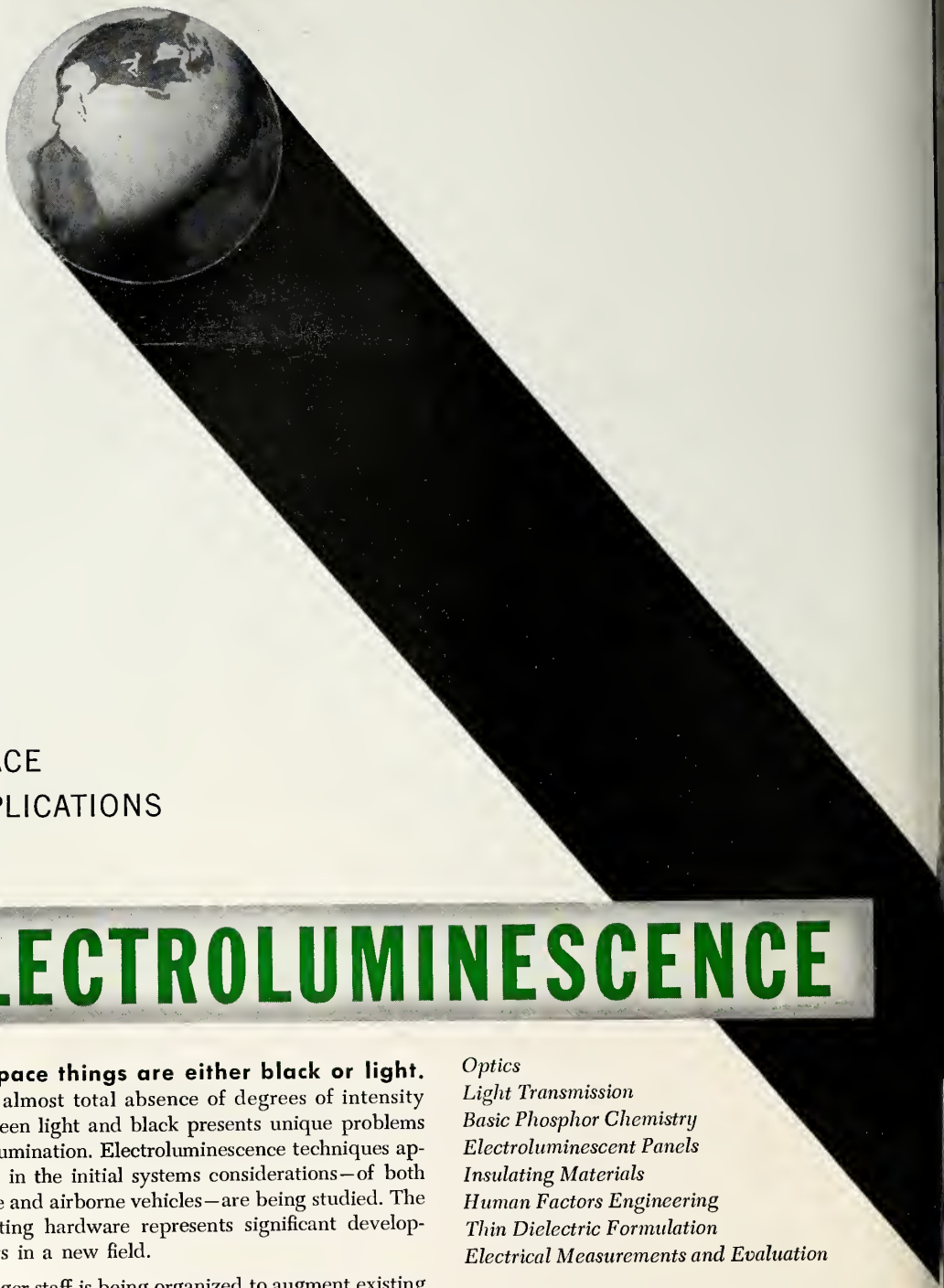
Melpar is an arsenal of technology supplying vital electronic elements linked to the nation's alert, en garde defense posture. Advancing the state of the electronic art is our mission — involving original conception, design, expedited production, and logistics support. Melpar equipment is created and produced for world-wide governmental, industrial and space application.

MELPAR INC

A SUBSIDIARY OF WESTINGHOUSE AIR BRAKE COMPANY

For details on provocative job openings in advanced scientific engineering areas, write to: Professional Employment Supervisor

3608 Arlington Boulevard, Falls Church, Virginia



SPACE
APPLICATIONS
OF

ELECTROLUMINESCENCE

In space things are either black or light. This almost total absence of degrees of intensity between light and black presents unique problems in illumination. Electroluminescence techniques applied in the initial systems considerations—of both space and airborne vehicles—are being studied. The resulting hardware represents significant developments in a new field.

A larger staff is being organized to augment existing personnel and facilities. Senior and junior staff positions are open for scientists and engineers who have experience in the areas listed on the right.

Optics
Light Transmission
Basic Phosphor Chemistry
Electroluminescent Panels
Insulating Materials
Human Factors Engineering
Thin Dielectric Formulation
Electrical Measurements and Evaluation

Graduate scientists and engineers with applicable backgrounds are invited to submit a resume to:

Mr. R. A. Martin, Supervisor
Professional Placement Staff
HUGHES RESEARCH AND DEVELOPMENT LABORATORIES
Culver City 62, California

HUGHES

©1959, HUGHES AIRCRAFT COMPANY

AUGUST 24, 1959



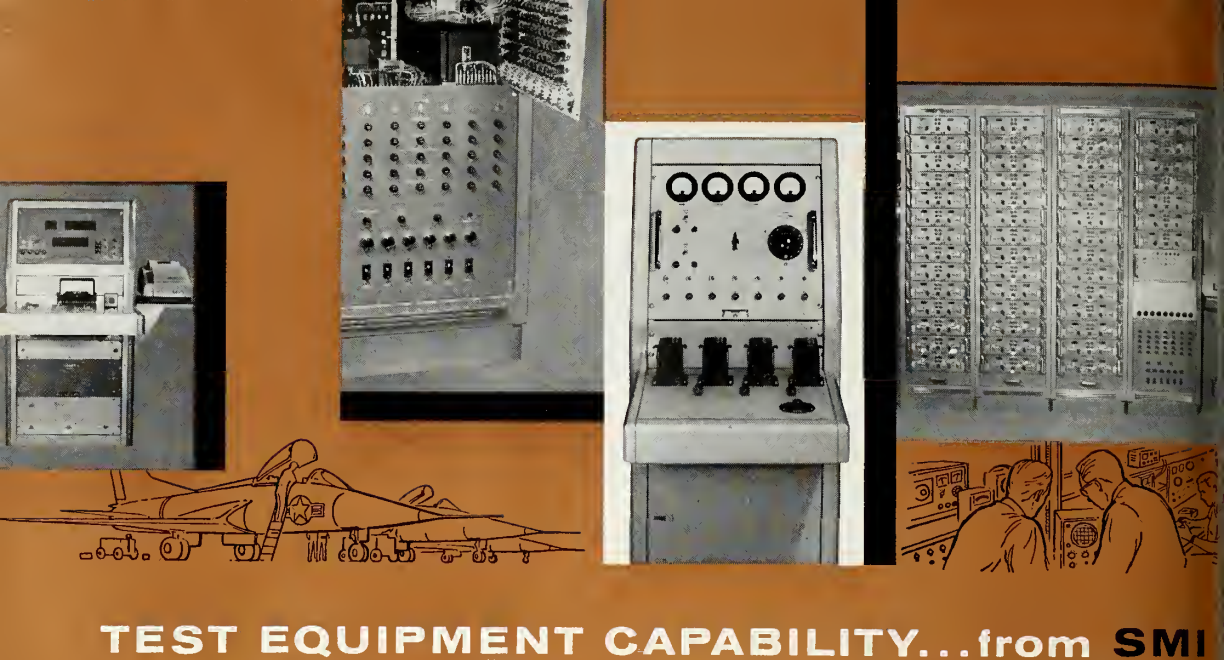
HEAVENLY HOT ROD

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

ghtning—Future Red Weapon? . . 13
PU Advantages of Batteries . . . 15
eport on Telemetry Receivers . . . 26

AN AMERICAN AVIATION PUBLICATION



TEST EQUIPMENT CAPABILITY...from SMI

On flight lines and at missile launching sites...in production plants and depot maintenance centers...wherever speed and precision are vital, SMI test equipment capability meets the need with new levels of utility, repeatability...resolution...accuracy.

The SMI line of test equipment ranges from small, portable units that test single functions to console models that test complex airborne and missile electro-mechanical and electronic systems. Included in the line are pressure generation devices capable of generating static, differential and total pressures to simulate conditions from 1000 feet below sea level to 80,000 feet at speeds to Mach 5.

For example, SMI's TS 539 Air Data Computer Test Set is used for checking out elements of the Hughes Aircraft Company MA-1 aircraft and weapon control system. The TS 539 provides both electrical and pneumatic signals to the computer under test, achieving extremely high accuracy by means of electronically controlled force balance sensors. Mach readings are accurate to .7 millimachs and altitude readings within 15 feet at a speed of 1.4 Mach and an altitude of 30,000 feet.

Write today for further information on the TS 539 Air Data Computer Test Set and for details on SMI capability in test equipment.

Engineers: Investigate the opportunities available now at SMI in the fields of aircraft and missile instrument-control systems development.





SERVOMECHANISMS SMI INC.

LOS ANGELES OPERATIONS: *12500 Aviation Boulevard, Hawthorne, Californ*

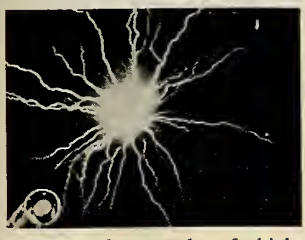
MECHATROL DIVISION: *Westbury, L.I., New York*

RESEARCH AND DEVELOPMENT CENTER: *Goleta, California*

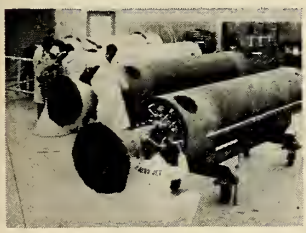
The products of SMI *are available in Canada and throughout the world through Servomechanisms (Canada) Limited, Toronto 15, Onta*



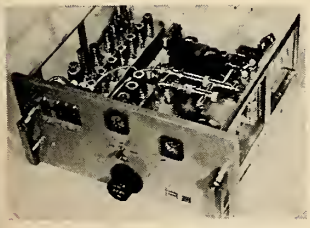
COVER: An ionic-propelled spacecraft proposed by Lockheed scientists would be powered by nuclear reactor separated by mile-long coaxial cable. Unit would weigh about 3½ tons.



SOVIET photograph of high-voltage discharge produced under water at Leningrad Polytechnic Institute. Russians are studying possible use of lightning as weapon. See p. 13.



ASSEMBLY of *Able* rockets at Aerojet-General's Azusa plant. Aerojet designed, developed and is manufacturing the rocket used as second-stage for *Thor-Able, Vanguard*. See p. 22.



PHILCO'S 1435-1535 mc FM receiver. This band is mainly used for aircraft testing. The relatively small telemetry receiver industry is surveyed in story beginning on p. 26.

missiles and rockets ®

MAGAZINE OF WORLD ASTRONAUTICS

AUGUST 24 HEADLINES

Russians May Use Lightning as A Weapon
Soviet scientists are researching possibilities of artificial lightning and may have made machines to create anti-missile "balls of fire" 13

IAF London Meeting May Set Attendance Record 14

Missile Work Expands in Pennsylvania, New Jersey
Both states earn upwards of $1 billion a year; astrionics leads the continuing growth. Second of a series on Middle Atlantic states 30

Authorization 'Rider' May Drag Out Procurement
Defense Department officials fear that additional Congressional testimony may further complicate and slow down contract negotiations 32

NASA May Try Moon Orbit in October 33

Navy Wants Huge Fleet of Missile Subs, Warships
But tight money picture may force choice between limited-war carriers and proposed missile/space and USW development. Second in a series on Pentagon planning 36

ASTRIONICS

Batteries Retain Major Missile Power Role
Survey shows electrochemical batteries are desirable auxiliary power sources for many uses; sales expected to grow ten-fold .. 15

Promise of New 'Decision Threshold Computer' 18

Bowmar Leads Precision Gear Manufacture 21

ASTRONAUTICS ENGINEERING U.S. Reg. Pdg.

The *Able* to *Delta* Success Story
A history of the progress of the Aerojet-General system from four failures in the *Vanguard* program to a perfect batting average with *Thor-Able* 22

Lindberg's Furnace—the Latest in Heat Treating 28

MISSILE SUPPORT U.S. Reg. Pdg.

Telemetry Receivers Post Few Problems
One firm—NEMS-Clarke—does 95% of the business; receivers are considered the most reliable part of the telemetry system .. 26

THE MISSILE WEEK U.S. Reg. Pdg.

Washington Countdown 7

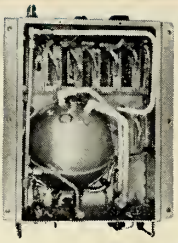
Industry Countdown 11

More About the Missile Week 43

DEPARTMENTS

British Astronautics 24
Soviet Affairs 38
West Coast Industry 41
Propulsion Engineering .. 42
People 44
Contracts 47
When and Where 49
Editorial 50

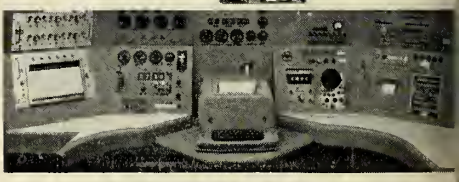




Automatic Dewpoint Hygrometer



Rocketsonde Test Vehicle



Sensor and Computer Airborne Control Console



Ozone Sensor



Aircraft Installation for Transonic Sonde Ejection

AN/AMQ-15

. . . concept to reality in one year

Just one year ago, the Air Force Global Weather Reconnaissance Program was only a system concept. Today, the feasibility of this advanced airborne system has been demonstrated at realistic speeds and altitudes.

The Bendix AN/AMQ-15 system includes advanced aircraft sensors for measuring thirteen geophysical parameters along the flight path, and advanced dropsonde and rocketsonde sensors for measuring eight parameters in a vertical profile from sea level to 150,000 feet. Other subsystems are storm radar, cloud top and base radar, air sampling, airborne digital data processing and display, and ground data handling.

For flight demonstrations up to altitudes of 45,000 feet, the Boeing Airplane Company has installed AN/AMQ-15 subsystems in their prototype 707 jet transport. In addition, Bendix has conducted firing of rocket test vehicles at Holloman Air Force Bas

In reporting this achievement of a major syste design and implementation, Bendix is very proud c the contributions of its own divisions, and is mo appreciative of the cooperative teamwork provided b the Air Force, Boeing, and other subcontractors. Th result is a flexible and modular system which can b used in various sized packages for all types of aircra ranging from strategic bombers to interceptors, an for civilian transport aircraft.

The AN/AMQ-15 is typical of the hard-hitting pr grams being carried out by Bendix Systems. Better e gineers and scientists interested in pioneering syste of the future are invited to join this growing tea

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

Washington Countdown

IN THE PENTAGON

Space mice . . .
may go into orbit again next month. ARPA and Air Force scientists probably will try to recover mice from an orbiting *Discoverer* satellite around the middle of September. Or they may put a camera in it.

• • •

Development of *Sentry* . . .
the U.S. reconnaissance satellite, is a lot closer than some have thought. The clue: *Discoverer V* achieved stabilization in a desired position this month while in orbit—the second time this has been achieved in the *Discoverer* series. *Sentry* must be stabilized to operate.

• • •

The real story . . .
of the Red missile-sub threat is this: The Russians have not only beat the United States in development of submarines capable of firing missiles while submerged. They also have built a sizeable fleet of the big Z Class missile-subs that cruise within striking distance of U.S. shores. (M/R Aug. 10) Adm. Arleigh Burke, Chief of Naval Operations, gave out only a watered-down account of the threat at his recent news conference.

• • •

First powered flight . . .
of North America's *X-15* rocket plane is expected by about the end of the month. Glide tests of the early rocket craft are reported to have been perfect.

• • •

Underwater missile bases . . .
an idea often heard discussed, is considered impractical by top Navy research experts. They contend *Polaris* submarines are easier to build and will do a better job. However, the idea continues to intrigue some military officials.

ON CAPITOL HILL

The back door fight . . .
between the House Space Committee and the House Armed Services Committee over jurisdiction is far from over. Rep. Carl Vinson, powerful chairman of the Armed Services Committee, warned the Space Committee privately to keep hands off purely military matters. But the Space Committee apparently feels "purely military" is hard to define.

• • •

The boron fuel inquiry . . .
now planned by the Space Committee is the latest example. The committee plans to investigate the recent cancellation of boron exotic fuel contracts—specifically as it affects NASA. The investigation may come within the next few weeks.

• • •

Despite all the noise . . .
don't expect any action soon on congressional demands for much more subcontracting of the defense program. The water is still much too muddy with proposals. But something may come of it all next year.

• • •

Watch for a move . . .
in Congress next year to throw open to public scrutiny U.S. missile aid to NATO and other U.S. allies. The move can be expected to come in the form of a tough new freedom-of-information provision far tougher than the one now moving through Congress.

AT NASA

Attempt to . . .
recover the *Discoverer* payload with sky hooks by the Air Force last week was to test the feasibility of the operation for NASA's Project *Mercury*. NASA biomedical scientists are worried that the astronaut might be injured as a result of a water impact or water seepage.

• • •

Sputnik's *III*'s life . . .
is much longer than was originally calculated. It was originally expected to die Aug. 15 after 15 months in orbit, but the Smithsonian Astrophysics Laboratory in Cambridge now gives its death date as December 3. The Russian satellite's apogee has shortened over the last 15 months from 1167 miles to 720 miles, its perigee from 135 miles to 128 miles, and its period from 106 minutes to 98.09 minutes.

AROUND TOWN

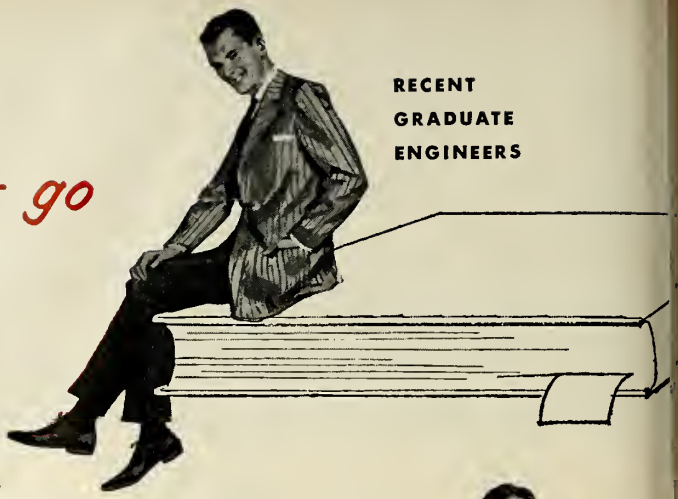
Some of the reports . . .
being passed as "the latest" in the nation's capitol:

. . . A whole series of interservice missile/space fights are brewing—some far bitterer than the fight over *Nike-Hercules* and *Bomarc*.

. . . Civil defense against missile attack may become a major campaign issue next year.

. . . There is pressure for toughening with sizeable deployment of missiles the small nations of Southeast Asia—the underbelly of the Far East.

How far can an engineer go at AC?



RECENT GRADUATE ENGINEERS

Free education for the space age

Three levels af special advanced training that can help yau prepare far pramatian and enhance yaur prafessianal status. That's what yau'll find when yau go to wark in AC's instrumentatian business.

Program A—far recent graduate engineers—gives yau a salid faundatian in the theary and application af inertial guidance systems and servamechanisms.

Program B—for experienced engineers—consists of upgrading studies in inertial guidance, servamechanisms, enviranmental prablems, engineering math and physics, plus advanced state-af-the-art caurses.

Program C—far all engineering supervisors—invalves management training develaped by a team af AC executives and University of Chicaga industrial relatians experts.

Camparison will prove these are the finest "in house" pragrams available anywhere. And they are educatianal "extras," far AC affers them in additian to their educatianal assistance pragrams far men who wish to study for advanced degrees in nearby universities.

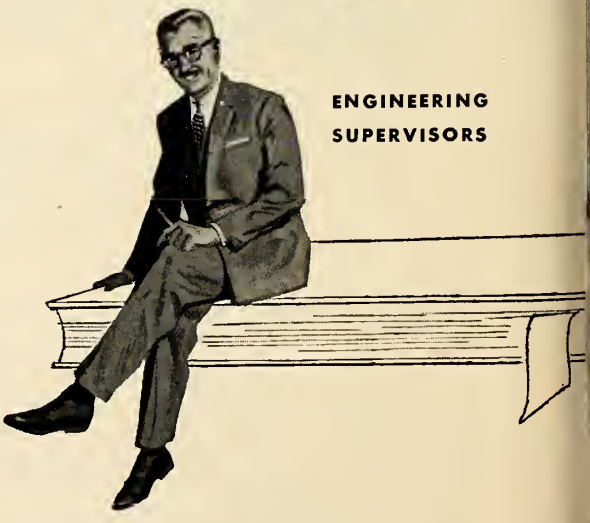


EXPERIENCED ENGINEERS

You may be eligible for training . . .

if yau are a graduate engineer in the electranics, electrical ar mechanical fields, or if yau have an advanced degree in mathematics ar physics. Yau'll study while yau work on the renawned AChiever inertial guidance system or a wide variety af ather electramechanical, aptical and infra-red devices.

For mare infarmation, write the Director of Scientific and Prafessianal Emplayment: Mr. Rabert Allen, Oak Creek Plant, Dept. H, Box 746, South Milwaukee, Wisconsin.



ENGINEERING SUPERVISORS

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

INERTIAL GUIDANCE SYSTEMS • AFTERBURNER FUEL CONTROLS • BOMBING NAVIGATIONAL COMPUTERS • GUN-BOMB-ROCKET SIGHTS • GYRO-ACCELEROMETERS • GYROSCOPES SPEED SENSITIVE SWITCHES • SPEED SENSORS • TORQUEMETERS • VIBACALL • SKYPHONE

CHECK YOUR PULSE, SIR?

"SCOTCH" BRAND High Resolution Tapes deliver a sharper pulse—with fewer dropouts!



In instrumentation, as in life, it's often the pulse-count that counts. So what if your recording impulses are as square as a bar-graph? If your tape only records camel-backed humps, where are you? Probably about due for a change—to "SCOTCH" BRAND High Resolution Tapes.

Your equipment is somewhat like the proverbial sweater—no matter how advanced, you can only get out of it what you put in. And that calls for "SCOTCH" BRAND High Resolution Tapes—made to deliver improved resolution as pulse density climbs and effective frequencies soar upward to stratospheric heights.

Like so many other advances in tape technology, this superior resolution is a product of 3M research. For one thing, "SCOTCH" BRAND high potency oxides give coatings a higher magnetic retentivity—about a third more than standard. And since the shorter wave lengths of high frequencies are recorded by the surface of the coating, a coating of these potent oxides can be thinner and yet provide equal flux line strength. Results? A flexible tape for intimate tape-to-head contact, a cleaner, sharper recorded pulse.

"SCOTCH" BRAND High Resolution Tapes offer these potent coatings on your choice of two tough polyester backings—158 for standard play, 159 for extra-play. And both are designed to line up your square-waves as densely as a close-order drill, so sharp and clean you'll never miss a bit.

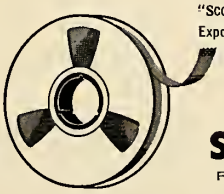
In taping high frequencies, the tested uniformity and dropout-free performance of "SCOTCH" BRAND Magnetic Tapes give the added bonus of reliability. The greater the density of information, the more critical the need for defect-free tapes, and here's where experienced "SCOTCH" BRAND Tape technology really tells.

Whatever your application—data acquisition, reduction or control programming—"SCOTCH" BRAND Instrumentation Tapes supply the reliability you need today and continue to anticipate tomorrow's needs with newer, more sensitive tapes.

In addition to "SCOTCH" BRAND High Resolution Tapes 158 and 159, check the others for your application. "SCOTCH" BRAND High Output Tape 128 offers top output in low frequencies, even in ambient temperature extremes. "SCOTCH" BRAND Sandwich Tapes 188 and 189 end rub-off, build-up, reduce head wear to an absolute minimum, show little wear after 50,000 passes. "SCOTCH" BRAND Instrumentation Tapes 108 and 109 remain the leaders for top performance at low cost.

Where there's no margin for error, there's no tape like "SCOTCH" BRAND Magnetic Tape for instrumentation. For details, write Magnetic Products Div., Dept. MBW-89, 3M Company, St. Paul 6, Minn. or mail the inquiry card. © 1959 3M Co.

"SCOTCH" is a registered trademark of 3M Company, St. Paul 6, Minnesota. Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontario.



REG U.S. PAT. OFF.
SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

3M's Missile Industry Liaison translates your problems to 3M specialists in your field of interest. Write for free brochure.





Headed for History... on Schedule

Behind the spectacular fury of a successful rocket or missile launching is the perfect operation of a vital and spectacular valve.

More than likely this important valve is one of the Crane cryogenic globe valves, specially designed for precision control of liquid propellants at temperatures to minus 297 F.

Here again Crane demonstrates some of the reasons for its leadership in valve manufacture. Whether your need is for special valves for missile fuel handling—or valves for a more "down-to-earth" application in the control of water, steam, air or any fluid—Crane can meet your specifications.

Valve guide for the asking

You will find the Crane handbook "Valves for Guided Missile and Rocket Services" very helpful in specifying for liquid fuels, gases, and other fluids used at launching pads, test stations and operating bases. Request your free copy on your business letterhead from your nearest Crane branch or write to address below.



Write for this free handbook

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Illinois—Branches and Wholesalers Serving All Areas

HYDRO-AIRE Division, Burbank, Calif.—Controls for Every Basic Air-Borne System

Industry Countdown

MANUFACTURING

Faulty release mechanism . . .

is attributed to failure of *Titan* ICBM in its fifth flight test Aug. 14 at Cape Canaveral. The bird was held to stand by special clamps for several seconds after ignition while full power was generated. Clamps released prematurely, before umbilical severance. This caused automatic shutdown of main engine, and the bird settled back on the pad.

• • •

Most successful metal . . .

rocket motor cases manufactured so far are rolled and welded and then hydro-spun. Process is used by **Kaiser Metal Products** on *Polaris* cases; by **Pratt & Whitney** on *Minuteman,* and by **Borg-Warner's Ingersoll-Kalamazoo Division** for special test cases. **General Electric's** rocket engine section is using ausforming—hydrospinning during heat treat cycle.

• • •

Materials most used . . .

in these cases are MBMC-1 and **U.S. Steel's** airhardened X-200. Consistent mimimum yield strengths for the cases in the cases in excess of 225,000 psi are reported in each instance, with some test cases running considerably higher.

• • •

This could mean breakthrough . . .

is near in problem of notch sensitivity—the brittle fracture phenomenon which has seriously limited reliability of high-strength, thin-wall cases at strengths in excess of 200,000 psi.

• • •

Fiber metallurgy . . .

is an **Armour Research** project. Hope is for high strength plus permeability in new materials similar to plastics and ceramics. Rocket nozzles are one possible use; another could be for transpiration cooling of re-entry bodies.

PROPULSION

Aluminized powder injections . . .

to speed burning of *Polaris* first-stage solid engine apparently is creating another chain of problems. With faster burning comes high temperatures, particularly in nozzles. Moly nozzles so far are said to be adding a weight penalty in coping with the higher temperature. Other materials—notably steel—may still be used in *Polaris* nozzles. Despite contrary reports circulating in industry, a top Navy official claims "all problems associated with motors in first models have been solved." However, he declines to pinpoint problem areas.

• • •

Charged liquid colloidal . . .

system for low-thrust (2000-3000 I_{sp}) deep space rockets still looks more attractive than the higher-temperature ion electrical propulsion system. **Aerojet-General** is said to have come up with a colloid source which makes problems of focusing, acceleration and neutralization easier to solve. Company believes flyable colloid system is possible in around five years—perhaps less if there is more rapid advancement in development of nuclear-electric source to free the particles from the colloidal solution.

ELECTRONICS

Promising new process . . .

developed by **Stanford Research Institute's** ceramics technology group may raise temperature limits for transistor and diode operation from 400°F to about 1800°F.

• • •

Air Force $10 million . . .

contract to **Page Communications Engineers Inc., Northrop Corp.** subsidiary, for multichannel troposcatter complex will cover 1700 miles, link the United Kingdom, Spain and Morocco.

• • •

Formation of joint . . .

industry-government group to solve problems plaguing telemetry industry is being studied. Purpose would be to coordinate three unrelated groups involved in telemetry—missile ranges, missile makers and instrumentation manufacturers. Joint group would function as a report center and information exchange.

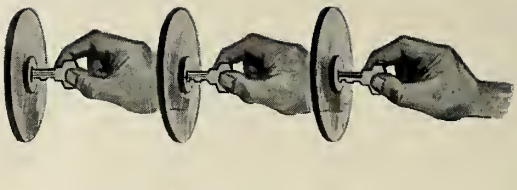
WE HEAR THAT—

Cheaper titanium is coming . . .

Norton Co., Worcester, Mass., has electrolytic process for producing ductile titanium of high purity which may pave the way . . . Copper will be in good supply for 90 days, despite shutdowns. But price of copper is another matter; it's on the way up—fast . . . Plastics information center similar to Battelle Memorial Institute's Defense Metals Information Center, Columbus, will be established at Army's Piccatiney Arsenal . . . **Avco's** Research and Advanced Development Division has delivered an 18,000°F plasma generator to Jet Propulsion Laboratory for NASA re-entry studies.

More about the Missile Week on page 43

3-way locking action



assures

fail-safe missile fueling



FUEL OXIDIZER
Servicing Nozzle
SERIES 13110

G.S.E. personnel deserve it and now can have it!... triple protection in handl oxidizers or exotic fuels... with the new Lear Fuel Oxidizer Servicing Nozz Fail-safe procedure requires 3 separate locking actions before fuel can flow.

Developed originally for safe transfer of nitric acid, the nozzle and adapter make possible a sealed, pressure-proofed closed circuit servicing system to provide "safety-assured" protection. Complies with military test specification

ENGINEERING DATA...

Flow and pressure rating....125 gpm at 60 psig
Operating temperature range....−65 to +140
Maximum operating pressure....240 psig
Military Specifications (Test)
Nozzle... MIL-N-25556 Adapter... MIL-N-25

Complete technical data and costs on requ

RO-25

LEAR

LEAR-ROMEC DIVISION
ABBE ROAD, ELYRIA, OHIO

Reds May Use Lightning as Weapon

Soviet scientists are deeply involved with study of artificial lightning and may have made machines to create anti-missile 'balls of fire'

by Donald J. Ritchie*

DETROIT—Lightning balls, among ature's rarest phenomena—described "balls o' fire" in the language of ie mountaineer—may one day be put work as a Soviet weapon of war.

Soviet scientists are using huge- ale laboratory equipment to study tificial lightning. Russian engineers e carrying out programs for de- loping very high voltages and cur- nts. And in the area of basic re- arch, such Soviet physicists as I. M. nyanitov are investigating atmospheric ectrical discharges.

A hint of the military applications ntemplated comes from Physicist eorge I. Babat, head of the Soviet stitute of Energetics. Babat proposes generate balls of lightning in the y high above cities by focusing an tense electromagnetic field with the e of two huge parabolic antennas.

Thus a small artificial star or sun ould be formed. It would be fed from ie ground by electromagnetic energy, it its light output would originate in a uclear fusion process occurring within e ball of lightning—or plasma. The asma ball could be easily moved rough the sky by directing the ground ntennas. The effect of directing it at aircraft or missile can be easily agined.

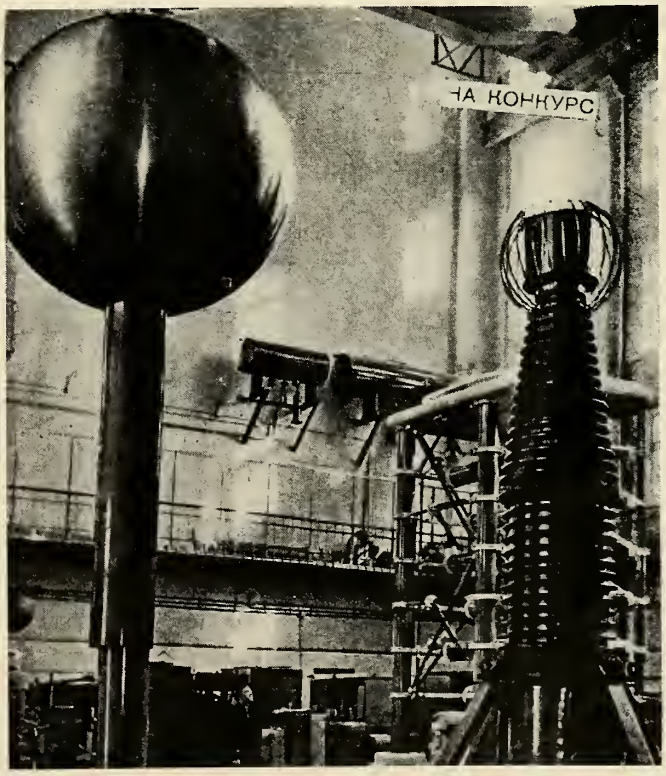
Such a Soviet weapon is not, of urse, just around the corner. The ork in progress almost certainly is ill in the research phase. But Russian ience is rapidly expanding its under- anding of electrical discharge, ball ghtning and lightning under water. he ability of Soviet engineers and ientists to make very practical use techniques and processes at hand as been demonstrated in the past.

• **Observed data**—Although some uthorities stoutly deny the existence ball lightning, others, such as B. F. J. Schonland, have compiled a great deal of data on characteristics. (*The Flight of Thunderbolts,* Schonland, Oxford University Press, 1950). The present author once observed a lightning ball about four inches in diameter during a violent storm at Kenmore, N.Y.

Lightning balls seem to appear near the end of a severe storm—after the air has been highly ionized and is filled with electromagnetic disturbances caused by genuine lightning. Their diameters range from a few inches to —in rare instances—many feet. They move by rolling or sliding along conductors such as telephone wires, fences and other metallic objects. They travel up and down channels such as chimneys and move both with and against air currents.

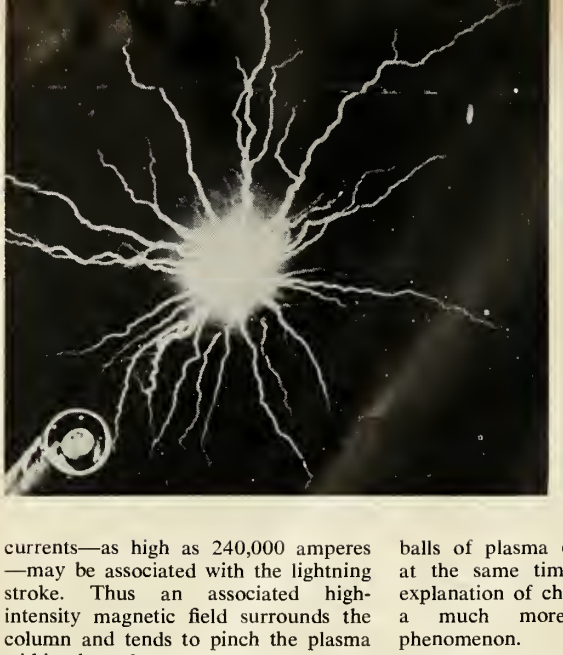
The lifetime of a lightning ball may range from a few seconds to many minutes. Its surface temperature can reach 9000°F. When it decays, a great deal of energy is released.

• **Pinching plasma**—One possible method of natural lightning-ball formation is by the "pinching" of a portion of plasma formed in the core of a column of air through which a lightning stroke has passed. Very great



LIGHTNING RESEARCH in the Soviet Union is carried out through the use of such equipment as this, part of the machinery at a high-voltage lab.

Project mathematician, Research Laboratories Div., Bendix Aviation Corp., and close observer of Soviet military science.



BALL OF FIRE under water. Soviet photograph of high-voltage discharge produced at Leningrad Polytechnic Institute shows that end of "projector" is coaxial cable or waveguide, seemingly coroborating idea that lightning ball is combination of electric and eletromagnetic activity. Engineer Lev Alexandrovich Yutkin has charge of work.

currents—as high as 240,000 amperes —may be associated with the lightning stroke. Thus an associated high-intensity magnetic field surrounds the column and tends to pinch the plasma within the column.

An average lightning flash may discharge about 20 coulombs through a length of two kilometers. With the presence of an oscillating field between the ground and the thundercloud, magnetic lines will become unstable and will tend to pinch off a portion of the plasma. Then this is fed by the oscillating electrical field. Many such balls of plasma could be pinched off at the same time. This may be the explanation of chain or bead lightning, a much more frequent natural phenomenon.

• **Equipment produced**—Photographs in Soviet technical journals show equipment alleged to create balls of lightning. Apparently these are formed by a combination of high-voltage discharge and electromagnetic fields. The same sort of research is in progress in the United States, but with rather low voltage and moderate electromagnetic field strengths.

Soviet Academician Peter L Kapitsa believes that the lightning ba is a mass of highly ionized plasma fe continuously from outside by resonanc absorption of intense radio waves. H indicates that artificial lightning bal can be created by a powerful source c sustained radio waves in the decimet range, focused into a small volume c space.

Lev Alexandrovich Yutkin, an e gineer at the Leningrad Polytechn Institute, has made considerable stuc of high-voltage discharge under wate One published photograph of the ph nomenon shows that the end of th "projector" is a coaxial cable or wav guide. This seems to corroborate th idea that the lightning ball is a con bination of electric and electroma netic activity. A recent Soviet relea stated that Yutkin has produced an put to work a discharge of "far great power than lightning."

An obvious application of ba lightning is in igniting controlled the monuclear fusion reactions—avoidin the messy alternative of setting off fission bomb. Thus far, the instabilit of the electric arc discharges used h slowed progress on both sides of th Iron Curtain. Until a method of ign tion is found, it will not be possib to obtain power or propulsion fro fusion reactions. Perhaps the lightnin ball will provide the solution.

IAF's London Meeting May Draw Record Attendance

LONDON—The annual meeting of the International Astronautical Federation at Church House, Westminster, Aug. 31 to Sept. 5 may turn out to be the largest in the Federation's 10-year history.

President Andrew G. Haley of Washington, D.C., estimates that approximately 600 of the world's leading space scientists will attend. The Federation has 3200 members throughout the world.

This year's congress is being organized by the British Interplanetary Society. By maintaining a stricter standard, the various national screening committees have managed to keep the number of technical papers to be presented down to 80; about half of these are from the United States.

• **Soviets uncommunicative**—This figure includes any that might be given by Russian delegates. Despite all the regulations regarding submission of papers, the titles of those from Russia are never known until just before a Congress. This year, the Russians have been unusually reticent and it is not even known whether they will be attending.

Some delegates from beyond the Iron Curtain will be present. These include several representatives from Poland, and one from the Commission on Astronautics of the Czechoslovak Academy of Sciences.

Several hundred members of the American Rocket Society are expected. Included in the American delegation will be seven U.S. Congressmen, members of the House space committee.

The meeting will cover almost every aspect of space exploration. Subjects include space medicine and biophysics, nuclear and electrical propulsion, satellite design, space communications, planetary landings and base operations, astrophysics, rocket postal service, space guidance and navigation, tracking, orbits and trajectories.

Business meetings of the society will deal with such problems as international cooperation in astronautics, documentation, classification schemes and terminology, the need for a permanent headquarters for the IAF, satellite tracking, and the establis ment of an international Academy Astronautics. British delegates to th Congress include G. V. E. Thompso a contributing editor to MISSILES AN ROCKETS, and A. H. S. Candlin.

• **Commonwealth foregathering**— The Congress is being preceded b the British Commonwealth Spaceflig Symposium, August 27-29. Some 1 papers will be presented including or dealing with Britain's place in inte planetary exploration. Some others i clude altitude sounding by solid roc ets, a review of *Blue Streak*, instr mentation, economics of space flight soft moon landings, satellite trackin and recovery, and navigation.

In conjunction with the Congres a Space Law colloquium is to be hel September 4 in the Great Hall, Li coln's Inn, under the chairmanship President Haley.

The Congress will be opened by th U.K. Minister of Supply, Aubre Jones, and a government reception Lancaster House will be held th evening. Other social events include tea party for participants' wives at th House of Lords, an excursion Windsor Castle, receptions and a co cluding banquet at the Dorchester H tel, Park Lane.

Batteries Retain Their Power Role

Survey shows that electrochemical batteries are desirable auxiliary power sources for many missile and satellite uses—sales expected to grow 10-fold

by Charles D. LaFond

WASHINGTON—Electrochemical batries provide a very practical auxilry power source in both missiles and tellites. Fuel cells, nuclear power acks, thermoelectric generators, and e gas-turbine APU have the potential r greater future use, but today the ttery retains its prominence.

According to a **General Electric** pace Vehicle Division spokesman, batries are quite satisfactory and even sirable in missiles as long as the hyraulic and ac electrical systems reire less than 70% of total power—herwise the APU is required.

Batteries won the battle recently for condary power for the *Atlas* ICBM. et cell batteries are used in the *Atlas* drive a **Bendix** ac inverter. After ending something in the area of $20 illion, **Convair-Astronautics** halted exnditure of further funds for **Sundrand's** development of a monopropellt power system for the *Atlas*.

(Sundstrand had come into the *At*s secondary power picture through purchase of the **American Machine Foundary Co.'s** Pacoima division. ne latter had been working on a biopellant system for the *Atlas*. Sundrand changed to a monopropellant ter it took over.)

Convair currently is buying silverlt batteries from **Yardney Electric,** ne **Eagle-Picher Co.,** the **Cook Co.** in enver, and AMF.

• **Business outlook**—Yardney Elecc has indicated that its annual batry sales are in the range of $6 to 7 illion. Of this, 75 to 80% goes to issile, rocket, torpedo and satellite ograms.

Yardney looks forward to a tenld growth of the missile industry by 70 and it expects its battery sales to rallel this growth. Other battery manfacturers share this confidence, at ast for the present.

Auxiliary power for missiles and satellites presents some unique requirements. Requirements for electrical power exist in communications, guidance and control, telemetering, pump motors, ignition, destructive systems and warheads. The accomplishment of this task calls for power ranging from fractions of watts to kilowatts.

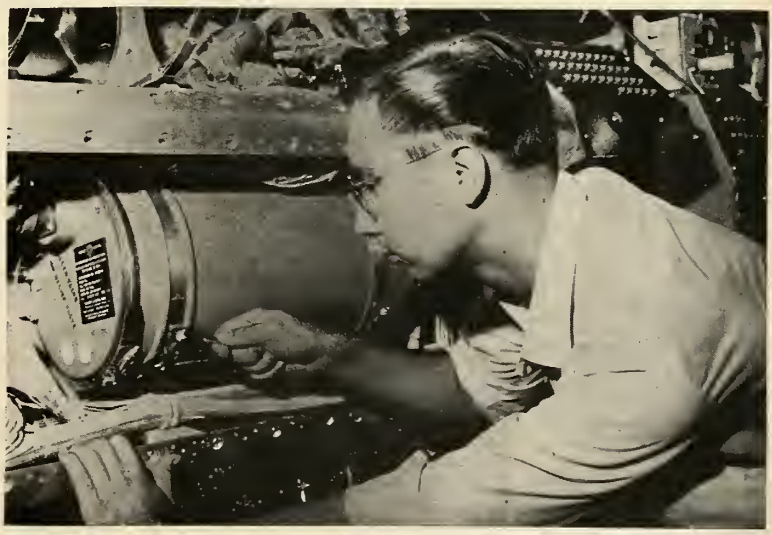
In addition to these requirements, an auxiliary power source must meet most or all of the following requirements: it must be lightweight and require little space; it must have good voltage and high rate discharge characteristics; it must be a maintenance-free system and have the ability to be placed into operation on very short notice; it must withstand varying temperatures, low pressure shock, vibration, acceleration, and in some cases, zero gravity.

Depending on the use, primary and secondary batteries meet these needs. Auxiliary power units (APU's) are excellent in view of the weight-and-volume factor. However, they are very expensive and—most important—not yet wholly reliable. Therefore, they are limited in use.

• **Trends**—In general, mercury cells top the list at the present time for satellite use. **P. R. Mallory and Co.** is the principal manufacturer. The mercury cell has a high watt-hour rating but it also has demonstrated a sensitivity to low temperatures. For this reason, the small-size silver-zinc batteries may find increased use in this field.

The trend appears to run toward the standard storage batteries—lead-acid, nickel-cadmium and silver-zinc.

Because of its relatively heavy weight, the lead-acid battery has found few missile applications compared with either the nickel-cadmium or the silver-zinc battery—the most-used power sources for spacecraft. The nickel-cadmium battery gives excellent performance at sub-zero temperatures and stands up very well under maintenance



ELECTRIC Silvercel battery by Yardney is being installed in an Air Force ICBM, to supply main power during flight. It discharges 300 amps at 26 volts for 10 minutes.

electrochemical advantages . . .

abuses. In weight and output, however, the silver-zinc battery is far superior.

Compared to nickel-cadmium, silver-zinc batteries are only a third as heavy; yet their capacity on an equal-weight basis is four times greater.

Because of their low-weight, small volume, high-capacity and reliable-behavior factors, these batteries are considered superior to all others in missile applications.

For the future, some manufacturers feel there may be a move toward use of primaries instead of rechargeable batteries, because primaries offer indefinite shelf life, require no maintenance, and can be used at a moment's notice.

Secondaries, however, have proved their high reliability and—unlike primaries—can be checked before use.

• **Advantages**—The importance of electrochemical battery sources for missiles and space flight can be shown by some of the principal advantages in missile systems.

• They provide direct conversion of chemical energy into electrical energy.

• They are convenient in scaling power systems either up or down.

• Since they have no moving parts, their maintenance is simple and reliability is high.

• The tapping and transmission of power for varying loads is reliable and easy.

• They provide high energy per unit weight.

• They provide high specific power output, particularly in the range of small-size devices.

Primary batteries find extensive missile application because of the short, one-time use involved (excluding ground checkout procedures). The average battery life in a missile varies from four to seven minutes. This short life span requires batteries capable of high drainage, often referred to as "high rate" cells.

Because of the urgent need to save every single pound of weight in missiles, there has been a renewed surge of interest in the development of new and better battery systems.

Secondary batteries (storage batteries) have limited but very useful applications for spacecraft, particularly for use in satellites in conjunction with solar cells. This provides a means of power storage regeneration when the collector area is fully exposed to sunlight and in turn provides power when the satellite is on the dark side of the earth.

• **Silver-zinc**—The most widely used battery for missile applications is the dry-charged silver-zinc system, which has been adapted to auxiliary power applications, because it most nearly fits all of the missile requirements. Also, it can deliver its power output in a very short time. This battery has the highest capacity of all known practical systems. Primary or one-shot batteries are available in automatically or manually activated models; to supply the requirements of a secondary battery, rechargeable models are also available.

Leading silver-zinc battery manufacturers, in order of importance in the missile industry, are Yardney Electric, Frank R. Cook, Eagle-Picher Co., and the Exide Div. of **Electric Storage Battery Co.** The Yardney Silvercel—a silver-zinc battery—has been applied with a record of success in a great many space vehicles, including:

Titan, Polaris, Falcon, Dart, Pioneer, Snark, Goose, Bomarc, Aerobee, X-7, Jupiter, Vanguard, X-17, the *Atlas* satellite and weather satellite.

A *Viking* rocket, powered by a Silvercel battery, was employed several years ago to photograph the earth from an altitude of some 150 miles.

Finally, almost all U.S. Navy electric torpedoes are now using Yardney Silvercels for propulsion and homing devices.

For the design engineer, faced with the increasingly critical limitations of space and weight, the Silvercel battery has shown several strong attributes—a high-rate, rechargeable source of power in a small lightweight package. It can produce the same amount of electrical energy as other battery types, though only 1/5 their volume and 1/6 their weight.

Where high current drains are essential, it can be discharged at rates as high as 30 times the ampere-hour capacity rating. Its voltage is unusually flat, permitting high operational efficiency and dependability. These batteries are available in two rechargeable and two primary types.

Yardney's newest Silvercel, the PM 200, is capable of an output of 80 watt hrs./lb. The company is currently developing a successor to produce 10 watt-hrs/lb.

Exide Industrial Div. of Electric Storage Battery Co. also produces a whole family of silver-zinc secondary cells. Light weight and small, the units vary from outputs of 7.5 to 200 ampères for one hour at 77°F.

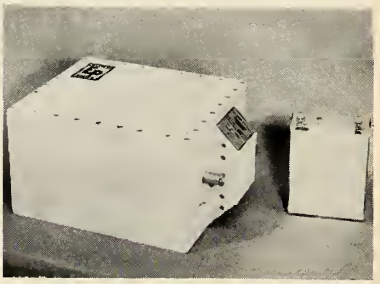
• **Nickel-cadmium** — Nickel-cadmium batteries are most widely known for long life characteristics due to their ability to be trickle charged and overcharged without injury. These qualities make them especially suitable for use as secondary batteries. The low temperature charge and discharge characteristics are quite good and its rugged construction is well suited to resistance of extreme environmental conditions. Although its power output per unit weight and volume is not as high as some other systems, it does provide very dependable long life, secondary battery where weight is not a primary consideration.

Leading manufacturers in the nickel-cad battery field are **Sonotone Corp.**, Eagle-Picher, and **Gulton Industries.** The Yardney Electric Corp. is a newcomer, but, with its new Silcad as a satellite power source, it will be making inroads in this field.

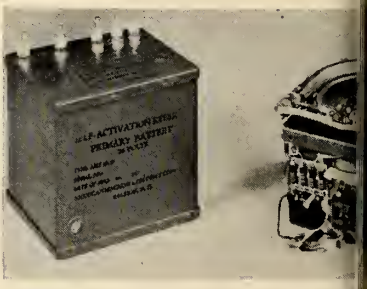
Here the nickel-cadmium system is particularly desirable because high reliability can be achieved by continuous flow of high charging. The units provide good performance over a temperature range of −60° to +160°F and good shelf life in the wet discharged state.

In addition, the nickel-cadmium batteries provide service life from 30 to 2000 charge-discharge cycles.

Another newcomer to this field is **Delco-Remy Div.** of **General Motors Corp.** The company's Electrochemical Research Dept. currently is conducting



MANUALLY activated satellite battery developed by Eagle-Picher Co. has a power-to-weight ratio of 80 watt-hour/lb. including package and hardware.



AMF's Electric Battery Co. has developed this first automatically activated chemically heated Ag-Zn primary battery, less than ½ cu. ft. in total volume.

study program to develop refined sil-r-zinc and nickel-cadmium batteries d new sources of electrical energy.

company spokesman said that new stems under way may provide yields 00% greater than from present bat-ries. The company is known to be orking on a new battery, designated elco-X," but details are still con-lered proprietary and are expected be classified for sometime.

For satellite, telemetering, and re-arch and development applications, anually activated units provide ex-emely high power-to-weight ratios in essentially off-the-shelf item. Each these units is usually modified and ckaged for a particular application.

Eagle-Picher has developed and de-gned manually activated batteries for tellite applications. One such battery, own in photo, has a power-to-weight tio of 80 watt-hours/pound includ-g packaging and other hardware. En-ronmental conditions imposed on any of these types of units include)-g vibration, 60-g shock and 18-g celeration in addition to many other vironment extremes.

• **Solid state**—The Patterson-Moos esearch Division of **Universal Wind-g Co.** has developed a family of solid-ate batteries for subminiaturized sys-ms. Based on the use of a crystalline ectrolyte, conduction is entirely ionic. alled "Dynox," cell configurations are vailable having cell thicknesses of less an 0.005 inch and total power pack zes less than 6 cu. inches. Some units, cording to Patterson-Moos, have op-rational lifetimes in excess of 10 years.

Hermetically sealed, the batteries rovide high shock and vibration re-stance. They can be operated in a mperature range of from —100° to 70°F.

Producing 0.8 volt per cell, single nits can be obtained which will pro-ide up to 950 volts (open circuit) and current of 10^{-3} milliampere for 100 ours at 70°F. Voltage drop is less than 0%.

Dynox batteries have an estimated shelf life of 20 years at from –40° to 70°F (2 years at 130°F).

• **Nuclear**—Another Patterson-Moos Research development is a family of nuclear batteries. Weighing 9 grams, the units measure 9/16" x ½" diameter. They can supply currents rated at from 10 to 200 $\mu\mu$amperes with equilibrium voltages from 5000 to 10000 volts at 70°F.

Construction consists essentially of an emitter electrode coated with a radioactive isotope (β-emitter) and separated from a brass collector case by a solid dielectric.

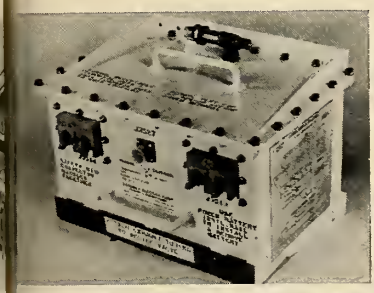
Having a shelf life and use life of 25 years, the units also are independent of adverse physical and chemical conditions, according to Patterson-Moos.

Nuclear power packs—called Raypaks—also are available. Comprised of a PMR nuclear battery, a capacitor, and voltage regulation network, the units are completely encapsulated. These units are provided with voltage ratings of either 375 or 750 volts. They weigh 80 grams and are 1.5" long x 1.25" diameter overall. Particularly designed for trigger power in weapon and ordnance systems, Raypaks can provide a pulse energy source of from 800 to 337,000 ergs.

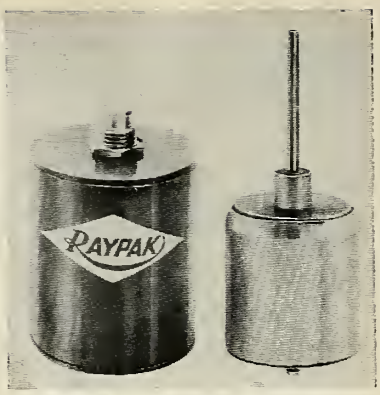
• **Thermal**—Thermal cells are primary cells or batteries incorporating a solid salt electrolyte which is activated by melting the solid electrolyte to make it conductive. This feature provides excellent unactivated shelf life and a means of operation independent of ambient temperature. Although its capacity is not high when compared to other practical systems, it does possess advantages which suit it to specific power requirements. Currently under development by the Eagle-Picher Co., applications and details of these thermal cells are classified.

• **Water activated**—Water activated batteries, also produced by Eagle-Picher, are units which operate when immersed in, or wet by water of 0 to 4% salinity at 28 to 210°F. They are capable of voltages from 1.5 to 1000 volts at currents of from hundreds of amperes to milliampere ratings with discharge life ranging from a few seconds to two days, and with activation time variations from one second to one-half hour. These broad capabilities are covered, in general, by two similar electrochemical systems: silver chloride-magnesium and cuprous chloride-magnesium batteries.

In general, these batteries are designed for air discharge or submerged discharge. The former are manually activated by soaking in water prior to use, while the latter operate submerged in water. Typical applications for the air-discharged are as power supplies for radiosonde balloons. A principal use for water-submerged batteries is in underwater ordnance.



NLY 55 pounds, this Yardney Elec-ic rechargeable Silvercel battery sup-lies energy for guidance electronic gear nd telemetering in missiles.



TWO MEMBERS of the Patterson-Moos family of nuclear power sources. Left, nuclear power pack; right, nuclear battery. Both have 25-year life.

• **Late report**—As M/R went to press, late information was received indicating the reason for Convair's cancellation of the hot-gas APU programs at Sundstrand and Aerojet-General for *Atlas* and *Titan* ICBM's.

A comparative study of hot-gas vs. battery auxiliary power sources for the *Atlas* was performed recently by the Frank R. Cook Co. The report indicated that in all instances of comparison hardware for missile batteries proved to be of less weight than that required for the hot-gas APU's.

After review by the USAF Ballistic Missile Division and Ballistic Missile Office, the APU program cancellation immediately followed.

Frank R. Cook has stated that his company is providing units for "all eight *Atlas* type batteries, four types for *Polaris*, two for *Minuteman*, and others."

New Process for Synthesizing Crystals

SAN FRANCISCO—A new method of synthesizing nearly perfect ferrite monocrystals from a mixture of ferric oxide and other oxides has been revealed by International Telephone and Telegraph Corp.

Developed by ITT Laboratories, crystals can be grown in quantity by a process described as "flameless fusion." This is a thermo-chemical reaction (2000°F) accomplished with high frequency radio energy.

ITT believes process will open new avenues in solid-state electronic research.

Crystals approximately 1.5" x ¾" diameter were displayed for the first time at the 1959 Western Electronics Show and Convention here at the Cow Palace.

Page's DTC Has Wide Potential

Simple device performs well in NATO scatter stations and is expected to find application in telemetry, especially over long distances

by Charles D. LaFond

WASHINGTON—Sometimes a simple, inexpensive gimmick can be as noteworthy as a more impressive breakthrough—that is, if the gimmick has potentially wide application.

Such a device may be **Page Communications Engineers'** new circuit technique called a "decision threshold computer" (DTC) which enables a frequency-shift-keyed receiver system to use information in mark and space channels independently when fading exists between the mark and space frequencies.

Designed, built and tested in Page's Takoma Park, Md. lab and at its Taylors Island Field Station near Cambridge, Md., the diversity technique has produced a significant performance improvement in high frequency and scatter communication circuits.

Currently employed with marked success in NATO's European scatter stations, the technique will be utilized in the many other scatter links around the world. It should also find use in telemetry, principally for long-distance applications.

DTC is designed to make use of the normally deleterious effects of frequency selective fading. It provides up to a 30-fold reduction in telegraph and binary data transmission error rates. This corresponds to a 16-db improvement.

By using the lack of correlation in mark and space signal fading, it effectively provides additional orders of diversity. For a dual-space diversity system, DTC, according to its developers, will produce an overall advantage of quadruple AM diversity, if the correlation between mark and space signal fading is sufficiently low. This is accomplished by separately storing mark and space amplitude formation and deriving from this optimum threshold level.

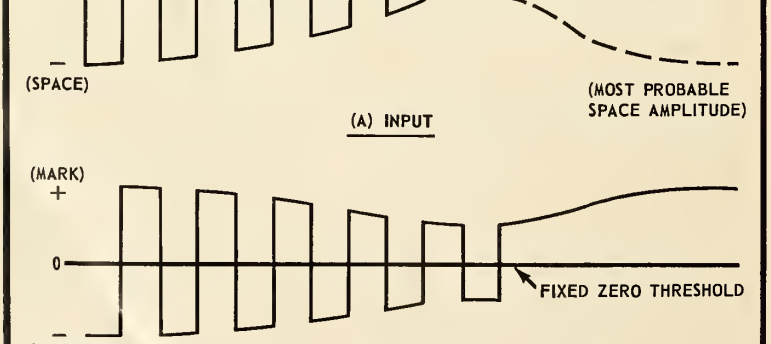
• **AM-FM decisions**—In the modulator of a typical FSK syste mark and space usually are rep sented, respectively, by positive a negative output voltages. The decisi threshold voltage is set at zero.

Unfortunately, FSK signals generally assumed to be balanced, the optimum decision process assur that the signal amplitudes and nc levels are the same for the mark space channels. (This is based on optimum decision criterion presen by Middleton and Van Meter, "Mod Statistical Approach Reception in Cc munications Theory," *IRE Professio Group on Information Theory*, S tember 1954).

Under conditions of selective f ing between mark-space frequenc the FSK decision criterion is no lon optimum. Moreover, with a deep f on either frequency a substantial nu ber of errors could result.

Thus another decision criterion needed, for an AM decision on eit mark or space, as appropriate, wo be optimum. Without this, there is provision for changing both the cision criterion and the threshold, performance would be unsatisfactor

The receiver makes an FSK cision between mark and space wh the amplitudes are equal, but ma an AM decision on the stron channel when the other channel fa completely. A function switch on DTC switches between four mo of operation: Bypass, DTC is connected from the circuit for use w Anti-Multipath Equipment (M/R, Ju 22, 1959) or for testing; Normal, D is connected; Mark, receiver makes AM decision on the mark signal or and Space, receiver makes an AM cision on the space signal only. T latter two positions are used in event of interference on either chan



PAGE decision threshold computer's input and output diagrams.

MOVING AHEAD----

"TO PROVIDE FOR THE COMMON DEFENSE"

Only by conceiving today the weapons which will be needed tomorrow; can the free world continue to preserve the peace—or successfully meet an attack.

TIME IS OF THE ESSENCE!

ANOTHER STEP FORWARD

To cope successfully with this urgent and continuing problem, RCA recently extended to a corporate-wide basis the techniques which had been proven successful within its various departments, by creating an *Advanced Military Systems* organization at Princeton, New Jersey. There, in an atmosphere of intellectual freedom, a group of mature scientists and engineers are engaged in the analysis and study of our national defenses—present and future—and how they can be made most effective to meet any future enemy capability.

These studies are conducted at the frontiers of knowledge and encompass such areas as the physical and engineering sciences, military science, economics, and geophysics. Studies have, as an end result, the creation of military systems which will satisfy projected military requirements.

A SPECIAL KIND OF MAN

Members of the technical staff are at the highest creative and intellectual level. They have a degree of maturity which comes only with many years of experience. They generally have held responsible positions in research, advanced development, or systems planning. Most of them have an extensive background in the broad fields of electronics, vehicle dynamics, physics (astro, nuclear, or plasma), or military science (operations research). All are temperamentally suited for performing highly sophisticated, comprehensive analysis and planning of a detailed nature. They are men who enjoy seeing the fruits of their work turn into realities that have an extensive effect on the defenses of the country.

A SPECIAL KIND OF CLIMATE

Each member of the technical staff operates either independently or in a loosely organized group, and is generally free to select his own area of work. The only condition: results must have a direct application to problems of national defense. He has no responsibility for administrative details, although he must be ready to give guidance to program implementation. He can call in any specialists he may need. He has full access to all available information—military, academic and industrial. Specialized research projects and laboratory work can be carried out at his request by other departments of RCA. In a word, he is provided with every opportunity and facility to use his creative and analytical skills to maximum advantage and at the highest level.

A SPECIAL KIND OF ENVIRONMENT

Princeton offers unique civic, cultural and educational advantages along with the convenience of its proximity to New York City. In this pleasant environment, Advanced Military Systems occupies a new, air-conditioned building on the quiet, spacious grounds of RCA's David Sarnoff Research Center. Working in individual, well-furnished offices, staff members find their total environment highly conducive to creative activity.

INQUIRIES ARE INVITED

If you are interested in learning more about this far-reaching program, write:

Dr. N. I. Korman, Director,
Advanced Military Systems, Dept. AM-1H
RADIO CORPORATION OF AMERICA,
Princeton, New Jersey.

EQUAL JOB OPPORTUNITY For All Qualified Applicants

RCA

RADIO CORPORATION of AMERICA

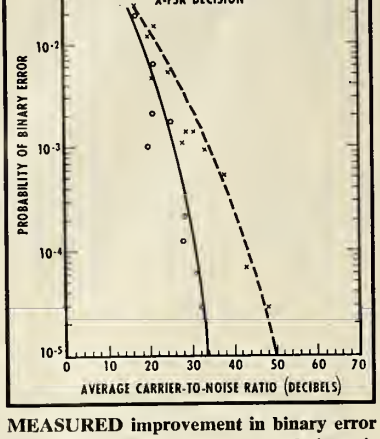
remarkable gains in detectability . . .

and for testing.

When the DTC is operated in the Mark position, the receiver in effect becomes an AM receiver operating on the frequency of mark signals only. The space signal is ignored by the decision threshold computer, and the resultant intelligence is translated from unipolar to bipolar keying to actuate the remaining circuitry of the combiner. In this way, disruptive interference occurring on the space frequency can be avoided at the expense of a slight degradation of normal performance. For reception in the Space position, the converse of the above is true.

The British "assessor" (described by Allnat, Jones and Law, "Frequency Diversity in the Reception of Selectively Fading Binary Frequency Modulated Signals," *Proceedings IRE,* Aug. 1956) can be used to automatically change the decision threshold, but its frequency response does not extend to dc. Thus, a decision failure may result with some types of traffic.

The Page DTC provides automatic adjustment of the decision threshold. Also, if signal polarity remains constant, the decision threshold is returned to zero for the FSK decision.



MEASURED improvement in binary error rate using Page's new DTC technique is shown by comparison of data with contemporary FSK decision method.

• **Performance**—Extended tests of DTC using the facilities of the ionoscatter test link between Round Hill, Mass., and Streator, Ill., showed that the circuitry remarkably improved the detectability of FSK signals. Mr. Ga Boggs, assistant director of researc at Page, has stated that the use of th device, under some conditions, mig recover traffic on scatter circuits th would otherwise be lost. Page eng neers also felt that an operational a vantage was achieved because le critical receiver balance adjustmen were needed than with convention FSK decision techniques.

The experiments by Page have ind cated that using the DTC circuit tec nique with live FSK signals, in th presence of selective fading mak possible a 5- to 20-fold reduction errors over those resulting with co ventional FSK reception using du space diversity. Similar improveme can be obtained with a 3 to 6-db i crease in transmitter power. Whe operating non-diversity with a sing receiver and under comparable cond tions, the error rate was reduced 10 30 fold, corresponding to an improv ment of 10 to 16 db. An example the results obtained in the latter ca with live signals is shown in the grap to illustrate the effectiveness of th technique.

Tiny Resistor Produced by Sputtering Technique

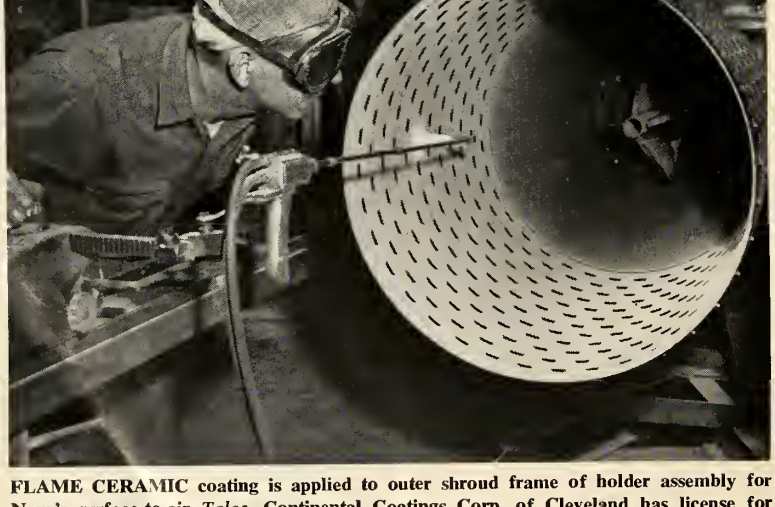
NEW YORK—Microminiaturizatic has moved another step ahead wit **Bell Laboratories'** announcement "sputtered" thin-film resistors. The r sistors, formed from refractory meta such as tantalum and titanium, can b produced on glass or ceramic bases i lines as narrow as one mil. Equivale printed circuits produced by regul methods are more than four times th size of those made by sputtering.

Bell has been researching the spu tering technique for several years. La year it announced the production tantalum capacitors by this method.

Sputtering is an old technique i which ionized gas molecules bombar a cathode, dislodging atoms of met which redeposit on nearby surfaces.

In producing a component by th method, an overall thin film of copp is first sputtered onto the surface the base. Then the desired pattern etched into the copper surface b standard photoetching, leaving the ba substrate exposed. The tantalum—o other refractory metal—is deposite onto the etched copper pattern. Th copper with its overlay of tantalum removed in an etching bath, leavin only the tantalum which was in direc contact with the bare surface. Sinc the masks are extremely thin, fin detail is possible.

Talos Gets Coating



FLAME CERAMIC coating is applied to outer shroud frame of holder assembly for Navy's surface-to-air *Talos*. Continental Coatings Corp. of Cleveland has license for process, developed by Armour Research Foundation. Aluminum oxide coating is applied in powder form to metal combustor. Molten alumina then freezes on metal and adheres by mechanical bond.

Bowmar Leads Precision Gear Field

Firm makes millions in work largely ignored by big missile manufacturers and its head views today's precision miniatures as mere prelude to future

FORT WAYNE, Ind.—Producing iniature gear packages for use in **onvair's** *Atlas* telemetry, **Martin-Or-ndo's** new *Pershing* inertial guidance, nd **North American's** *X-15* spacecraft avigation, the **Bowmar Instrument Co.** rapidly cornering a large portion of ne of the missile industry's youngest nd fastest-growing fields—develop-ient and production of precision, iniature transmissions.

These components have been some-hat ignored in the past by the large anufacturers because of the meager emand for the midget units, and be-ause it was uneconomical to establish ie miniature, high precision tooling equired.

Bowmar is the nation's largest pro-ucer of miniature mechanical com-onents with control of more than alf the market. Although there are andard lines of gearheads and servo-ackages produced in the industry, uch of the work deals with the de-gn and production of custom-devices or air and space navigation and con-ol systems, as well as telemetry, round computers, and atomic engine erve centers.

• **Doubles gross**—In 1956, Bowmar chieved an annual gross of just over 1 million. The annual gross has more an doubled each year since 1956. pproximately 92% of Bowmar's 1958 ales (total over $4 million) were tied military contracts. The remaining % of their business was for com-ercial airliner controls and naviga-on applications. Along with the ever ontinuing need for greater minia-urization for the missile industry, the uture growth area in this field cer-ainly appears to be in this latter evelopmental group.

To build these micro-mechanisms, Bowmar spokesman said that the ompany currently operates on speci-ed tolerances of 0.0002 inch for meas-rements of center shaft diameter, haft center distance, tooth to tooth, tooth width, tooth backlash and out-side diameter.

This kind of precision requires ex-tremely tight controls through the entire manufacturing operation. The gears are manufactured on both Swiss and American type precision gear hob-bing machines. The teeth are cut to the accuracy required in one operation and are finished except for minor burr removal which is performed after-wards. To check the exacting toler-ances, a great many precision equip-ments are required, such as gear roll-ing machines that record total com-posite error of the gears to less than 0.00005 inch.

To increase reliability, the tiny parts are ultrasonically cleaned and assembled in a dust-proof chamber. Bowmar maintains a "clean room" that is pressurized, sound proof, and tem-perature controlled at a positive 72°F and controlled 50% relative humidity.

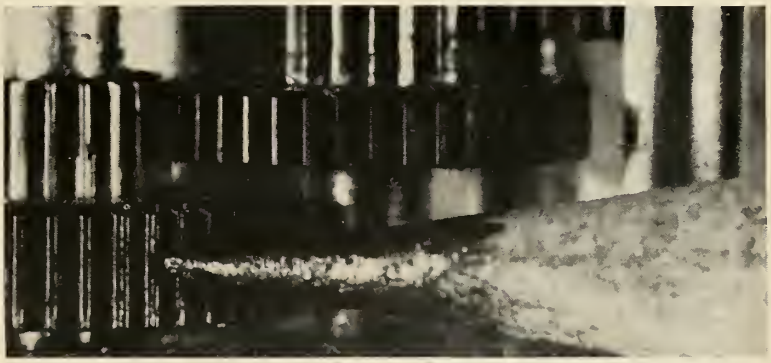
Each month the company assembles an average of 125,000 individual parts, ranging from gears of 0.177" diameter, to pinions of 0.09" diameter and to ball bearing units 0.1" diameter. Fitted together under microscopes, these parts are combined into gearheads, speed re-ducers and servo-packages.

New techniques have permitted the development of ¾-ounce transmissions that can increase torque from a 0.3 inch-ounce input to an output of 540 inch-ounces, using motors of 0.00008 horsepower.

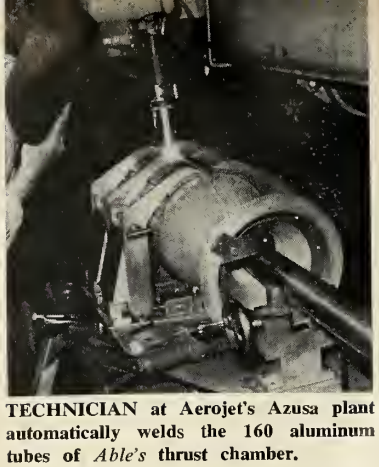
Biggest problem is to keep up with the servo-motor manufacturers, who are currently shrinking motors to these small diameters, and low outputs. Given the job of miniaturizing the size and weight of an inertial-guidance servo-package to meet new specifications for the Army's *Pershing* IRBM, they reduced the unit three times to a final miniaturization of 2½ x 2½ inches and less than 20 ounces in weight.

Grape-sized miniature gearheads are now being produced ranging in speed-reduction ratio up to 3 million to 1 and priced up to $2000 each.

Currently working on a 1" long gearhead that will produce a 6000-to-1 reduction ratio, Bowmar's president Ed White contends that his company and its fellow miniaturists have barely scratched the surface. Before space ve-hicle design can go much further, he believes it will require mechanical pack-ages even more reduced and complex. Compared to future units, Bowmar feels that current devices will seem not only crude but outrageously large.



SCARCELY larger than sharp pencil point, this Bowmar miniature gearhead is used in guided missile control packages and, more commonly, to slow down computer motors.



TECHNICIAN at Aerojet's Azusa plant automatically welds the 160 aluminum tubes of *Able's* thrust chamber.

Success Story: Improvi

History of the progress of the system from four failures in the Vanguard effort to perfect batting average with Thor-Able

by Frank McGuire

AZUSA, CALIF.—From *Vanguard* to *Thor-Able* to *Delta* represents considerable progress since the beginning of the Space Age, and one second stage has prevailed through all three programs. From an unimpressive record of four failures in the *Vanguard* program, the system progressed to a nine-out-of-nine success record in the *Thor-Able* program.

Aerojet-General Corporation, producer of the system, will turn out 15 second-stage systems for the *Delta* program of NASA under a $6 to $8 million contract. The stage is a modification of the *Thor-Able* version, which in turn is a modification of the *Vanguard* version. AGC will be a subcontractor to **Douglas Aircraft Company** on the program.

• **October launching?**—Delivery of the first *Delta* second-stage system to Douglas by AGC was made the first week of this month. The first launching of the complete three-stage vehicle should be sometime in the fall—about October. The third stage is a solid-propellant system produced by **Allegany Ballistic Laboratory.** Gross weight of the *Delta* vehicle is 100,000 pounds.

The only modification of the *Able* system necessary to enable its use in the *Delta* program is the addition of a coast phase altitude control system.

Along with production of the second-stage system, delivery of which will extend over a two-year period, AGC will provide necessary missile support equipment and technical services.

In its *Able* configuration, the system was vital to re-entry tests and deep space probes by the Air Force. The startling thing about this *Able* system is that it moved from idea to initial delivery date in eight weeks.

The entire *Able* system—including test support and propulsion units—was scheduled to be designed, fabricated and tested in 26 weeks. AGC's assignment as of November 27, 1957, was to "produce six rocket propulsion units—to be designated AJ10-40—including systems for attitude control, separation, required airframe structures, and all associated test support equipment." Delivery date was set for May 31, 1958.

The first unit was delivered to **Space Technology Laboratories** on January 17, 1958. It was assembled with other missile systems and shipped to Cape Canaveral for testing.

Initial announcement of the *Delta* contract to Douglas was made April 29, 1959, by NASA, and the first unit was delivered by AGC early in August.

• **Adapted existing engine**—The tight schedule on *Able* forced engineers to adapt an existing rocket engine to the job, and to conduct all component development programs simultaneously. Since basic design requirements were quite similar to those of AGC's second stage *Vanguard* unit, this system was incorporated into *Able*. Two surplus chambers and tank assemblies from *Vanguard* were transferred to *Able*.

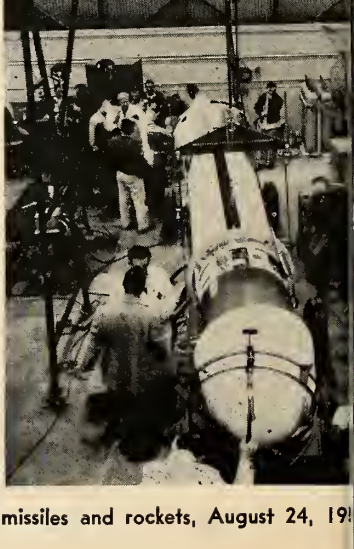
Remaining time was devoted to development and fabrication of 18 functionally distinct items of test support equipment and the modification of the *Vanguard* propulsion system. Excluding the tank and thrust chamber assemblies, Aerojet-General developed nine component systems: gimbal actuation system; helium pressurization system; roll control system; interstage separation system; payload separation system; destruct system; vent and relief system; electrical system; and the aft skirt transition assembly and controls compartment.

As incorporated into the *Able* unit, the propulsion system developed about 7800 pounds thrust. The 66-pound engine is regeneratively-cooled and uses a hypergolic combination of unsymmetrical dimethylhydrazine and white inhibited fuming nitric acid as propellants. The WIFNA oxidizer circulated through the 160 pre-form aluminum tubes comprising the cha ber wall. An impinging injector is us offering early ignition at the l chamber pressure of 206 psi.

Pressurization of propellant tanks accomplished by a helium system wh is beefed up by a solid-grain heat g erator when helium pressure drops 200 psi. The solid-grain generator he and expands the remaining helium.

Tank assembly for the system fabricated by welding two cylindri sections to form each tank. They stainless steel, 0.0050″ thick. Her spheres drawn from tapered blar form the tank ends and the heli sphere.

The gimbal actuation system, wh corrects for pitch and yaw duri flight, is capable of moving the thr



he *Able*

chamber plus or minus 3° and is operated by a hydraulic control system mounted inside the aft skirt adjacent to the thrust chamber. Roll stabilization during powered flight consists of two solenoid shut-off valves responding to control system signals, and two pairs of nozzles mounted on the periphery of the forward skirt. Regulated helium gas from the spherical tank is expelled through selected nozzles, two clockwise and two counter-clockwise, depending on the control desired. Each nozzle of the selected pair produces seven pounds of thrust for a maximum of 20 seconds.

• **Simultaneous venting**—The vent and relief system is designed to simultaneously vent the oxidizer, fuel and helium tanks by means of three vent valves. This is designed to provide a fail-safe means of venting all tanks during a sudden pressure build-up, extended hold during countdown, or valve failure.

Four explosive bolts join the two stages of the *Thor/Able* combination, and separation is achieved when the bolts are exploded by a signal from the thrust chamber pressure-switch which detects rising chamber pressure in the second stage propulsion system, and then effects separation.

Pendulum tests of the payload-separation system were conducted with dummy payload and vehicle structures. The 611-pound payload dummy was joined to a second-stage forward control compartment by two explosive bolts. Both the dummy payload and the control compartment, which had been ballasted to 858 pounds, were suspended to simulate flight position. After actuation of the explosive bolts, separation is achieved through four spring-loaded plungers which push the payload away from the vehicle. A high order of reliability was reported, correlating within 5% the separation velocity measured at 1.6 fps.

The destruct system, composed of a 15' length of primacord strung along the side of the tank assembly, was capable of completely destroying the second stage in one second.

The first test firing of the *Able* propulsion system was a 10-second calibration run, followed by a 60-second checkout firing. Both took place on Christmas Eve, 1957. Thereafter followed compatibility tests to study overall performance and to determine the effect of gimbaling and roll control jets on propulsion-system performance.

• **Test support equipment**—Two sets of TSE units were built, to be used interchangeably at either the launching area or at the hangars. The original schedule called for the entire TSE package to be delivered and checked out before the first *Able* propulsion system arrived at Cape Canaveral. This was done by building, testing and delivering the TSE within 60 days.

Prime support function of the TSE was multi-fold: pre-launch instrumentation; launch control and electrical systems monitoring; functional pressure checkout; missile-control-system checkout; explosive-bolt and squib checkout; hydraulic servicing; supply and maintenance of system equipment; fuel and oxidizer servicing; missile tank decontamination; propellant-tank drying; and missile handling. The vehicle-handling trailer is a three-purpose vehicle acting as road carrier, lifting sling and as a roll-over and handling frame for inspection and test work.

After thorough testing by Space Technology Laboratories upon receipt of the *Able* stage, it was again completely tested at Cape Canaveral.

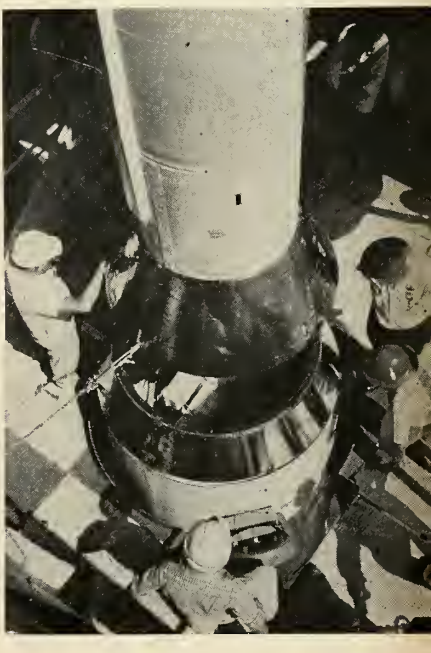
During countdowns, there reportedly was no major hold during the *Able* phase of the terminal count. Aerojet says that during each flight in which it was called upon to operate, "the second-stage *Able* fired, and flew a predetermined course down range, delivering its instrumented nose cone within the target area. It thus became the first American missile to fly an intercontinental range of better than 5000 miles."

←

AT LEFT, the nose cone and transition skirt (which attaches the *Able* unit on top of the *Thor*) is assembled at Space Technology Lab, Inglewood, Calif.



EARLY STAGES of assembly of *Able* rocket unit at Azusa. Left to right, tank assembly, aligning aft skirt, riveting skirt, assembly of thrust chambers.



→

LIQUID-POWERED second-stage *Able* unit is mated atop the *Thor* missile forming the *Thor-Able* test vehicle at Cape Canaveral, Fla.

Spectres Ready for Missile Role

by G. V. E. Thompson
Contributing Editor to M/R

LONDON—The *Spectre* series of kerosene-hydrogen peroxide-propelled rocket engines now in production are intended for both missile and manned interceptor propulsion.

While no information has been released about the use of *Spectre* as a missile propulsion unit, it has a big advantage over liquid engines in that the missile could be held in a state of instant readiness for months without losing oxidant by evaporation.

Manufacturer of the *Spectre* series **—de Havilland Engine Co.**—began work on rocket propulsion in 1946. The first project was the *Sprite*, an ATO unit intended for use with Comet I aircraft.

Sprite was a "cold" unit in which hydrogen peroxide was decomposed with calcium permanganate catalyst (later replaced by solid silver). It functioned successfully but never became operational owing to the use of more powerful jet engines. However, out of it was developed the *Super Sprite*, now in use as an ATO unit for the **Vickers** Valiant bombers.

In *Super Sprite*, kerosene is burned in decomposed peroxide (silver-plated nickel gauze is used as catalyst for the peroxide). Normal maximum thrust is 4200 lb., and duration 40 seconds, but they can be varied within certain limits. The engine weighs 620 lb. dry, 1460 lb. when fueled, and has an overall diameter of 20¼" and a length of 117¼".

The propellant tanks and combustion chamber are made of stainless steel. Only the nozzle is regeneratively cooled. The kerosene tank is wrapped around it to keep the engine as simple as possible. The combustion chamber temperature is kept to 1500°C (instead of a potential 2000°C) by employing excess peroxide. Within the combustion chamber is a large cylindrical flame tube fabricated from Nimonic 75 sheet by argon arc welding.

The combustion products flow down inside this tube. A relatively cool stream of superheated steam and oxygen from decomposed peroxide flows down the annular space between the flame tube and the stressed chamber walls, protecting the latter from the combustion products. The two streams are allowed to mix in the nozzle throat.

• **Advanced series**—The work on *Sprite* and *Super Sprite* has provided a useful basis for the development of the more advanced *Spectre* series of rocket engine. One of *Spectre's* intended uses was as the main power plant of a manned interceptor aircraft. In design the emphasis has been placed on reliability up to accepted aircraft engine standards.

Although the propellants are still kerosene and HTP, *Spectre* is intended for either "hot" or "cold" operation, so HTP has to be used as the regenerative coolant. After experimenting with an indirect system (in which the chamber was cooled by water which then passed to a HTP heat exchanger before recirculation) and then with low-pressure HTP cooling (one pump delivers HTP to the coolant jacket, a second raises the heated peroxide to supply pressure), high-pressure cooling was finally adopted.

An intensive programme of ground and flight test has been carried out, particularly with the **Saunders-R** S-R.53 research aircraft. Thrusts over 7000 lb. were obtained (the engi is designed to yield 8000-10,000 lb Several different units are no available.

Spectre 5 is a variable-thrust un designed to be capable of running any output between its full thrott power and ground idling. All pump valves and controls are in a compa and robust assembly which can rapidly installed, and is much light than the original *Spectre 1*.

A simplified constant-thrust versi *(Spectre 4)* is also in production. Wh used as an ATO unit, it is designed f repeated use and is mounted within releasable nacelle together with ker sene and HTP tanks and parachu gear. The V-bomber force of the RA **(Avro** Vulcans and **Handley Page** Vi tors) is provided with these units.

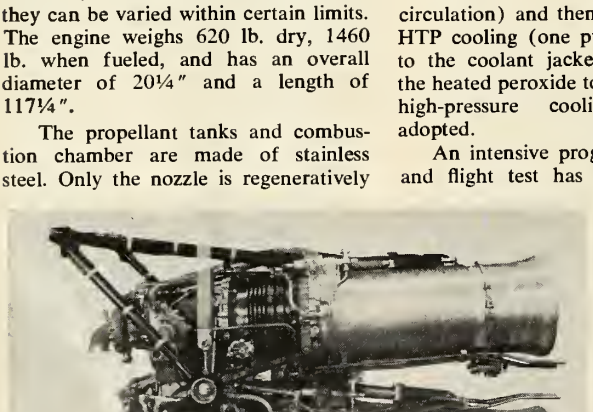
• **Newer addition**—A more rece addition to the series is the *Doub Spectre* (D.Spe.D.1). This consists of fixed-thrust *Spectre 4* mounted abo a variable-thrust *Spectre 5*, with on minor modifications to each. The tw units are essentially independent, a though carried on a common tubul frame and connected by certain pip runs. The combined unit is entirel self-contained.

To operate the engine, the pow rocket must first be started. It is fitte with a spherical starter bowl and ca ries a small pressure bowl of nitroge on the starboard side to initiate th start. Once the lower unit is operatin a small bleed of HTP is fed across t energize the turbine of the pump f the upper unit, which can then b started. The whole procedure takes b a few seconds.

The upper unit is either inactive c operating at full thrust; the output c the lower unit is controllable at an value between idling and its maximu thrust. Once started, either unit ma be shut down independently of th other.

Its principal dimensions are: overa length 58.6"; maximum height 37.5 maximum width 36.6".

All the *Spectre* engines are designe so that it is impossible for kerosene t be injected into the combustion cham ber unless HTP was already flowin through.



MOUNTING a *Spectre 4* **fixed-thrust engine on frame above** *Spectre 5* **variable-thrust unit produced new** *Double Spectre* **in which the two units are largely independent and can be separately shut down.**

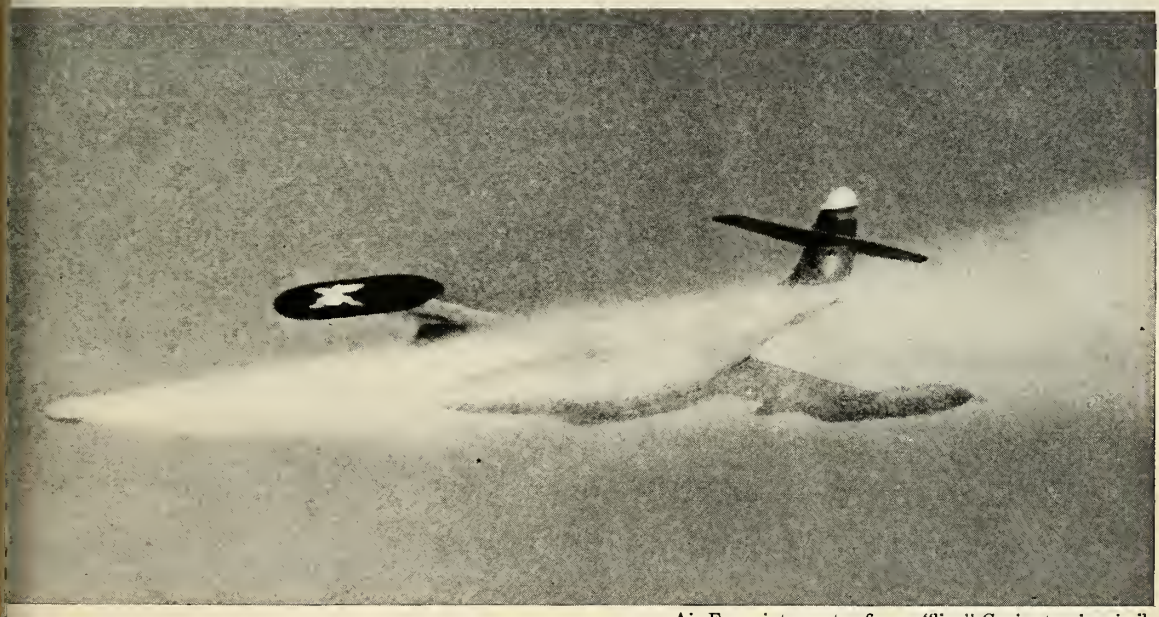
The men:



. . . USAF ordnance technicians assigned to service the Douglas *Genie* air-to-air nuclear-armed missile. They have undergone extensive training in Air Force technical schools and from Douglas field service engineers to become proficient in both rocketry and nuclear ordnance.

The mission:

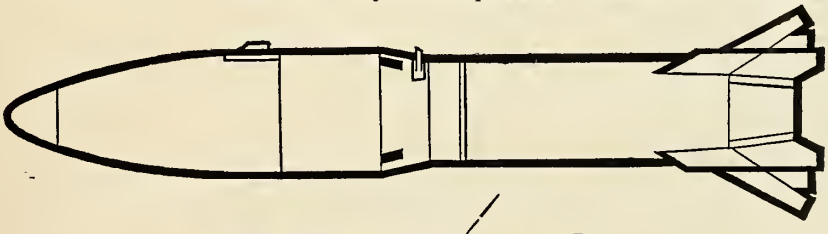
. . . high-level interception of enemy aircraft. Ideal interception would take place far from U.S. boundaries. The atomic warhead of the Douglas *Genie* was detonated under test conditions over friendly troops with no resultant danger.



Air Force interceptor fires a "live" *Genie* atomic missile

The missile:

. . . the Douglas-built *Genie*. This nuclear missile has actually been fired in flight. Retractable fins allow the missile to nest close to the plane's fuselage. Or it can be carried in the bomb bay. Interceptors can be armed with two *Genies*.

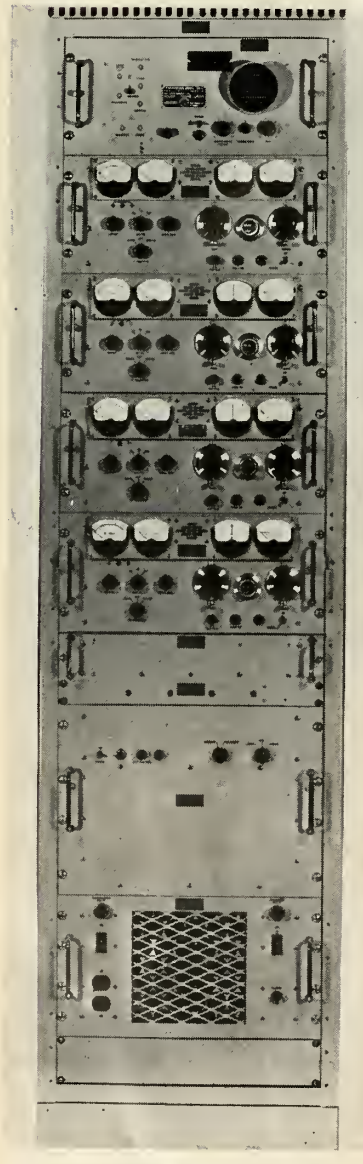


Depend on **DOUGLAS**

The Nation's Partner in Defense

Trouble-free Telemetry Receivers

This small industry—largely in the hands of one company—produces highly reliable and durable units which stay well ahead of their requirements



GROUND receiving station contains four NEMS-Clarke 1400 series receivers.

by Hal Gettings

WASHINGTON—In the hectic flurry of missile research and development at least one vital system part—the telemetering receiver—seems completely competent to handle its important job, today and in the near future.

The specialized radio receivers for missile telemetry have enjoyed a series of steady improvements which keep them ahead of their requirements and promise a continuing capability. They present no real problem in reliability and their operation is generally so dependable that they receive little attention.

The receiver industry is small—and likely to continue so for some time to come. Last year's volume was less than $3 million; 1959 will run under $4 million. And 95% of this business is done by one company—**NEMS-Clarke Division of Vitro Corp.**

There is practically no replacement market for receivers. They have to be repaired and maintained, but they seldom wear out. The first unit developed by NEMS-Clarke, still operating, was built in 1947 for the Bureau of Standards and used for collecting test data on an early parachute-ejection system.

• **Accuracy paramount**—Receivers for missile telemetry must be much more than just good communication equipment. Accuracy of received data is paramount—the receiver must not add any distortion or inaccuracies. Numerous information channels must be crowded in one band and the receiver characteristics must be sharp and clean. Frequency stability must be held within close limits. (Units with variable frequency oscillators provide up to ±0.005%; crystal-controlled units ±0.002%.) Noise figures of less than 8 db, and better, are considered standard. Equipment must be versatile to provide both AM and FM reception —and sometimes CW—and video and audio outputs. Some units feature selectable i-f bandwidths.

This precision and reliability mus be designed in. As a result, equipmen is rather expensive; the best standar units go for around $2500. Many buy ers, though, want a few minor modi fications included—and the price goe up from there. Most in demand woul seem to be a "custom-made standar unit."

• **Limited potential**—There ar probably less than 4000 telemeterin receivers in use today—almost all a missile ranges. The Atlantic Missil Range, for example, has 270 units o one NEMS-Clarke model installed an an unnumbered total of other models

Potential market growth is pretty well limited to two areas: new missil range installations and new telemeterin frequency allocations. It's hard to de fine just exactly how much hardwar will go into these applications, bu estimates are that the business will g along on a slowly increasing level fo the next several years. And, as spac programs grow, the demand for re ceivers will see a commensurate growth

Several major—and many minor— improvements have been made in re ceiver equipment in recent years. Th field has seen no tremendous break throughs, however—possibly becaus none have really been demanded. Mos telemetry people feel that the receive is probably the best and most reliabl part of the telemetry system.

• **Phase-lock progress**—The mos significant advancement has been th development of correlation detection This technique—commonly known a phase-lock demodulation — effectively lowers the receiver sensitivity threshold Gains of from 5 to 15 db have beer realized by the incorporation of phase lock in receiver front ends.

In operation, the phase detector o multiplier compares the instantaneous phase of the FM input signal with that of a locally generated carrier obtained from a voltage controlled oscillator and produces an output voltage proportional to the phase difference. This voltage is fed through an amplifier and

ter network back to the input of the CO which is locked in phase with the coming signal. Since the VCO is following the incoming signal in frequency, the voltage, which causes it to follow in frequency, is proportional to that frequency and thus represents the demodulated output signal.

When the signal input becomes noisy, the ordinary demodulator does not operate properly and the output signal-to-noise ratio deteriorates rapidly. The point at which the demodulator ceases to function correctly is known as the improvement threshold. Phase-lock, by lowering this improvement threshold, increases the sensitivity of the receiver. This is equal, in effect, to increased antenna gain or transmitter power.

No one firm can take full credit for the development of phase-lock. **Radiation, Inc.** several years ago developed an accessory plug-in unit for standard receivers and applied for patents. NEMS-Clarke offers certain models of its 1400 series with phase-lock incorporated.

• **Preamps vs. paramps**—Considerable improvements are expected in low-noise preamplifiers to further increase the sensitivity of receivers. The recently announced "tunnel diode" offers promise in this area.

One industry spokesman feels that efficient advances may be made in tramps to bring them within two db of the parametric amplifier. Problems due to the complexity and stability of the parametric would make the improved preamp more desirable for most applications.

Others feel, however, that the paramp offers a magnitude of improvement not attainable by the other. Especially in the 2200 mc band, the noise temperature seen by an antenna pointed at the sky is low enough to allow the full potential of paramps to be realized.

• **Predetection recording**—One of the most significant advancements in telemetry reception is that of predetection recording. This technique, first used in the reception of radar signals from Venus by **Lincoln Lab's** Millstone antenna, offers great promise in higher reliability of telemetered signals. Receiver input is picked off just ahead of the detection stage, tape recorded, then later demodulated.

The advantage here is in the possibility of applying advanced demodulation techniques to periods in which data are lost due to poor signal-to-noise ratio or interference. Future improvements in this technique are expected to significantly advance long-range telemetry.

Radiation, Inc. has designed and built models of a 2200 mc "state-of-the-art" receiver which provide this feature. Production of commercial models is contemplated.

• **Frequency allocation**—A great hassle has long existed regarding the allocation of frequencies for telemetering use. Today's "standard" band is 215-260 mc and most present receivers are built to cover these frequencies. Predictions are that most of this band will be used at least until 1970. Some equipment is being built to cover the "new" 2200-2300 mc band and it is expected that receiver techniques generally will be advanced as new equipment is developed to fit these higher frequencies. The 1435-1535 mc range is also being used to some extent—primarily for aircraft testing.

NASA has requested assignment of the 135-136 mc band to move the 108 mc Minitrack frequency for future space programs. Although Minitrack is used primarily for tracking, a limited amount of telemetered information is transmitted on this band. A few receivers have been built which cover this band in a spread from 55 to 260 mc.

Generally, the lower frequencies are considered more desirable for their propagation characteristics—and because microwave plumbing in missile transmitters offers problems. Choice is limited, however, by the bands available. Too, missiles are very restricted in the size and type of antennas that can be used—which, of course, has a definite relation to frequency selection.

• **Small business field**—Surprisingly, none of the big radio manufacturers are in the telemetering receiver business to any extent. This is probably because the annual volume is such a small one and that large production runs are not possible. Also, most standard units must often be modified to fit particular applications.

The bulk of the receivers are made by NEMS-Clarke in nearby Silver Spring, Md. This 60-year old firm has been in the field for twelve years. It manufactures a complete line of telemetering receivers and many accessory units such as preamplifiers, multicouplers, and combiner/adders. It heavily emphasizes reliability and goes to great lengths to maintain strict quality control. The company even manufactures almost all its own receiver components—from transformers and i-f coils to plastic panel escutcheons.

NEMS-Clarke produces several series of receivers specifically for FM telemetry. Their 1400 series—with phase-lock in some models—is practically a standard at missile ranges. An estimated 2500-3000 units of their models are currently in use. The company is a leading contender for telemetering receivers for Project *Mecury*.

Tele-Dynamics Inc., formerly **Raymond-Rosen,** was one of the early manufacturers in the field. They built the UKR-2 2000 mc receiver, still being used presently in the *Titan, Polaris* and other missile programs. About 10% of their current business is in receivers; they specialize in miniaturized units for both telemetering and command destruct applications.

Practically all of Tele-Dynamics' business is concerned with telemetering equipment. They claim to be the only company manufacturing a complete system from transducer input to recorder output, including the radio link.

Receivers for all three frequency bands are manufactured by **General Electronics Laboratories,** Cambridge, Mass. They are currently producing one lot of 25 215-265 mc units for the Pacific Missile Range.



TELEMETRY receiving station installed aboard picket ships of the Pacific Missile Range which are deployed to supplement range stations on various Pacific islands.

The Latest Word in Heat Treating

Alco uses a Lindberg furnace with operating temperatures up to 1950° F to treat flight cases for Pershing missiles forged at Latrobe

DUNKIRK, N.Y.—Heat treat of missiles today is a far cry from earlier times, when among other things:

• Armorers quenched the famous swords of Damascus by plunging them into the flesh of the strongest slaves. They believed that the strength of the slaves was transmitted to the steel.

• Metals were immersed in the urine of three-year-old goats that had been fed on ferns for three days.

• The urine of young, healthy, red-headed boys was used.

Little is left to superstition nowadays. Heat-treating facilities are keeping pace with the Missile Age. Metals are quenched after heat treatment in a special oil with temperature specially controlled. The furnaces and tanks all respond to electronic controls, thermocouples and other modern devices.

One of the nation's newest heat-treating facilities, a **Lindberg** electric drop-bottom for missile metals, is installed at the **Alco Products Inc.** plant here. For some six years, Alco has been a key supplier of bodies for the *Honest John*. It has had contracts for making *Nike-Zeus* nozzles and now is producing first-stage flight cases and nozzles for the *Pershing*.

The Lindberg is a versatile furnace. It can perform hardening, stress relieving, normalizing, quenching and tempering, annealing and spheroidizing. Operating temperature ranges from 1400° to 1950°F for 1000 pounds and up to 1650°F for 2000 pounds.

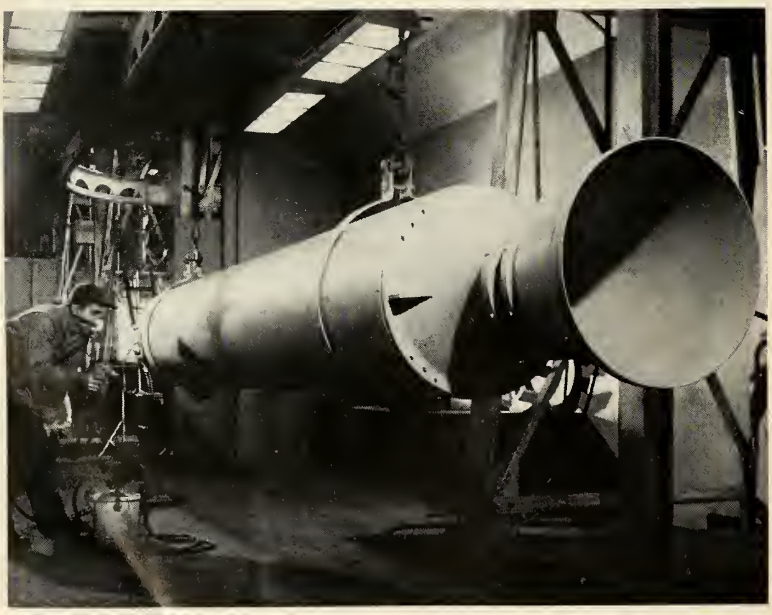
Alco makes motor cases for the *Pershing* on a subcontract from **Thiokol Chemical Corp.,** which has responsibility for the propulsion system. Three precision-made test versions of the motor cases were made first for use in static-fire tests. Later, Thiokol awarded a production order for additional cases, with even more exacting tolerances.

The cases must not be distorted from heat treating in excess of 10 total indicator runout, nor must the 0.105″ skins be decarburized to depth exceeding 0.003″.

The *Pershing* flight case is forge at the Alco plant in Latrobe, Pa. Bot the front and rear heads are hot-presse and contour-machined here. The fro head is hot-formed from ½″ plate an pressed to shape. Then it is roug machined and the center-part forgir is welded in. The head is X-rayed an finish contour-machined to 0.01 thickness.

The rear head is fabricated from seamless forged ring, swaged ar formed to its conical shape and the contour-machined to 0.015″ size. Th shell is formed by rolling and weldir AISI 4130 sheet steel. Then the fro and rear heads are welded to the she to form the case. All welding is dor by automatic Heliarc. Heat treatir brings the yield strength in the 41 case to 180,000 psi.

The **Martin Co.** is prime contracto for the *Pershing*.

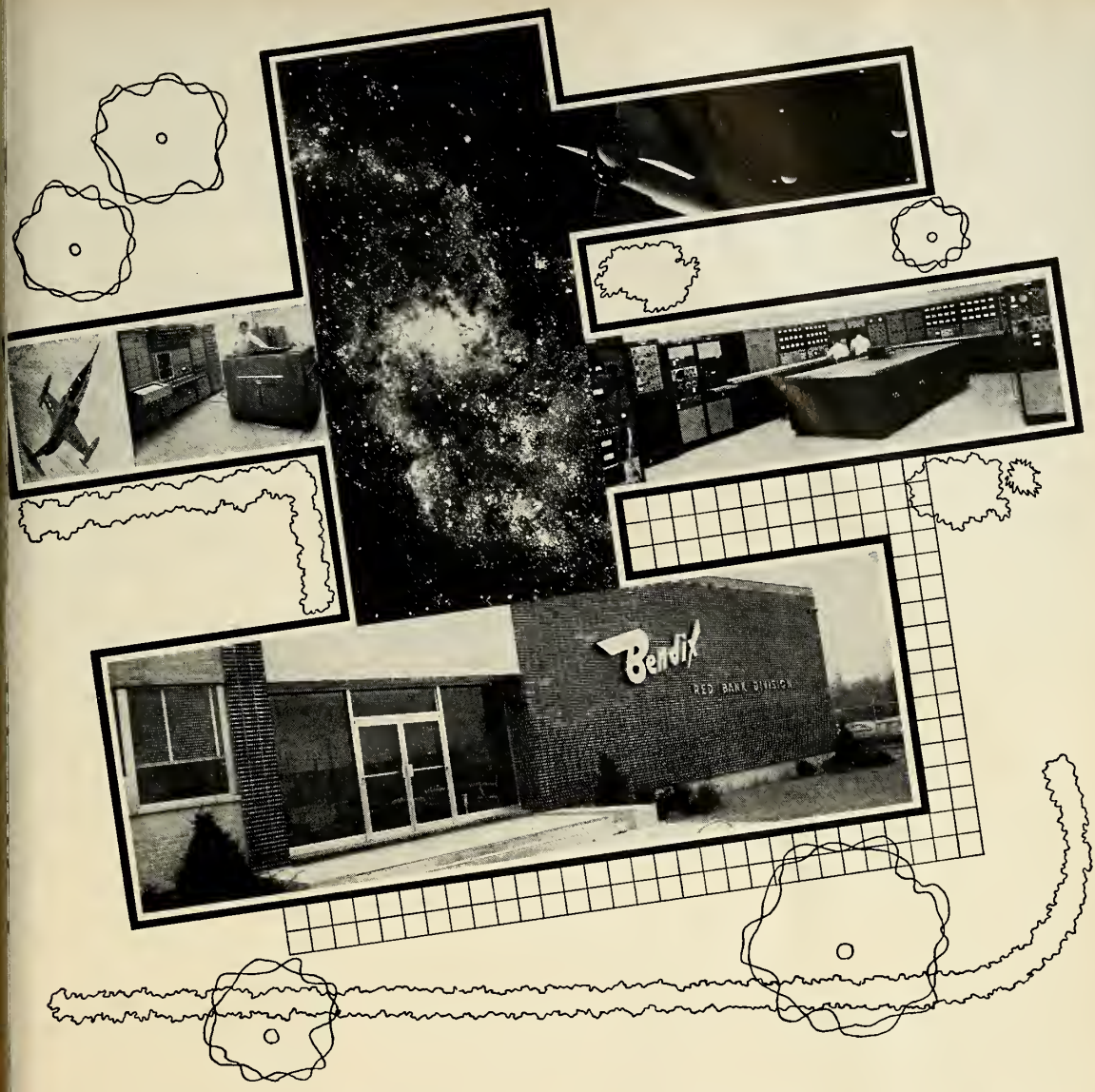


ROCKET BODIES for *Honest John* are heat treated in new facility at Alco Products Inc. plant in Dunkirk, N.Y. Prior to shipment, each body receives careful painting.

Semiconductor Can Serve As A Complete Circuit

SAN FRANCISCO—The newest in growing number of microminiaturize semiconductor devices that can ser as a complete circuit was demonstrate here at WESCON by Bell Telepho Laboratories. The device—a p-n-p semiconductor element—is the bas building block of a silicon steppi transistor. It measures only 0.04″ diameter.

The stepping transistor acts as pulse-controlled on-off switch simil to a gas stepping tube. It can be us as a basic stage in certain digital cor puter logic circuits. It is capable many high-speed functions usually pe formed by complex circuitry. Te models of the device have operated speeds up to one million pps. High speeds are expected with improv design.



THE HOUSE WHERE TOMORROW LIVES . . .

Our newest engineering facility, in Eatontown, New Jersey, is dedicated to creating new ideas and products that will help you meet tomorrow's electronic, missile and aircraft needs today.

This ultramodern, completely air-conditioned structure houses the most modern and exact testing devices. Fresh approaches to even the most complex engineering problems are encouraged and facilitated by an environment conducive to imaginative, creative thinking.

Bendix Red Bank's rapid growth since 1941 from a small maker of electrical devices to its present role as producer of a multitude of complex electrical and electronic systems is your added assurance that advanced engineering is a built-in Red Bank feature.

West Coast Office: 117 E. Providencia, Burbank, Calif.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliate: Aviation Electric, Ltd., P. O. Box 6102, Montreal, Quebec.

Red Bank Division
EATONTOWN, NEW JERSEY

Bendix
AVIATION CORPORATION

Expansion in Pennsylvania, N.J.

Both states earn upwards of $1 billion a year from missile work; astrionics leads the growth. Second in a series on Middle Atlantic states

by William E. Howard

PHILADELPHIA—Barring a hatch-out of more "bugs," the Air Force in a few weeks will pronounce **Convair's** *Atlas* an operational weapon—the Nation's first ready-to-shoot ICBM. When this missile milestone occurs, it will have particular significance to thousands of scientists and technicians in eastern Pennsylvania and New Jersey. For this hustling industrial area is one of the major subcontracting centers for the big war-bird.

Hundreds of companies in this area are contributing to the development of *Atlas* and dozens of other missile/space systems. Moreover, engineers here hold the prime responsibility for developing BMEWS—ballistic missile early warning system designed to give the country's retaliatory forces 15-minutes advance notice that an enemy ICBM attack is on the way.

Missiles today are an important force throughout the economy of the two states. Defense Department procurement figures and independent estimates place missile-related manufacturing conservatively at more than $1 billion a year in each state. Employment is in the hundreds of thousands. And despite the lack of a major prime missile systems contract, the industry is growing—especially in astrionics.

Much of the activity is concentrated here in the Philadelphia-Camden area. The Big Four of the industry are **General Electric Co., Philco Corp., Burroughs Corp.** and **Radio Corporation of America.** These companies alone employ a total of around 30,000 on missile/space projects and their aggregate contracts run well over $500 million yearly.

GE's Missile and Space Vehicle Department here is developing *Atlas* and Douglas *Thor* nose cones under $168 million worth of contracts. Currently it is working on advanced *Atlas* re-entry vehicle designs in its 120′ shock tunnel which can simulate re-entry environment, including heat transfer, pressures, flow characteristics and other phenomena. Recently the tunnel completed its 1000th firing.

The department also has developed the *Thor-Able* nose cone data capsule recovery system. Its 780 engineers and scientists and nearly 5000 other employees are working on the *Discoverer* satellite series, fuzing and arming *Lacrosse* and *Little John* Army missiles, and pushing R&D on a number of advanced data processing and other projects.

A $700,000 Army contract for *Courier* communication satellite shrouds and code tapes recently went to Philco, which has nearly 5000 employees at its Government Industrial Division here. The company has just received a $13 million follow-on for the Navy *Sidewinder,* which it is co-priming with GE, Utica, N.Y.

Philco in addition has the guidance for Convair's *Redeye*—the Army's new bazooka-type weapon—and the fuzing for *Falcon, Terrier, Tartar, Talos, Little John, Corporal* and *Sergeant.* Philco is now building a new plant for its Transac computer at Willow Grove, Pa.

Just outside Philadelphia in Paoli, Burroughs has a 2000-employee Research Activity which is developing *Atlas* radio inertial guidance computers and electronic devices for a number of other missiles including *Titan* and *Thor.* This facility includes the Ballistic Missile Division of the company—and in the words of Burroughs president John S. Coleman it is the "heart of the participation by Burroughs Corp. in weapon systems programs."

• **Shape of the future**—Across the Delaware River in Camden, RCA—prime contractor for the $1 billion BMEWS (ballistic missile early warning system)—has 15,000 employees at its Defense Electronic Products Division. They are also turning out *Atlas* and *Hawk* checkout gear and working on the Air Force's global communications AIRCOM network, the means whereby SAC will flash the word "Go!" in the event of nuclear attack.

On the plains outside Moorestown, N.J., RCA is constructing the first BMEWS prototype facility. When it's completed, travelers along the New Jersey Turnpike will see something resembling a huge orange sitting on a flat lunchbox.

This full-scale working model of BMEWS installations now under construction in Thule, Greenland, and Clear, Alaska, will be high as a 15-story building—176′. Workmen have completed the three-story base of the facility and will soon finish its top—a gigantic radome 140′ in diameter.

Earlier this month RCA received a multimillion-dollar contract from **Boeing Airplane Co.** for major R&D on sensitive-command and support information networks of *Minuteman's* launch control system.

The whole RCA Defense Electronic Products division is currently doing at least $250 million a year and is growing rapidly.

The missile/space activity of these four major concerns is fostering a profusion of satellite industries. Each company has suppliers, vendors and subcontractors by the thousands. In the past few years many small firms like **Brown Instruments, Suckle Electronics** and **Magnetic Metals,** to name a few in this area, have grown to substantial size.

• **New Jersey electronics**—Missile electronics predominates throughout New Jersey. **Bell Telephone Laboratories** at Whippany is performing for **Western Electric** the R&D on the $450-million *Nike-Zeus* anti-ICBM program. The company's several thousand scientists and researchers also have developed the command guidance system for *Titan* which will be phased out soon by **AC Spark Plug's** all-inertial system.

ITT Laboratories division of **International Telephone and Telegraph**

Corp. has its main installation at Nutley. ITT Labs employs 3500 persons—1100 of them professional engineers and scientists—and they are hard at work on a variety of missile DOVAP (Doppler, velocity, position) guidance systems. Programs include *Lacrosse* and *Talos,* interceptor missile evaluation for *Bomarc* and a number of other contracts running into the millions of dollars.

Only recently ITT Labs received an $800,000 Army award for three *Courier* communication satellite ground stations. In the spring, the parent company established a new unit—ITT Communications Systems Inc.—to handle overall development, design and master planning of AIRCOM. RCA is a principal associate.

One of ITT Labs' subcontractors is **Applied Science Corp.,** Princeton, which is now working for ITT on a $794,000 digital data transmission system to be installed at Eglin AFB, Fla.

The Princeton area holds a small cosmos of missile/space research outfits orbiting around Princeton University's aeronautical laboratory, and the Army Signal Corps' Research and Development Laboratory at Fort Monmouth. This latter unit currently has a $190 million-a-year research program underway and is funding work in some 250 commercial laboratories and 50 educational and non-profit institutions.

Kearfott Co. Inc., a subsidiary of **General Precision Equipment Corp.,** Little Falls, is rapidly growing into one of the state's major missile subcontractors. Recipient of a new $4.5-million assignment from Boeing for production of attitude converter systems and related directional control equipment for *Bomarc,* Kearfott is now in the process of building a million-dollar addition to its main plant. The company employs 5000 now and expects to increase its payroll shortly.

• **Elsewhere about the state—Avion Division** of **ACF Industries,** Paramus, is working on a $435,000 NASA contract for transistorized radar beacons to track the *Mercury* manned space capsule; **Daystrom Inc.,** Murray Hill, a leader in anti-submarine detection devices and producer of missile/space instrumentation, is clipping along at an annual sales rate of $76 million.

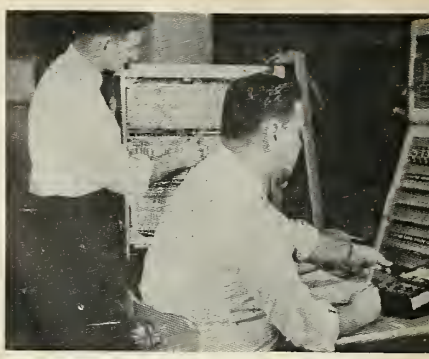
Thiokol Chemical's Reaction Motors Division, Denville, employs in the neighborhood of 1600 persons. Second largest division of the company, Reaction is producing liquid propellants, including storables and advanced packaged fuels. In the engine line, it produces the powerplant for **North American Aviation's** *X-15* rocket plane; *Guardian I* and *Guardian II* rocket engines for the Navy and the engine for the Navy's *Bullpup* and *Covus* air-to-surface missile which homes on radar.

Other New Jersey companies deep in missile work include **Airborne Accessories,** Hillside; **Curtiss-Wright Corp.** at Carlstadt; **Walter Kidde & Co.'s** Aeronautical Division at Belleville; **Gulton Industries** in Metuchen; **Hydromatics Inc.,** Livingston, and **Thomas Edison Industries,** West Orange.

• **Atoms and cryogenics**—Across the state of Pennsylvania there is increasing missile activity—chiefly in the support field. **Westinghouse Corp.,** Pittsburgh, is manufacturing the nuclear powerplants for nine *Polaris* submarines. Each sub costs $100 million.

Westinghouse a few weeks ago established at Pittsburgh an astronuclear lab where scientists will develop nuclear energy for outer space.

U.S. Steel, Bethlehem Steel and **Crucible Steel** are among the state's heavy industries involved in R&D and production of high-strength, high-temperature steels for missiles. Earlier this year Crucible reported a 25% increase in sales of vacuum-melted alloys for jet engine parts, bearings, missile and electronic parts. Sales have jumped for



MORE THAN 200 persons are employed in Burroughs' Ballistic Missile Division at Paoli, Pa., near Philadelphia.

the **Beryllium Corp.,** Reading, as missile makers find more applications for the lightweight metal.

Still another maker of missile steels is **Latrobe Steel Co.,** Latrobe, which this year put into operation a new vacuum arc melting furnace with a 6 million-pound annual capacity output.

In addition to its New Jersey operation, Thiokol's Reaction Motors division has a plant at Bristol, Pa., which is now working on a $3.5-million production contract of *Guardian II* prepackaged rocket engines.

Air Products Inc. at Allentown has grown into a major company apace the missile/space age. It supplies 90% of the liquid oxygen used in the missile program and has a host of industrial customers. It is in the process of building a $6-million facility outside Pittsburgh at Glassmere to produce high purity LOX, liquid nitrogen and liquid argon.

There is missile activity in virtually every corner of the state. The Naval Ordnance Plant at New York is making the launching system and power driver for *ASROC* surface-to-underwater anti-submarine rocket and the assembly and test of *Weapon A.* At McKeesport, the **National Tube Division** of U.S. Steel is fabricating the war head for the Navy's *Bullpup.* John R. Hollingsworth, Phoenixville, is principal subcontractor for generator sets and frequency changers in the *Nike Ajax/Hercules* series. **Hamilton Watch Co.,** Lancaster, is providing safety and arming devices for *Sidewinder* and *Tartar.* **Landsdowne Steel & Iron Co.,** Morton, is making the rocket head for *Zuni.*

There are many more companies producing components and support items and the list is growing. As one industrialist put it recently: "Missiles and spacecraft are the vehicles carrying us into the future. For the company that doesn't climb aboard now—there many not be any room later."



NOSE CONE of *Atlas* built by General Electric's Missile and Space Vehicle Department in Philadelphia is checked by GE technician at Cape Canaveral.

New Regulation May Slow Procurement

DOD officials fear that new 'rider' will further complicate negotiating job

by Betty Oswald

WASHINGTON—"The time is coming when two sets of secretaries will be needed at the Pentagon"—This was the prediction of a long-time Defense Department employee as he left the Puzzle Palace for greener pastures.

The prediction was based on the strong belief that top civilian officials would be forced to spend more and more time on Capitol Hill, leaving less and less time to do the planning and the paper pushing that is required to make a decision and perhaps more important, to make the decision stick.

Now there is new evidence of the need for more top level officials. It is a small rider which the Congress attached to the Military Construction Authorization Act. It provides, simply enough, that beginning with fiscal 1961, Army, Navy and Air Force must request and obtain authorizations for the purchase of missiles, aircraft and warships.

This means that top-level civilians and military officials will be required to justify their procurement programs before four committees of the Congress, the two Armed Services Committees and the two Appropriations Committees, which seemingly will double the time that these men must spend on Capitol Hill.

But time is only one small factor in the new complications added to the already cumbersome process of first preparing, then submitting and finally justifying defense programs.

• **How much detail?**—Perhaps the most difficult question which the rider creates is: "How much detail will the House and Senate Armed Services Committees really want?" Will they want to authorize specific numbers of aircraft and missiles at specific prices or will they know merely that in a period of five years, the plan is to outfit—numbers of squadrons of intercontinental missiles to cost an estimated number of dollars, leaving to the Appropriations Committees the job of approving the specific plans to buy a specific number of missiles in support of that program each fiscal year? Defense Department officials hope that this is all the Armed Services Committees want.

They are afraid, however, that following the pattern of the construction authorization, the House and Senate Armed Services Committees will really want to get down to specifics. In the construction authorization hearings, Pentagon officials are asked to justify the need for everything from machine shops to bachelor officers quarters, including the number of units.

Any such detail when applied to missiles and aircraft, and even more particularly to spares would almost inevitably bog the whole budgeting process down indefinitely. Yet it is hard to expect that Congress will ask for any less detail, since the legislative rider was not passed until after Congressional Committees had repeatedly expressed their dissatisfaction about the way money was appropriated for one program and used for another without consulting the Congress.

• **Wasted time?**—As Defense officials see it, every trip to Capitol Hill takes time needed for other jobs. While it is recognized that the Congress, as it controls the purse strings, must know what goes on, it is equally true that Congress can't do the programming but must leave the job to the military experts and to their civilian masters. Old timers say, however, that Congressional concerns are valid—particularly because decisions to cut down on required programs are based frequently on the hard facts of economic life rather than changes in legitimate military requirements.

As matters now stand, the hope is for a compromise when the Defense Department and the House and Senate Armed Services Committees sit down together early next year to spell out the ground rules needed to implement the rider.

Issues which must be decided include:

(1) The amount of detail the committees will want to provide necessary authorization. Do they want numbers of aircraft and missiles? Is ground support equipment to be included?

(2) Timing of authorization requests so that they won't get in the way of the appropriations bills. It is necessary that authorizations precede appropriations or the appropriation for a given program may become invalid for purely technical reasons.

(3) A definition of what is meant by "procurement" of "operational" missiles, aircraft and warships. Nobody is quite sure whether spares and repair parts are to be included. Also there is some variation in definition by the services as to what constitutes an "operational" weapon.

(4) Test and evaluation of new-weapon systems is now funded out of procurement accounts. DOD officials want to know whether these items will have to be justified or whether test and evaluation ought to be removed from the procurement accounts and handled as research and development. In some cases, this becomes a difficult problem because production for inventory and research and development for product improvement move ahead at the same time.

What does this rider mean to industry? The answer is that it could mean nothing at all. However, what is considered more likely is that contract negotiations will be bogged down on occasion while waiting for both authorizations and appropriations. Programs on which the industry bases its own planning are likely to be changed more often—once as a result of the shift in Defense planning and once as a result of Congressional action.

• **Biggest problem** — However, everyone seemingly agrees that the biggest problem created will be to find the time—time to prepare the justifications needed for authorization—time to appear on Capitol Hill before both sets of committes and finally time to reconcile differences between the Armed Services and Appropriations Committees. End result is that the already drawn-out process of contract negotiation will be delayed still further and the apportionment process by which the Defense Department gets the funds needed to operate will be slowed.

Biggest hope is that when the Congress receives a report from the Pentagon which shows current programs and how the Defense Department is planning to finance them that there will be a change of heart and the rider will be repealed.

NASA to Try Moon Orbit in October

Space agency to use Atlas-Able vehicle which was earlier scheduled for Venus probe

by Paul Means

WASHINGTON—The National Aeronautics and Space Administration will attempt to place a payload in orbit around the moon in early October.

The vehicle to be used, an *Atlas-Able,* was originally scheduled for a Venus probe in early June. The most advantageous date for the moon orbit attempt at Cape Canaveral would be within a few days either way of Oct. 8 —the date when the moon is furthest south.

The *Atlas-Able* vehicle will hurtle its approximately 200 lb. payload into space at just a little less that escape velocity—approximately 24,000 miles per hour. After the payload leaves the atmosphere, the external aerodynamically shaped shroud will be thrown off, exposing the approximately 70 lb. solid retro-rocket developed for the vehicle by the **Atlantic Research Corp.**

At a point around 200,000 miles from earth and 40,000 miles from the moon, the moon's gravitational pull will exceed that of the earth, and the vehicle will approach the moon. Near the point of closest approach, the retro-rocket will be fired, reducing the payload's speed by about 1,500 miles per hour, and placing it into orbit around the moon.

• **Objectives**—The instruments in *Atlas-Able*'s **Space Technology Laboratories'** payload, which is similar to the payload sent aloft by *Thor Able III* in *Explorer VI,* will allow NASA scientists to learn much about the moon's magnetic and gravitational fields.

Other objectives of the experiment are to learn the properties of cislunar space, of the moon's mass, and to gain information about the moon's configuration, surface details and composition, atmospheric composition and density, and radioactivity.

• **Moon's unseen side**—The STL-developed facsimile system, somewhat like a TV camera, which is presently transmitting pictures of the earth from *Explorer VI,* could reveal in some detail for the first time the unseen side of the moon. This unit consists of a tube containing a mirror which receives and focuses light and dark impressions, and an electronic counter which computes and records the impressions before they are converted into radio signals.

A new device to maintain temperature control in the instrumentation compartments—currently being tested in *Explorer VI*—will get a real workout in the *Atlas-Able* moon orbiter. Surface temperatures on the moon range from 212°F on the sun side to –243°F on the dark side. The unit, developed by STL, relies on the absorption and reflection qualities of black and white surfaces, and operates when preset high and low temperature extremes are reached.

Information from the moon-orbiter will be relayed from a tiny electronic brain called "Telebit," also used on the *Explorer VI* experiment. "Telebit" is a digital unit responsible for the gathering and relaying of data concerning scientific data received by the payload's instruments. The instrument not only collects data, but stores and calculates it before transmitting the totalled data earthward via radio signal.

• **Ground stations**—Receiving the data from the moon orbit payload's ultra high frequency payload will be the large Jodrell Bank radio telescope near Manchester, England and the Air Force's 60 ft. diameter dish in Hawaii.

The *Atlas-Able* vehicle consists of an *Atlas* with **Aerojet General's** second stage *Vanguard* engine and **Allegheny Ballistic Laboratories** third-stage *Vanguard* engine on top. It is capable of sending 200 lb. payloads into deep space.

In order to leave its moon orbit and return to an eliptical earth orbit, all that *Atlas-Able's* payload would need is an additional solid rocket capable of increasing its speed by 1500 mph. This would allow it to escape from the moon's gravitational pull, which is about 1/5th that of the earth.

If successful, the *Atlas-Able* will be succeeded by instrumented hard and soft landings on the moon, and eventually, manned flight around and to the earth's satellite.

Other vehicles NASA hopes to utilize to put unmanned orbiters around the moon are *Thor-Delta,* which could orbit 65 lbs.; *Atlas-Hustler,* which could orbit 250 lbs.; and *Vega,* which could orbit 980 lbs.

Rough landings will be attempted by *Thor-Delta,* with a 50 lb. payload, and *Vega,* with a 650 lb. payload. Soft landings will be attempted by *Vega* with 430 lbs., *Centaur* with 730 lbs., *Saturn* with 1700 lbs., and *Nova* with 19,900 lbs.

Vehicles expected to orbit the moon and return to earth with their instruments are *Centaur* with 275 lbs., and *Saturn* with 700 lbs. *Saturn* is also expected to soft land 200 lbs. on the moon and return part of the payload to earth.

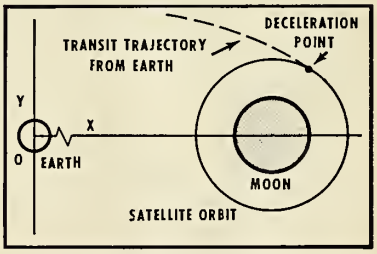
Manned lunar landings and return with a payload of 2100 lbs. will be attempted by *Nova.*

Hardware and Trajectory—



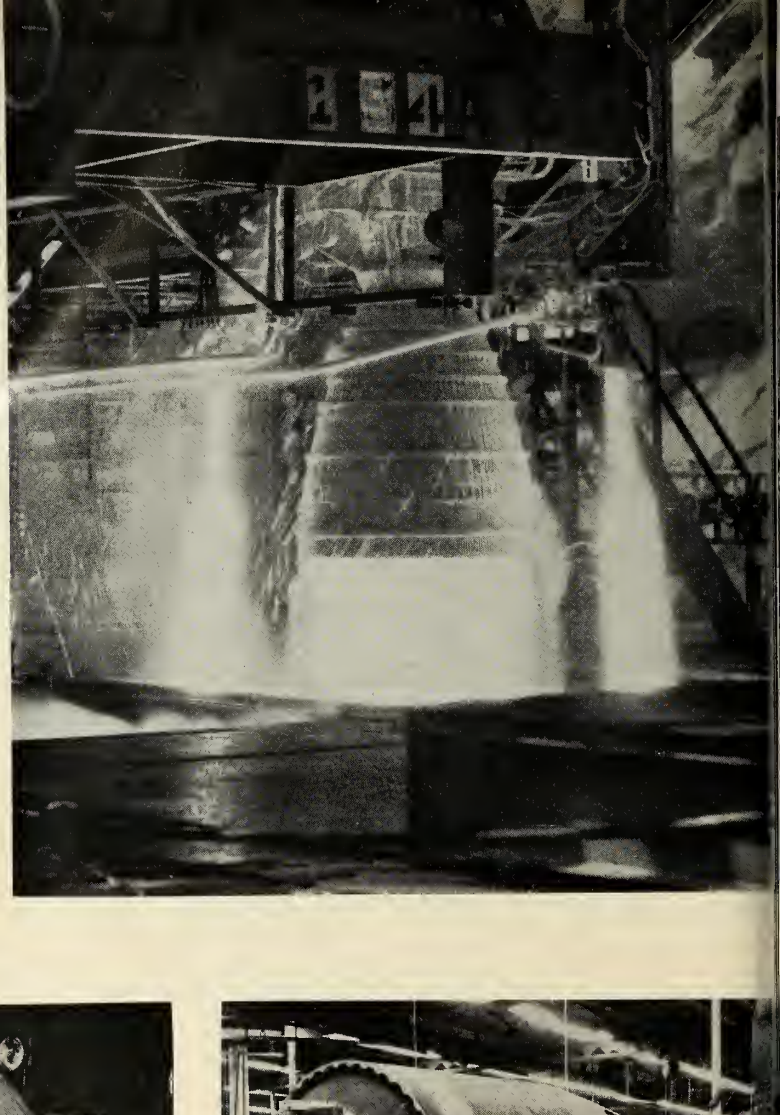
• **Left**
Atlas-Able

• **Right**
Moon satellite orbit

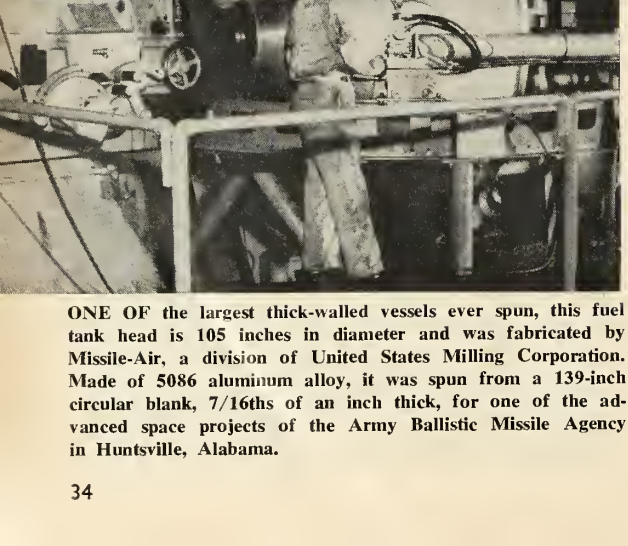




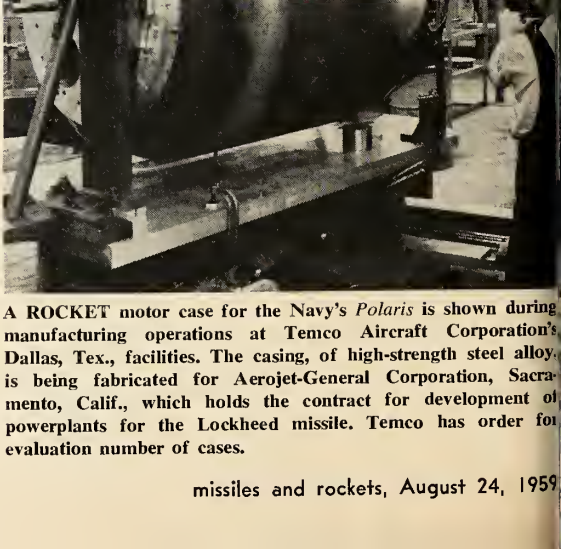
PICTURES IN THE NEWS



ICE-COATED *Thor* **rocket engine leaps to life immediately after 72 hours exposure to freezing temperatures in an environmental chamber. The Rocketdyne 150,000-pound thrust ballistic missile engine was exposed to five days of 160 degree heat and 95% relative humidity.**



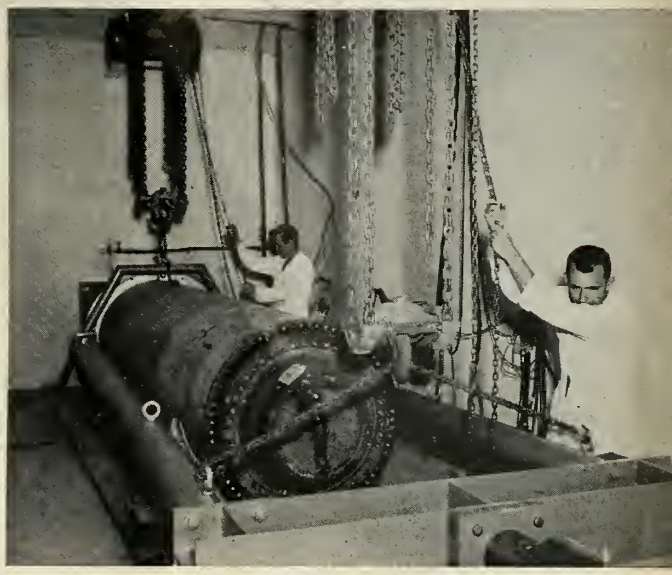
ONE OF the largest thick-walled vessels ever spun, this fuel tank head is 105 inches in diameter and was fabricated by Missile-Air, a division of United States Milling Corporation. Made of 5086 aluminum alloy, it was spun from a 139-inch circular blank, 7/16ths of an inch thick, for one of the advanced space projects of the Army Ballistic Missile Agency in Huntsville, Alabama.



A ROCKET motor case for the Navy's *Polaris* is shown during manufacturing operations at Temco Aircraft Corporation's Dallas, Tex., facilities. The casing, of high-strength steel alloy, is being fabricated for Aerojet-General Corporation, Sacramento, Calif., which holds the contract for development of powerplants for the Lockheed missile. Temco has order for evaluation number of cases.



COMPLETE *Atlas* is loaded aboard Air Force plane. The Convair ICBM is expected to be operational soon.

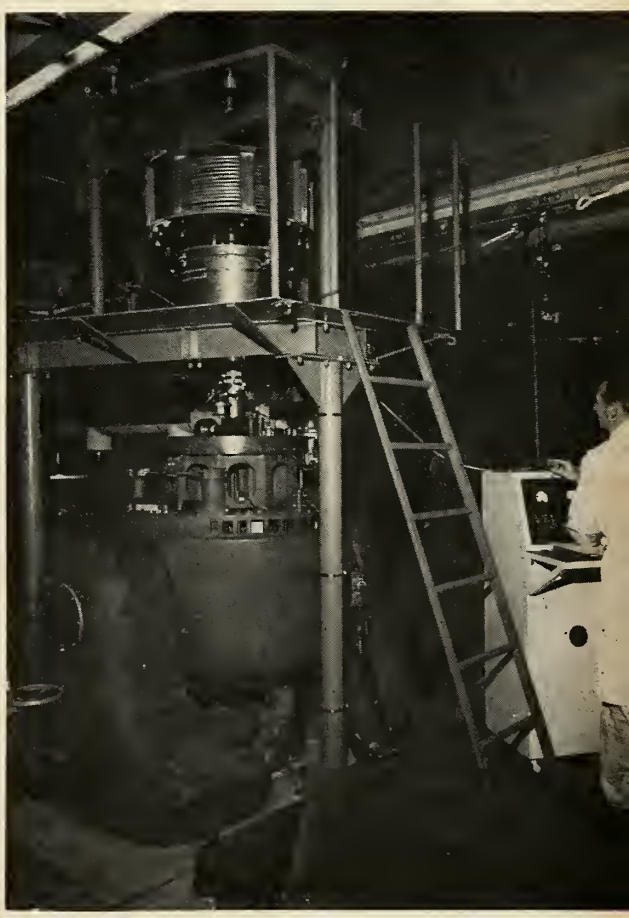


SUSTAINER motor for *Nike-Zeus* is located in thrust cradle at Grand Central Rocket Company.

AT RIGHT, AiResearch engineering lab has built a rig to test missile solenoid valves, in the combined environment of vibration, acceleration, altitude and cold, while flowing helium at a pressure of 4500 psi. The basic test rig is a centrifuge built atop a C100, MB Shaker.



ABOARD the USS Norton Sound, a high-performance *Tartar* surface-to-air guided missile leaps from its launcher and streaks toward its target off the Pacific Coast. The supersonic Convair *Tartar* is about 15 feet long and slightly more than a foot in diameter. This photo was made from a stationary high-speed sequence camera mounted on the Norton Sound's after-deck.





USS Boston is armed with *Terrier* missiles. Total of 27 ships will have them.

Navy Wants Huge Fleet of Missile Subs, Ships

But tight money picture may force it to choose between limited-war carriers and proposed missile-space plans. Second in series on DOD planning.

by James Baar

WASHINGTON—The time: The late 1960's. The place: The oceans of the world. Beneath the surface some 50 *Polaris* submarines wait on station. On the surface cruise a score or more of *Polaris*-packing warships.

Meantime, Navy task forces built around attack and ASW carriers stand ready around the earth.

Ships and planes bristle with whole arsenals of new and improved missiles. Navigational, communications and reconnaissance satellites flash far overhead.

These are the strategic pictures framed in the minds of top Navy officials as they struggle with their new budgets and plan against the dangers of the coming decade.

Their approach is a two-fold one designed to meet what they see as the double threat of total and limited war. Their prime problem is lack of money. They need billions more each year to do what they feel they ought to do.

The **Lockheed** *Polaris* is the Navy's top claimant for scarce dollars. But the Navy also needs money for such missile/space projects as:

- A wide variety of satellites—both permanent and temporary.
- New and improved ASW weapons for both detection and kill.
- Development of families of cheap missiles designed to carry conventional warheads.
- *Polaris* **beef-up?**—The cost of the *Polaris* program already has passed the $2 billion mark. However, this is nothing compared to what the Navy would need to employ fully the missile's potential capabilities.

As of today, the Navy has received authorizations and money for a fleet of nine *Polaris* submarines and some long lead-time items for three more.

Navy officials talk in terms of building a fleet of about 50. Moreover, the Navy would like to deploy the *Polaris* on cruisers and possibly carriers and battleships.

Polaris tubes would be installed in the decks of cruisers and now mothballed battleships. They would be attached as pods to the sides of carriers.

Cost of nuclear-powered submarines for *Polaris* is running about $100 million each. Cost of installing *Polaris* on cruisers and carriers is considered relatively small as long as facilities for only half of a 16-missile round are involved. But the cost of converting cruisers and battleships into huge Polaris launching platforms would be much greater. The total cost for subs and surface ships alone could range from $6 to $10 billion.

However, the Navy contends that the security the nation would get from a mighty fleet of *Polaris* submarines and warships is well worth the price.

Each *Polaris* submarine carries 16 missiles. Cruisers and carriers could be quickly converted to carry eight apiece and new cruisers can be designed to carry a full round of 16. A fully converted cruiser or battleship could carry 100.

A fleet of some 50 *Polaris* submarines and a score of warships could rain more than 1000 megatons on Russia.

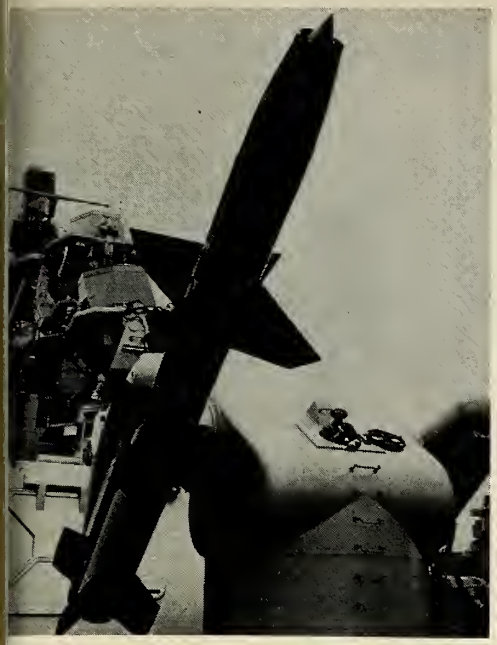
Such a devastating launching would be impossible to prevent. The fleet would be scattered throughout the Atlantic and the Pacific, the Indian and the Arctic Oceans. It would be on the move continually. It would be impossible to cripple it by surprise.

No place in the Soviet land mass would be safe from a retaliatory attack by the 1500-mile range missiles except for the small area around Alma Ata in the deep interior of Kazakh. And Navy plans to extend the range of *Polaris* would leave no part of Russia a sanctuary.

The first *Polarises* scheduled to become operational late next year probably will have a range of about 800 to 1000 miles. However, the Navy expects to extend the range rapidly to 1500 and later to about 2200.

The Administration-enforced ceiling on military spending has left little room for a rapid early build-up of a large *Polaris* fleet. And there is no indication of much change in the Administration's attitude.

The Navy this year sought authorization for three more *Polaris* submarines. It got the long lead time items, instead. It probably will seek a new block of nine *Polaris* submarines next year. At best, it probably will get three past the Bureau of the Budget. It has sought authority to install *Polaris* launching facilities aboard some cruis-



FIRING of mock-up *Polaris* missile from an observation ship. Navy wants many *Polaris* ships.



FIRST ship to be equipped with *Talos* was USS Galveston. Present shipbuilding program calls for seven cruisers armed with *Talos*.

ers. But the Joint Chiefs of Staff has tentatively shelved the plan.

•Space entries—The Navy's move into the national space program is increasingly determined.

Transit—the navigational satellite—is being developed by the Navy for ARPA. The Navy is fighting hard to keep it when it becomes operational. The Navy also feels it has a strong need for communications, weather and reconnaissance satellites.

In this line, the Navy is devoting its considerable in-house abilities to the development of equipment for operations in space rather than to development of equipment for getting into space.

Moreover, the Navy can be expected to play an increasingly greater role in missile and satellite tracking. It has developed part of ARPA's satellite detection fence. And earlier this month it disclosed Project *Tepee*—a high-frequency radar system capable of detecting at intercontinental ranges an ICBM launching seconds after the missile leaves the pad.

Finally, the Navy is taking the approach of closely watching all space developments for possible application to Navy missions. Some ideas already under more or less active consideration are development of:

• An anti-satellite missile for use against enemy reconnaissance satellites.

• A reconnaissance satellite that could be launched in the air from a carrier-based plane.

• An anti-missile system for protection of ships.

• An anti-submarine satellite—possibly for early warning of missile launchings from submarines.

In the missile field, the Navy is expected to move ahead as rapidly as possible with the development of such new missiles as **Temco's** *Corvus* and **Bendix'** *Eagle*.

Corvus is an air-to-ground missile that homes on radar. It is designed to attack heavily-defended ground installations and ships. Its engine is powered by a packaged liquid propellant.

Eagle is a nuclear-tipped air-to-air missile. It is designed to fly at high speed after being launched from relatively low speed aircraft.

Both of these are long-range programs. And the missiles are considered high priced.

In contrast, the Navy is extremely interested in the development of a school of "poor man's" missiles carrying conventional warheads.

Navy officials consider that they already have a "poor man's" air-to-air missile in the **GE/Philco** *Sidewinder*. They also feel they have a "poor man's" air-to-surface missile in the **Martin** *Bullpup*.

However, they are still looking for a "poor man's" surface-to-air missile. And at the same time they would like continued improvements in both *Sidewinder* and *Bullpup*.

One *Bullpup* improvement already planned is the increasing of its warhead from a 250 to a 1000-pound bomb. There also are plans to develop a small nuclear warhead for it.

A possible candidate for a "poor man's" surface-to-air missile is the **Convair** *Redeye* now under development for the Army. Navy experts are considering the possibility of adapting *Redeye* for use on landing craft.

But how fast any of these programs will be able to move—or whether in the end some will survive at all—is again dependent on how much of the thinly spread Navy budget can be devoted to them.

One of the Navy's toughest financial problems is the maintenance of its carrier strength in the face of increasing opposition from many quarters.

The Navy feels that it must have 14 attack carriers to maintain U.S. overseas commitments. This fleet at present is comprised of four 76,000-ton Forrestal Class carriers, three of the 62,000-ton Midway Class and the rest of the World War II Essex Class.

By the mid-60's the Essex and Midway Class carriers will be worn out. That will leave the four Forrestal Class carriers, two more that are under construction and the nuclear-powered Enterprise—a total of seven.

Congress appropriated a small payment this year for another Enterprise Class carrier after a bitter struggle. It is open to question whether the money ever will be forthcoming for completing its construction along with the construction of six more to replace the other aged carriers. More than $3 billion would be needed.

A new twist for **KARAK***
SPINNING "HONEST JOHN"



*carbon-graphite
by Ohio Carbon Co.

This is resistance in the dramatic extreme, to...

- thermal shock
- pressure shock
- erosion,

employed as a nozzle insert in the Thiokol M7A1 rocket motor used to give the "Honest John" surface-to-surface ballistic missile a greater degree of accuracy by imparting a stabilizing slow spin.

These same resistances make KARAK the **natural** answer to a growing list of conditions and design problems that **probably includes yours!**



TEST FIRING OF ROCKET WITH KARAK NOZZLE INSERT

WIDELY USED FOR:

Rings Pump Vanes
Bearings Pump Chamber
Seals End Plates

Special compounds developed for special applications.



FREE BROCHURE:
KARAK CHARACTERISTICS AND APPLICATIONS.

THE OHIO CARBON COMPANY

12508 Berea Rd., Dept. 35, Cleveland 11, Ohio

soviet affairs . . .

By DR. ALBERT PARRY

Launcher-trains for missiles . . .

Some time ago, American experts on Russia's vassal states in Eastern Europe suggested that Soviet IRBM bases, when established in Poland, Hungary, Bulgaria and other "people's democracies," may take the form not only of "hard" launching pads of permanent type, but also of a "soft," more flexible and less vulnerable kind—moved about on flat railroad-cars specially designed for the purpose. Although suitable for solid-fuel rather than liquid-fuel missiles, such launchers on wheels could in time (it was felt) be developed for liquid Soviet IRBM's, too. Whether or not such Red launcher-trains are already a fact, the Soviet government may indeed consider them a necessity.

Political vulnerability of IRBM bases . . .

in vassal territory is what the Soviet government wants to reduce. Despite all the shrill words Khrushchev utters on the subject of "love" allegedly felt by the East Europeans for his Russia, in reality there is ever a danger of sabotage, particularly if war does break out, sabotage by Poles, Hungarians and other captive nationals against the Soviet Russian masters and their armaments on vassal soil, including Red missile-launching sites.

Putting IRBM's on railroad wheels may give the Red missiles a mobility that would reduce their vulnerability, a safeguard not alone against Western weapons, but also against those native guerrillas.

Similar U.S. plans . . .

for missile launcher-trains have recently been made public for our solid-fuel *Polaris* and *Minuteman*. For the *Polaris* the recommendation of railroad wheels was included in the report of the President's Committee to Study the U.S. Military Assistance Program headed by William H. Draper, Jr. Plans of trains for the *Minuteman* have been presented by the **Bethlehem Steel Company** and the Los Angeles missiles engineering firm of **Paul Hardeman, Inc.**

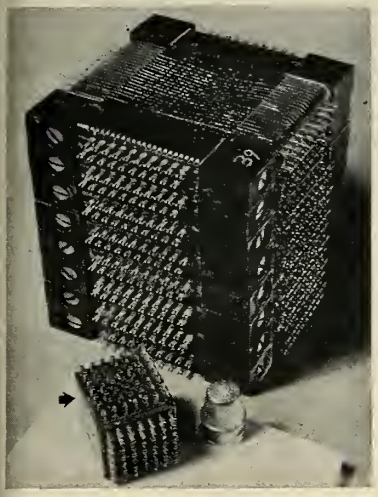
The main thought here is to reduce vulnerability of our missile sites as threatened not by sabotage at home (which we have lesser cause to fear than the Soviets have in Eastern Europe) but by the foreign foe's action. The consideration of expense is also important. Launcher-trains would cost less than permanent missile sites.

Expense as Soviet consideration . . .

Yet the point of expense may be applicable to the Soviet ledger, too. On his recent visit to this country, Soviet First Deputy Premier Frol R. Kozlov said to Vice Admiral Hyman G. Rickover that the Red government was cutting down on its atomic research and production because this nuclear program's cost had turned out to be unexpectedly high. Kozlov blamed Soviet scientists for leading their Communist government into too much expense. If Kozlov wasn't lying to Rickover (which is of course quite possible), the Kremlin's worry about the expense is valid not only for Soviet atomics but also for Soviet rockets and missiles (these have nuclear warheads, after all!). Reducing the cost of the nuclear and rocket-and-missile effort may well now be a goal for the Russians.

Where best to establish Soviet missiles? . . .

It may be worthwhile to hear from Khrushchev himself on the subject of best terrain for the establishment of his medium and short-range missile bases. In a speech to Albanians, on the occasion of his visit to their country early in June, Nikita said that Albania and Bulgaria had "exceptionally favorable conditions to put up rocket bases." He elaborated: "Mountains are high there, gorges are deep; that's the place to put our rockets."



Memory Stack's Size Reduced 50 Times

A new miniaturized memory stack for coincident current systems, whose physical volume is 1/50th of the conventional stack, has been developed by the Applied Logics Division, **General Ceramics Corp.**, Keasbey, N.J.

Improved design and assembly techniques, making possible the wiring of ferrite memory cores at a density rate of about 3.5 million per cubic foot, have produced prototype stacks consisting of 2048 cores in a unit measuring only 1 x 1.4 x 1.4 inches. This compares with a conventional stack measuring 3½ x 3½ x 4 inches. In each case the device consists of eight 16 x 16 arrays. Production models will be available in September.

The stack is said to increase reliability by sharply reducing the number of solder connections—in the case of the 16 x 16 x 8 unit from 1056 to 96. It also shortens lead lengths.

The stack, which is said to have as low a noise ratio as conventional stacks, is made up of .050-inch memory cores, the smallest in current usage. The original ferrite memory core and the .050 size were developed by General Ceramics.

Applied Logics Div., General Ceramics Corp., Keasbey, N.J.

Tiny Solid-state Decade Counter Module Produced

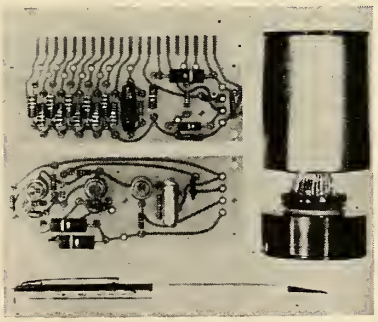
A miniature Decade Counter Module featuring a minimum of component parts has been announced by **Burroughs Corp.** Electronic Tube Division of Plainfield, N.J.

Called the DC-110, the new unit combines solid-state devices and the Miniature Shielded Beam Switching Tube in a circuit which is capable of resolving pulses at 250 KC rates. Electrical outputs are provided to operate remote Nixie Indicator Tubes, printers, and to perform other circuit functions.

The unique combination of transistors and the Beam Switching Tubes in the DC-110 makes possible a number of advantages never before available. Examples are: total power consumption of only two watts; elimination of as many as 90 components from the counting circuit; and increased reliability due to component reduction and use of the ultra reliable Beam Switching Tubes.

The DC-110 is designed as a plug-in module for use in computers, electronic counters, machine control, automation and test equipment. The units are directly cascadable and can be driven by a twelve-volt signal. The electronic and visual outputs which are provided suggest their use as preset or variable scale counters and as active elements in electronic systems, particularly where useful work must be performed.

Burroughs Corp. Electronic Tube Division. Plainfield, N.J.



Infrared-Transmitting Materials Improved

Reduction in cost of optically polished domes and windows for infrared-guided devices and enhanced transparency as far as 8 microns wavelength, even despite the blinding effect of re-entry heating, can be expected from a newly developed optical material, **Eastman Kodak Company** has announced.

Domes, prisms, and flats of the new material are already being molded, ground, polished, and sealed to metal by the company under the designation "Kodak Irtran Optics, Type AB-1". Interference Filters to pass specified infrared bands can also be produced on the new material.

In structurally adequate thicknesses, the Type AB-1 "Irtran" material is described as transmitting more than 90% of impinging energy from 3 to 6 microns. The company's tests indicate that the high transparency is retained at 800°C and even beyond. This eliminates the "hot window" effect, where image-forming radiation is drowned out by the emissivity of the optical parts themselves. Other effects of severe heating, as well as those of thermal shock, weathering, humidity, and abrasion, are said to be overcome in the "Irtran" material.

Refractive index of the substance at 6.7 microns is low—1.301. Reflection losses at "Irtran" surfaces are therefore so small as to obviate need for coating, the company feels. Microwave characteristics are close to those of natural mica for insertion losses and reflection in the 9 and 10 kilomegacycle range.

Special Products Sales
Apparatus & Optical Division
Eastman Kodak Co.
Rochester 4, N.Y.

High-Power Silicon Transistors Produced

New high-power silicon transistors, which, when operated as a switch, are capable of controlling over 5 kw of power, have been demonstrated by the **Westinghouse Corp.**, Pittsburgh, Pa.

According to D. W. Gunther, manager of the Westinghouse semiconductor department, "These are the highest power transistors, in either germanium or silicon, that have yet been developed. Although these first devices are still in the prototype stage, we expect commercial quantities to be available soon."

These transistors are suited for high-power switching and linear power applications since they have the following characteristics: collector-to-emitter voltage ratings from 30 to 200 volts; maximum operating junction temperature of 150°C; and saturation resistance less than 0.1 ohm. With a minimum current gain of 10 to 15 amperes collector current, these devices

have a maximum collector current rating of 30 amperes.

Because of the higher temperature capabilities of silicon, one of these transistors can be used in applications that previously required a number of germanium units in parallel. The low thermal drop from junction to case, coupled with this higher temperature capability enables these power transistors to dissipate up to 250 watts internally.

The predecessor to these high-power silicon units, a five-ampere silicon transistor, is ideally suited as a driver for this new 30-ampere device.

These new units use ultrapure silicon produced by the Siemens-Westinghouse process. They are of n-p-n configuration and use a new case that is specifically designed to take advantage of the high current and high voltage capabilities of the new device. The case is of double-ended construction and is hermetically sealed.

Mr. Gunther added that these devices can also be applied in high-power d-c to d-c and a-c to d-c converters;



d-c to a-c inverters; high-power d-c regulators for current and voltage regulation; and in high-power linear amplifiers.

Westinghouse Electric Corp.
Box 2278
Pittsburgh 30, Pa.

Converter Allows Input of Tape to Plotters

A new converter which makes possible the direct use of digital magnetic tape as input to automatic graph plotters and similar voltage devices is being manufactured by **Benson-Lehner Corp.** of Los Angeles. It eliminates the necessity for transferring data from magnetic tape to punched cards, and more than doubles plotting speeds even for existing plotters.

The unit has solid-state switching circuitry and can be adapted to magnetic tape from any digital computer. Selection of data by patchboard makes special programming unnecessary.

Unusual features of the Benson-Lehner Converter include a point density selector, automatic file and record run-up, parity check, off-scale error count or stop-plot, and provision for omitting records which contain specified characters.

Benson-Lehner Corp.
11930 West Olympic Boulevard, Los Angeles 64, Calif.

Digital Indicator Has Servo Null-Balance

A new servo null-balance digital indicator, Type 6R, has been added to the line of continuous reading indicating instruments of the Cox Instruments division of the **George L. Nankervis Co.**

The type 6R digital indicator features high-accuracy multichannel readout for measurement of flow, pressure, speed or frequency with pulse producing transducers.

This instrument qualifies for precision laboratory, production and process applications with an accuracy of plus or minus 0.25%. Linearity is plus or minus 0.25% at any point over a 10 to 1 range. With four digit readout, the Type 6R has a resolution of up to one part in 9000.

Ten scale ranges, with various cross range speeds, are available. This instrument presents an analog numerical readout which continuously follows both increasing and decreasing transducer output. An analog output voltage is also provided for use with oscillographs and recorders for measuring transients and high-speed fluctuations.

The unit contains a completely electronic frequency converter, which supplies the servo null-balance system with a dc voltage proportional to the transducer output frequency. A built-in, tuning fork controlled frequency standard supplies calibration frequencies with check points at 60, 120, 600, and 1200 cps.

The digital indicator can be supplied for one, two or three channel operation with manual and/or automatic channel switching. Span and zero adjustments for each channel and a specific gravity adjustment common to all channels are located on the front panel of the instrument. A variable damping control stabilizes the readout by smoothing transducer fluctuations



and transcients. A small meter on the front panel shows rapid changes in the measured variable which are not indicated by the damped digital readout.

The unit is available with scale ranges up to 9000. Transducer signals with a minimum output of 10 millivolts and a frequency range of 5 to 40,000 cycles can be read with this instrument. Type 6R has a 500 ohm input impedance and power requirements of 115 volts, 60cps and 80 watts. It is housed in a standard 19" rack mount, 7" high and 12" deep.

Cox Instruments Div., George L. Nankervis Co.
15300 Fullerton Avenue
Detroit 27, Mich.

We are FIRST in
ROKIDE
Applications on the WEST COAST

—and the best evidence we can give you is the following list of customers who have used our services for years:

• MARQUARDT • AEROJET • CONVAIR
• THIOKOL • NORTH AMERICAN
• DOUGLAS • ROCKETDYNE
• AIR RESEARCH • AUTONETICS
• GRAND CENTRAL ROCKET

—and R & D ROKIDE Coatings, as well as all Ceramic Coatings on Missiles Produced in this Area, Including:

• Polaris • Hawk • Terrier
• Minute Man • Aerobee • Sparrow
• Vanguard • Titan • Bomarc
• Super Bomarc • Genie
and many others.

Send TODAY for your Copy of "Metallizing in ALL Its Phases"—then you'll have the complete picture of our services and facilities.

Yes, Just Another FIRST by

METLA METALLIZING CO. of Los Angeles

1233 So. Boyle Ave., Los Angeles 23, Calif.

west coast industry . . .

By FRED S. HUNTER

The time cycle in the fundamental sciences keeps moving faster. Here you have the reason for the **Boeing Airplane Co.'s** increasing interest in scientific research and its construction of a new $2.25 million building for the Boeing Scientific Research Laboratories. "If you aren't in the cycle, you don't know what's going on until it is too late," says Guilford Hollingsworth, BSRL director. "You have to be a member of the scientific research to keep pace."

Boeing is erecting the new laboratory . . .

building on a separate piece of property at Seattle. This is to avoid any possible conflict with security on the various classified projects on which Boeing engineering may be engaged. Boeing already has several foreign scientists at work in its scientific research laboratories and expects to add more. The laboratories engage solely in basic research in the physical sciences for the benefit of the company. There are no plans to do any contract research. The BSRL has 50 scientists on the staff now; they will number 100 when the new building is completed.

Fringe benefits are increasing . . .

faster in the industry than base pay. J. D. Hodgson, director of industrial relations at **Lockheed's** California division, reports that fringe-benefit costs have risen 161% on an hourly basis since 1946 against an average hourly base-rate increase of 80% during the same period.

Increase in production rate of the *Atlas* . . .

is indicated by the $85 million included in the 1960 appropriations bill as a first installment of the move to add eight new squadrons to the nine currently programmed. Each squadron is armed with 10 missiles. Employment also is going up at **Convair-Astronautics.** Net increase in the work force since Jan. 1 is 2318. The total payroll is expected to reach 14,260 by year-end.

Lockheed's California division has been . . .

working with **Hughes Aircraft** on a joint study of a space vehicle designed to carry personnel "commuting" between the earth and a space station for observation purposes or to assist in the actual construction of such a station. Hughes, it might be added, was recently reported to be seeking to acquire a gyro outfit, looking toward diversification into the stable platform field by the time its extensive aircraft weapon systems business (fire controls and guided rockets) reaches the end of the line.

Air Material Area base at San Bernardino . . .

is giving up most of its other logistic support responsibilities to concentrate on the ballistic missile group. It has relinquished control of the **Douglas** B-66 twinjet bomber, the **Ryan** Q-2 *Firebee* and the **Radioplane** *Q-4* drone to Mobile AMA, such aircraft as the **North American** B-45 jet bomber, **Douglas** C-47, C-54 and C-118 transports to Warner Robins and the **Hiller** H-23 helicopter and the **Ryan** L-17 observation plane to Middletown.

This is our last column from . . .

the Pacific Coast. We move East reluctantly. California provides a pleasant way of life. This is one of the big reasons defense companies on the West Coast are strong companies. People like to live here. Political pressures may bring about geographical replacements of contracts. If they do, the Nation's defense will be the loser.



RELIABILITY

is what determines the success or failure of any weapon system at launch and during flight. Here at the Missile Division of North American Aviation, we are constantly striving to improve this most vital state of the art through analysis and evaluation of environmental criteria, system design analysis, statistical test programs, and other advanced reliability techniques. Engineers and statisticians with a minimum of five years full time related experience in aircraft or missile engineering will find this a most stimulating career in present and future efforts under development.

Write or send resume to:

B. H. Cunningham, Mgr.
Employment Services
12214 Lakewood Blvd.
Downey, California

MISSILE DIVISION
North American Aviation, Inc.

ELECTRICAL-ELECTRONIC ENGINEERS
interested in
Electrical Component Design and Packaging

Expanding programs at Boeing in connection with Minuteman, the Air Force's advanced, solid-propellant, ICBM, have created a number of outstanding openings for engineers and scientists in the field of Electrical Component Design and Packaging. These are challenging assignments with the Electronic Sciences Section of Boeing, an industry leader in the development of advanced systems.

Openings include assignments in:

1. *Analysis of performance and reliability of components under various environmental conditions for electrical power distribution systems and electronic equipment.*
2. *Detail studies of component packaging in vehicle and ground equipment.*
3. *Detail design of electrical power distribution system components.*

If you are interested in the analysis, design and demonstration of electrical components and packaging techniques, you'll find in these openings all the scope you need to develop your career potential to the fullest. You will also enjoy a host of benefits at Boeing, including a retirement plan, paid vacations, insurance programs and an opportunity to participate in company-paid graduate study programs.

Write today to:

Mr. Stanley M. Little
Corporate Employment Administrator
P. O. Box 3822 - MRC
Boeing Airplane Company
Seattle 24, Washington



BOEING
...environment for dynamic career growth

propulsion engineering

By M/R STAFF

Dramatic changes in molecular sieves . . .
announced by the **Linde Company** give these sophisticated adsorbing powders a new and vital role in missile chemistry. Modifications developed by the Linde Division of **Union Carbide Corporation** change the molecular sieves from powders that extract undesirable impurities from chemical systems into powders that store desirable ingredients, unreacted, right in the system until reaction is deliberately promoted by heat or addition of another chemical.

'Chemical-loaded' molecular sieves . . .
as Linde calls them, may ease handling and storing of difficult fuels and ignitors. Company scientists also cautiously predict that the combustion characteristics of certain fuels may improve when they are loaded onto molecular sieves. Anti-oxidants and anti-ozonants for rubber and plastic gaskets, tubes, etc., already have been successfully loaded on molecular sieves, and many compounds that may be useful in high-temperature lubricants have been adsorbed.

Resembling white powders . . .
the sieves are synthetic metal-alumino silicate three-dimensional crystals containing water of hydration. Heat will drive out the water without collapsing the crystal lattice. The particle diameter ranges from one to three microns. They are inert to most chemicals except strong acids. Linde first made molecular sieves available in 1954. The new chemical-loaded sieves were announced last year, but Linde has just published detailed properties and suggested uses. The original sieves were removal agents used primarily for drying gases—including hydrogen and hydrocarbons—drying liquids including alcohols, other hydrocarbons and fluorocarbons, and for separating gases.

Sieves work this way:
Each particle of sieve powder is a crystal containing billions of cavities connected by channels of constant diameter. The uniform channel size and strong surface force isolate compounds contained in the crystal "cages." Compounds remain confined until released by heat or displaced by another adsorbable material. This is what led to their new use as carriers for chemicals. The sieve can "carry" a chemical into a mixture and keep it there, unreacted but ready for action. When it is time for the chemical to play its part, it is released by heat or displacement with water or another chemical.

Four major uses are:
(1) Isolate adsorbed chemicals within a solid, liquid, or gaseous system until release from the molecular sieve is desired.
(2) Establish an atmosphere in a confined space by slow displacement of the adsorbed chemical over an extended time.
(3) Reduce odor, noxious or dangerous properties, or volatility of many chemicals.
(4) Store chemicals for prolonged periods.

Some types of chemicals . . .
which have been successfully loaded on sieves include alcohols, peroxides, hydrocarbons, halogens, acid gases, organo-metallics, amines, ethers, aldehydes, ketones, esters, anhydrides, organic acids, and water.

Other types of chemicals . . .
cannot be loaded on molecular sieves: Compounds whose molecules have a critical diameter larger than 10 angstroms (e.g., cross-linked polymers, proteins, certain polycyclics); thermally unstable, low volatility compounds insoluble in nonpolar solvents; inorganic salts; metals.

Recovery Failure Mars *Discoverer V* Success

WASHINGTON—*Discoverer V* soared into orbit Aug. 13 handling ARPA and the Air Force a new success and a mysterious failure.

The **Lockheed** satellite was launched from Vandenberg AFB Calif., by a modified **Douglas** *Thor*. The entire 1700-pound second stage—called *Agena*—went into a 450-136 mile orbit.

The *Discoverer* achieved stabilization in a desired attitude and maintained its position in orbit. This is the second time in the launching series that a *Discoverer* has achieved stabilization—a key step toward development of a reconnaissance satellite.

The *Discoverer* also ejected its biomedical capsule as scheduled over the Hawaiian Islands area on Aug. 14. But Air Force and Naval units failed to recover it.

The failure was officially said to have been caused by loss of communication with the capsule. Recovery teams received no signals.

However, the loss of the signals was understood to have been caused by a malfunction in the capsule apparently resulting in a bad re-entry.

'Munitions Lobby' Probe Nears Temporary Halt

WASHINGTON—The House Armed Services Subcommittee investigation of the so-called "munitions lobby" is moving toward a temporary halt in its public hearings.

The subcommittee probably will adjourn its public interrogation of top industry and military officials until the winter—possibly December. (M/R Aug. 17)

Subcommittee staff members will use the interim period for following up on a number of matters that have come up during the current series of hearings.

The subcommittee in recent days has spent much of its time questioning military legal officers on what kind of legislation might be written to check possible pressuring of the Pentagon by retired military officers employed by defense contractors. The legal officers testified generally that they would put their reliance on the basic character of military officers. They shied away from proposals for tough new laws.

The subcommittee also heard a number of influence charges from Columnist Drew Pearson including an allegation that Dr. Richard Porter of **General Electric Co.** got the Pentagon to switch the *Vanguard* engine contract from **Reaction Motors** to GE. Pearson said the switch enabled Russia to beat the United States in launching the first satellite.

However, Pearson conceded under questioning that he had no "proof of influence peddling."

Porter denied Pearson's charge and called for an opportunity to rebut it before the subcommittee.

Steel Shipments Drop

In the first half of 1959, reports American Iron & Steel Institute, ordnance and other military groups (excluding aircraft) took 97,534 tons of steel, compared to 128,001 tons in the first half of 1958. Aircraft took 43,540 tons, compared to 30,021 tons.

Ordnance's share of all steel shipments was 0.2%, a significant drop from its share of 0.45% in the first half of last year. Aircraft's share of the market changed little: From 0.09% last year to 0.1% this year.

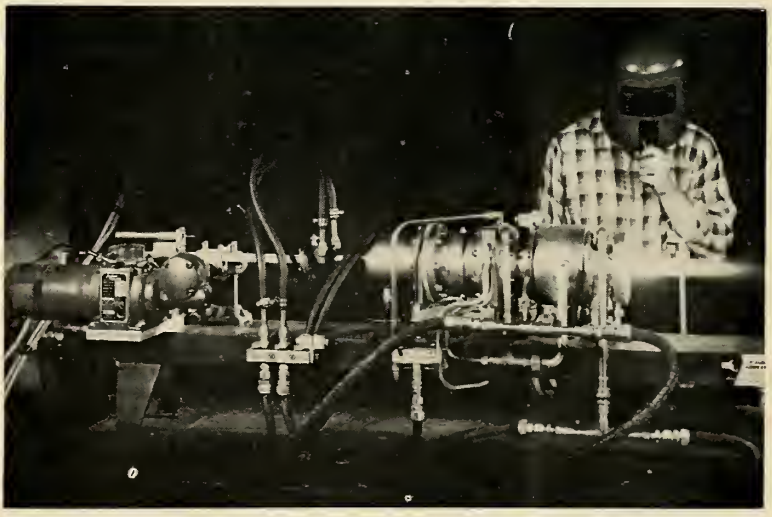
Steel setasides for defense needs are being drafted by the Pentagon. Chances are they will never be used, because stocks of special missile needs are reportedly in good enough shape for a 60-day strike, and the odds are for a settlement before then.

Beryllium extrusions by **Norair Division, Northrop Corp.,** are being developed to individual specifications, as a result of a 1958 survey of the aircraft-missile industry to learn just what engineers wanted from the glamour metal. Three of four builders of missiles and space vehicles will be using beryllium for primary flight structures within five years.

Martin's *TM-76B Mace* ground-to-ground tactical missile has been fired successfully from a simulated shelter, apparently a prototype of hardened base configuration in which the missile will be installed in Europe. The firing was from the AF Missile Development Center, Holloman AFB, N.M., to Wendover AFB, Utah.

Boeing Airplane Co. is consolidating its Systems Management Office, Seattle and Pilotless Aircraft Divisions into a single unit to be called the Aero Space Division . . . New entrant in germanium alloy junction and silicon transistor production is **U.S. Transistor Corp.,** Syosset, L.I., which also has taken over the sales organization of **Super Electronic Corp . . . Avien Inc.** is in the process of acquiring **Luther Mfg. Co.,** North Hollywood, Calif.

AVCO'S PLASMA ARC



FIRST production model of 18,000°F plasma generator turned out by Avco's Research and Advanced Development Division of Wilmington, Mass., was recently purchased by Jet Propulsion Laboratory. The arc was perfected by Avco as part of a materials testing program for re-entry vehicles for the Air Force *Titan* and *Minuteman* ICBM programs. It is the result of a two-year development program.


STEINHOFF

Appointment of **Dr. Ernst A. Steinhoff,** well-known, German - trained missile engineer, as director of its newly formed Missile Department, was announced by the Crosley Division of Avco Corp. Dr. Steinhoff was technical director for flight mechanics, ballistics, guidance and control, and electronics at the German Rocket Research Center at Peenemunde under **Dr. Wernher von Braun.**

Since coming to this country in 1945, Dr. Steinhoff has been chief scientist of the Ordnance Department for the Army at Fort Bliss, technical director at Holloman AFB and has served on the technical management council of the Air Research and Devclopment Command. He served on the Teller Committee in November of 1957 and in March of 1958 received the Exceptional Civilian Service Award of the U.S. Air Force.

Prior to his Crosley appointment, Steinhoff was deputy technical director in charge of Defense Products for the Aerophysics Development Corp., a subsidiary of Curtiss-Wright.

The board of directors of Litton Industries has elected **Charles R. Abrams, Jr., Dr. George Kozmetsky,** and **Harry J. Gray** vice presidents and **William L. Reynolds** secretary of the corporation.

Abrams, who has been treasurer of the company since August, 1955, a post he will continue to hold, joined Litton in February, 1954 as controller. Dr. Kozmetsky, assistant general manager of the Electronic Equipments Division, came to Litton in May, 1954, as director of the company's digital computer and controls development work.

Gray joined the company in November 1954 and has held various management positions in components since. Reynolds, who came to Litton as general attorney on June 1, had previously been general counsel of the Electronic Industries Association.


BAKER

Stanley E. Baker, Rocketdyne, N.A.A., is newly elected national president of the Society of Photographic Instrumentation Engineers. Baker is supervisor of the Photographic Instrumentation department for Rocketdyne and a charter member of the society which elected him to its highest office.

"Rapid diversification" of its billion-dollar-a-year business, according to Lockheed Aircraft Corp. has resulted in the formation of separate aircraft and missile-electronics combinations. each headed by a group vice president.

William R. Mogg has been appointed general manager of Crucible Steel Co.'s Spring Division succeeding **T. T. Crowley,** who has been named vice president and general manager of Crucible Steel of Canada, Ltd. Mogg joined Crucible last year as sales manager for the Spring Division after leaving Cleveland Graphite Bronze Co., where he was sales manager of Special Products.

Max F. Balcom, director-consultant of Sylvania Electric Products Inc., was recently reappointed chairman of the Electronic Industries Association Legislative Policy Committee. Members of the committee, in addition to Balcom, are: **Ben Adler,** Adler Electronics, Inc.; **E. C. Anderson,** Radio Corp. of America; **William F. Ballhaus,** Nortronics, Div. of Northrop Corp.; **Roland M. Bixler,** J-B-T Instruments, Inc.; **Sidney R. Curtis,** Stromberg-Carlson; **L. Berkley Davis,** General Electric Co.; **Philip Dechert,** Philco Corporation; **J. B. Elliott,** Tele-Dynamics Inc.; **Robert W. Galvin,** Motorola Inc.; **H. Leslie Hoffman,** Hoffman Electronics Corp.; **W. F. Joyce,** Texas Instruments Inc.; **Robert C. Sprague,** Sprague Electric Co.; **D. R. Hull** (Ex-officio), President EIA.


BROWN

Herschel J. Brown, assistant general manager since 1956, succeeds Root as vice president and general manager of the Missiles and Space Division. **W. A. Pulber,** assistant general manager, moves into Kotchian's former job as vice president and general manager of the Georgia Division.

Roy B. Williams has been named West Coast Plant Manager for American Machine Division, United States Chemical Milling Corp. as a part of an overall expansion program. The Division produces precision parts for the missiles and aircraft industry. Williams was formerly assistant to the vice president of manufacturing, American Bosch Arma Corp. American Machine Division and head of Operations Support in Arma's integration facilities on the *Atlas* missile program at Convair's Astronautics Division.

Aerojet-General Corp.'s Liquid Rocket Plant at Sacramento has named **Rudi Beichel** project engineer for the *Saturn* space vehicle's second-stage rocket engine.

He will head up the redesigning and modification work necessary for adaptation of the liquid-fueled *Titan* first-stage engines to second-stage use on the *Saturn.* Primary purpose of *Saturn* is to place large weights into orbit.

Beichel has been head of the Special Projects Department, Liquid Rocket Plant and formerly worked with von Braun at the German Rocket Research Center in Peenemunde. Von Braun heads the overall *Saturn* program.


FLYNT

Jerome D. Flynt has been named executive assistant to **Elmer P. Warnken,** president of CTL Inc. Flynt, who has been head of CTL's Technical Services Department, will continue this responsibility until a successor is named. He started at CTL in 1949 while a university student.

L. Eugene Root, vice president and general manager of the Missiles and Space Division since 1956, will become group vice president-missiles and electronics, covering the Missile Division and Lockheed's new Electronics and Avionics Division in Newport Beach and Los Angeles.

A. Carl Kotchian, vice president and general manager of the Georgia Division in Marietta, will be group vice president-aircraft responsible for Georgia, California Division, Burbank; Lockheed Aircraft Service, Ontario, Calif.; Lockheed Aircraft International, Los Angeles; and Lockheed Air Terminal, Burbank.

Neil M. Blair has been elected vice president and assistant to the president of Intelex Systems, Inc., subsidiary of International Telephone and Telegraph Corp. Blair, who will supervise the accelerating expansion of the firm into the commercial and industrial automation and control fields, was formerly vice president of Panellit, Inc., and vice president and general manager of Panellit Service Corp.

Maj. Gen. Thomas C. Musgrave, Jr. takes on the job of handling Air Force legislative liaison on Sept. 10, succeeding **Maj. Gen. William P. Fisher,** who will get a new assignment. Musgrave is now chief of manpower requirements and liaison in the office of the assistant secretary of Defense for manpower, personnel and reserve.

James G. Miles has been elected to vice president for Marketing. Since joining the company in 1957 he has been director of Service Engineering. Miles previously was with Remington Rand Univac as director of Special Sales, Bendix Aviation Corp. and Sylvania Electric Products, Inc. in engineering operations.



missiles and rockets

2nd ANNUAL MISSILE SUPPORT ISSUE

SEPTEMBER 21, 1959

From the magazine which is first and best in Missile Support—the most accurate picture available of the tremendous Missile Support field, which takes a big slice of every missile dollar. Penetrating articles and reports by recognized experts and experienced M/R staff members help you reach the heart of this multi-billion dollar market . . . through the pages of the technical/news weekly of the missile/space industry. Contact your *missiles and rockets* representative today, and find out how you can put your sales message before the men who make the important decisions concerning Support System equipment and capability.

NEW YORK CITY: 20 East 46th Street YUkon 6-3900 • DETROIT: 201 Stephenson Bldg. TRinity 5-2555 • CHICAGO: 139 N. Clark Street CEntral 6-5804 • LOS ANGELES: 8929 Wilshire Blvd. OLeander 5-9161 • MIAMI: 208 Almeria Avenue HIghland 4-8326 • TORONTO: 12 Richmond Street E. EMpire 4-2001 • LONDON: 28 Bruton Street GRosvenor 8356 • PARIS: 11 Rue Condorcet Tru 15-39 • GENEVA: 10 Rue Grenus 34 66 73

ADVERTISING FORMS CLOSE SEPTEMBER 1, 1959

M/R

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

NRL Reports Gains in Thermonuclear Control

by Jay Holmes

WASHINGTON—Controlled thermonuclear power—an ultimate source of propulsion for big interplanetary space ships—moved a giant step closer to reality last week.

Dr. Alan C. Kolb of the Naval Research Laboratory reported achievement of deuterium pressures consistent with temperatures on the order of 20,000,000°K for periods of 5 to 12 micro-seconds. These results, with high gas densities—upwards of 10^{16} particles/$_{cc}$ are about 10 times as long a duration as ever previously attained.

Kolb made his report at the Fourth International Conference on Ionization Phenomena in Gases, at Uppsal, Sweden. NRL officials here estimated that—as a result of the stepped-up progress—usable thermonuclear power might be produced within 20 years. Dr. C. V. Strain, superintendent of the Laboratory's radiation division, was even more optimistic. He remarked that research in this field is progressing at an ever-increasing rate.

"There is good prospect that on a laboratory scale a controlled thermonuclear reaction has already been achieved," an NRL statement declared. "The results satisfy all the experimental tests which have been applied. However, further tests will be necessary to establish beyond all doubt that a thermonuclear reaction has, indeed, been observed."

Kolb used relatively simple equipment. His experiments cost about $2 million, shared equally by the NRL and the Atomic Energy Commission, over about three years. His device consisted of a cylindrical magnet 12″ long, with a 6″ outside diameter and a 1½″ inside diameter. The deuterium gas is in a tube inside the center of the magnet.

The openings at either end of the magnet are less than ¼″ in diameter, creating a magnet mirror effect, with a field of 125,000 gauss compressed shock preheated gas. A 20-KV, 4-million-ampere pulse in the tube lasts from 5 to 12 microseconds. The current is supplied from a 285,000-joule condensor bank.

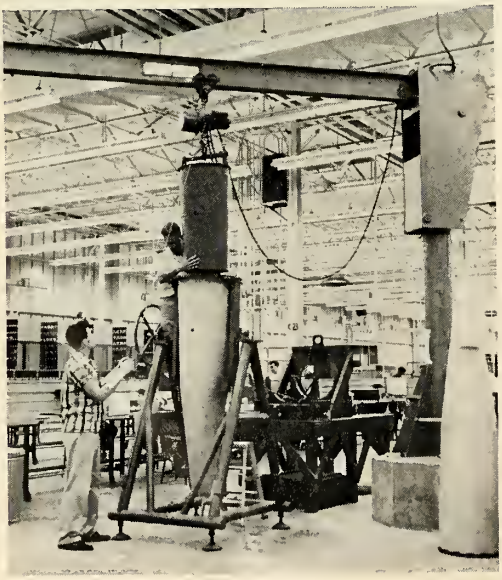
NRL's Dr. W. R. Faust said the next experiment should confirm the thermonuclear reaction. This would involve scaling up the present apparatus. The condensor bank would go to 20 million joules. The coil would be 15 cm in diameter and three meters long. He estimated that this would produce temperatures in the neighborhood of 50,000,000°K—possibly enough for a self-sustaining deuterium-deuterium reaction. It would cost another $2 million and take about a year to set up and perform.

The prime interest in controlled thermonuclear power is, of course, its potential for ground-based power, consuming the deuterium of the sea in tiny quantities. But the great efficiency of thermonuclear power also gives it great promise for space propulsion. Specific impulse would be measured not in hundreds but thousands and perhaps millions of seconds.

Many machines have been built in several parts of the world in efforts to tame the thermonuclear reaction—the nuclear fusion process in the Hydrogen bomb. (For a report on Soviet work in this field, see page 13.)

The difficulty in every case has been the instability of the high-current, high-voltage discharge used to generate the multimillion-degree temperatures needed to ignite the hydrogen fire. Kolb's results indicate this difficulty has been overcome.

ASSEMBLING LACROSSE



A CANISTER is installed in the nose section of a *Lacrosse* missile, in production at Martin-Orlando. *Lacrosse* equipment was delivered recently to Army at Ft. Sill, Okla.

Further *Explorer VI* Data Is Disclosed

SAN FRANCISCO—New details on *Explorer VI* were revealed at the WESCON meeting here by Dr. George E. Mueller of **Space Technology Laboratories.**

The satellite has counted one dust particle for every one hundred million cubic feet of space. This is equal to the space occupied by the Empire State building. Dust distribution is apparently uniform to an altitude of 22,000 miles.

The satellite has not found particles of sufficient size or momentum to harm space equipment. There is a larger concentration, however, of low-energy particles—mostly electrons—than had been anticipated.

These particles are on the order of 200,000 electron volts and up, and cover the entire Van Allen belt area. Two hundred thousand electron volts is the lowest energy being measured by the satellite.

There is no data to discourage man in space and Dr. Mueller estimated that a vehicle with reasonable shielding could get safely through the belt while traveling at escape velocity.

Explorer VI has a perigee of 134 nautical miles and an apogee of 22,900 miles. Scientists hope to get a crude facsimile picture of the earth at 10-20,000 miles altitude.

Monitoring instruments indicate that the solar cells are not putting out their anticipated power, Dr. Mueller said. The cells are covered by a glass protection with the exception of one uncovered test cell.

Dr. Mueller said the Van Allen radiation belt appears to be a fine, layered structure instead of one uniform area. The radiation level at 22,000 miles is low and probably would not endanger a manned space station at that altitude.

contracts

NAVY

$9,373,728—**Texas Instruments, Inc.**, for an advancement airborne surface search radar system.

$5,900,000—**Hoffman Laboratories, Div. of Hoffman Electronics Corp.**, Los Angeles, for production of a passive countermeasures system for underwater and surface craft.

$1,389,345—**Paul Smith Construction Co.**, Orlando, for construction of *Nike-Zeus* facilities.

AIR FORCE

$1,500,000—**Consolidated Systems Corp.**, subsidiary of Consolidated Electrodynamics Corp., Monrovia, Calif., for production of ground support equipment for the *Atlas* missile program. (Subcontract from Convair Div. of General Dynamics Corp.)

$1,000,000—**Perkin-Elmer Corp.**, Norwalk, Conn., for alignment theodolites to be used in conjunction with the *Atlas* ICBM. (Subcontract from Arma Div. of American Bosch Arma Corp.)

$780,000—**McDonnell Aircraft Corp.**, St. Louis, for production of *GAM-72* missile and launch gear.

$118,000—**Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co.**, Anaheim, Calif., for special cable assemblies for checkout and launching of the *Atlas* missile.

$90,000—**Raytheon Inc.**, Waltham, Mass., for the study of methods for converting microwave energy into heat.

$73,041—**Graflex, Inc.**, Rochester, N.Y., for camera sets and ground support equipment.

ARMY

$5,317,195—**George A. Fuller Co.**, Atlanta, for construction of *Minuteman* facilities at Patrick AFB.

$4,852,228—**Rheem Manufacturing Co.**, Downey, Calif., for an AN/USD-2 surveillance system.

$4,821,715—**Western Electric Co., Inc.**, N.Y., for engineering services and technical reports in conjuction with UNICOM.

$3,909,999—**Kaiser Steel Corp.**, Los Angeles, for construction of service tower at Patrick AFB.

$3,023,204—**Chris Berg, Inc.**, Seattle, for tracking and data acquisition station.

$2,768,964—**Five Boro Construction Corp.**, N.Y., for construction of *Nike-Hercules* facilities at Robins AFB. Macon, Ga., and Turner AFB, Albany, Ga.

$1,191,070—**Otto J. Eickhof & Sons, Inc.**, Crookston, Minn., for construction of electrical distribution power plant and radar tower for Finley AFB.

$865,700—**Edward R. Marden Corp.**, Brookline, Mass., for construction of *GAM-77/72* facilities at Griffiss AFB.

$806,852—**Diversified Builders, Inc.**, Cocoa, Fla., for construction of blockhouse for space systems launch facility.

$601,407—**R. E. Daily & Co.**, Detroit, for construction of radar tower, Selfridge AFB.

$426,539—**Parsons Construction Co.**, Omaha, Neb., for construction of nose cone facilities at Offutt AFB.

$279,505—**Raytheon Co.**, Newton, Mass., for electron tubes.

$104,000—**C. H. Leavell & Co.**, El Paso, Tex., for construction of *Nike-Zeus* facilities, Walker AFB.

$99,977—**American Machine & Foundry Co.**, Alexandria, Va., for research in the transmitting of beams of ions, neutral atoms and electrons over long distances through space.

$97,320—**University of Wisconsin**, for studies of the three-dimensional structure of the planetary boundary layer.

$92,600—**Sylvania Electric Products, Inc.**, Mountain View, Calif., for electron tubes.

$92,315—**American Machine & Foundry Co.**, Alexandria, Va., for technical and scientific assistance for range instrumentation facilities.

$69,695—**Sylvania Electric Products, Inc.**, Williamsport, Pa., for electron tubes.

$57,112—**Armour Research Foundation of Illinois**, for studies of micro-meteorological surveillance observing system.

BIDS

Rome Air Materiel Area, Att: ROPNA, Griffiss Air Force Base, N.Y.—Transmitter T-282 GR, 1 ea. Modulator Power Supply MD-141 ()/GR, 5 ea. required cable assemblies 5820 NSL, in acc./w Specs. MIL-T-4755A (USAF) dated 12 Mar. '59 and Amendment NR.1 thereto dated 26 June '59. Major spare components equipment and depot spares in acc./w MCP-71-673, Ground handling and special tools equipment and test equipment in acc./w MCP-71-650 and amendments thereto, 300 each. Two each first article will be tested in acc./w MIL-T-9107 and 1 each will be tested by Air Force. A 30-day continuous performance reliability test will be run. Models of similar equipment will be supplied for guidance purposes only. Closing date for receipt of bid requests is 14 Aug. '59.—IFB 30-635-60-47B—Bid opening 21 Sept. '59.

National Aeronautics and Space Administration, Lewis Research Center, 21000 Brookpark Rd., Cleveland 35, Ohio—Power supply, shall be rated at 0 40000 Volts D.C. at 0.1 amperes, continuous duty, current output continuously variable from Zero to 4000 volts in steps on exceeding one-half of one percent full voltage, 1 each. Power supply, high voltage D.C. 0-50 KV variable in steps of not more than one-half of one percent, 2 each.—IFB C-601—Bid opening 8-21-59.

Power supply, D.C., 20/40 volts, 7500/3750 amps, complete with saturable reactor, stepdown transformer—rectifier and balance coil assembly, temperature controller, input-output voltmeters and ammeters—1 each—IFB C-491—Bid opening 8-21-59.

Services, labor and materials for installation and connection of electrical equipment for NASA reactor facility in accordance with our specifications—Job—IFB C-534 PB—Bid opening 8-25-59.

U.S. Army Engineer District, Jacksonville, 575 Riverside Ave, Jacksonville, Fla.—Construction of space systems launch complex 36, AFMTC, Patrick AFB, Fla.—Job—IFB ENG-08-123-60-9 B—Bid opening 9 Sept. '59.

review

AIR RESEARCH AND DEVELOPMENT COMMAND TECHNICAL SYMPOSIUM, JULY, 1958, WADC, U.S. Air Force, Dec. 1958, Order No. PB151627 from OTS, U.S. Dept. of Commerce, Washington 25, D.C., 502 pps. $7.

This report contains technical papers and discussions of an ARDC symposium on materials for space vehicles and propulsion systems, held last July in Dallas.

Material covered includes papers on such structural materials as aluminum, magnesium, beryllium, steels, super alloys, adhesives, graphites, plastics, and surface treatments.

Special purpose materials such as elastomers, lubricants, glasses, shielding, and textiles are also in the report.

Material on electronic materials include papers on synthesis and application, energy transforming materials, insulation and dielectric materials, magnetic materials, and transistors.

AEROSPACE

ENGINEERS—SCIENTISTS

How about YOUR future?

Here's a company where the past and the present PROVE the future is interesting and worthwhile.

★ **Leadership in Engineering Design**

★ **Leadership in Business Airplanes**

★ **Leadership in Ground Support Equipment**

★ **Diversified Production Contracts**

★ **Winner of Mach 3 Alert Pod Design**

★ **Diversity of Creative Opportunities**

★ **Winner of Mach 2 Missile-Target Award**

★ **Builder of Major Assemblies for Fighters**

★ **Stability of Engineering Employment**

★ **Expansion Programs Now in Process**

BEECH AIRCRAFT has responsible positions open now for specialists in LONG RANGE programs on advanced super-sonic aircraft and missile-target projects in the following aerospace fields:

Human Factors

Analogue Computer

Reliability (Electrical)

Stress

Aero-Thermodynamicist (Heat Transfer)

Structures (Basic Loads)

Senior Weight

Dynamics (Flutter)

Systems (Missiles)

Electronic

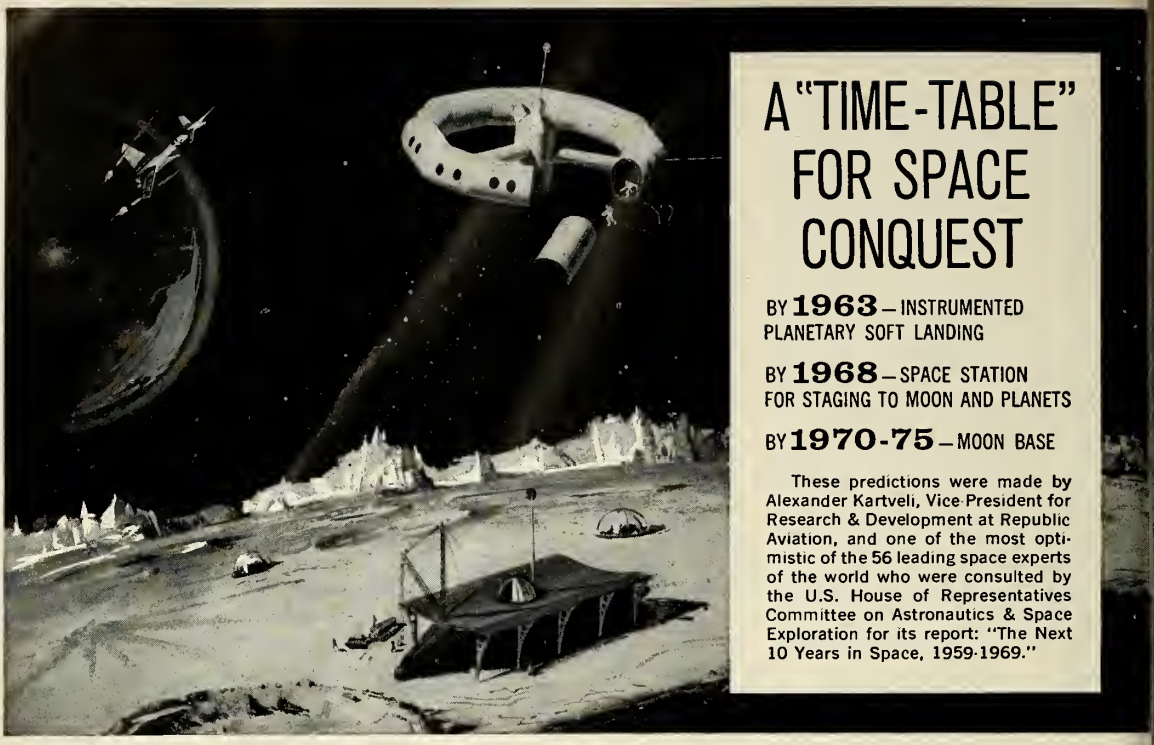
Electro-Mechanical

Airframe Design

For more information about a company WITH A LONG RANGE FUTURE where your talents will build your own future—call collect or write today to D. E. BURLEIGH, Chief Administrative Engineer, or C. R. JONES, Employment Manager, Beech Aircraft Corporation, Wichita, Kansas. All expenses paid for interview trip.

Beechcraft

Wichita, Kansas Boulder, Colorado



A "TIME-TABLE" FOR SPACE CONQUEST

BY **1963** – INSTRUMENTED PLANETARY SOFT LANDING

BY **1968** – SPACE STATION FOR STAGING TO MOON AND PLANETS

BY **1970-75** – MOON BASE

These predictions were made by Alexander Kartveli, Vice-President for Research & Development at Republic Aviation, and one of the most optimistic of the 56 leading space experts of the world who were consulted by the U.S. House of Representatives Committee on Astronautics & Space Exploration for its report: "The Next 10 Years in Space, 1959-1969."

JOIN REPUBLIC IN AN **INTEGRATED ATTACK** ON PROBLEM AREAS OF **SPACE EXPLORATION**

It's the fervent conviction of engineers and scientists at Republic Aviation that the courageous "Space Time-Table" above is entirely feasible – given a tradition-free, integrated approach to the problems. Such an approach is evident at Republic Aviation. Here, groups of specialists from many disciplines are working in close collaboration to solve problems across the entire spectrum of space technologies, which limit today's interplanetary and upper atmosphere flight capabilities.

Expanded by $35,000,000 last year, Republic's integrated Research and Development program has already produced signal advances in space guidance concepts; in new propulsion systems (plasma, nuclear); in radiation physics; in new materials and processing techniques; in unique hypersonic configurations; and in prototype development of hardware (as an example: hydraulic systems that operate reliably up to 1000°F).

Professional men—who can meet new challenges with enthusiasm and dedication – are urged to look into openings with our R&D groups, working in an atmosphere of exhilarating intellectual adventure.

Electronics
Inertial Guidance & Navigation
Digital Computer Development
Systems Engineering
Information Theory
Telemetry-SSB Technique
Doppler Radar • Countermeasures
Radome & Antenna Design
Microwave Circuitry & Components
Receiver & Transmitter Design
Airborne Navigational Systems
Jamming & Anti-Jamming
Miniaturization — Transistorization
Ranging Systems
Propagation Studies
Ground Support Equipment

Thermo. Aerodynamics
Theoretical Gasdynamics
Hyper-Velocity Studies
Astronautics Precision Trajectories
Airplane/Missile Performance
Air Load and Aeroelasticity
Stability and Controls
Flutter & Vibration
Vehicle Dynamics & System Designs
High Altitude Atmosphere Physics
Re-entry Heat Transfer
Hydromagnetics
Ground Support Equipment

Plasma Propulsion
Plasma Physics
Gaseous Electronics
Hypersonics and Shock Phenomena
Hydromagnetics
Physical Chemistry
Combustion and Detonation
Instrumentation
High Power Pulse Electronics

Nuclear Propulsion and Radiation Phenomena
Nuclear Weapons Effects
Radiation Environment in Space
Nuclear Power & Propulsion Applications
Nuclear Radiation Laboratories

Send resume in complete confidence to: Mr. George R. Hickman, Engineering Employment Manager, Dept. 4H-5

REPUBLIC AVIATION

Farmingdale, Long Island, New York

reviews

ADVANCES IN ASTRONAUTICAL SCIENCES, VOLUME 4. Proceedings of the 5th annual meeting of the American Astronautical Society, distributed by Plenum Press Inc., N.Y. 460 pps. $8.

This American Astronautical Society publication is a record of special lectures and technical papers presented at the AAS meetings held last December in Washington.

The volume includes material grouped under the headings of upper atmosphere research and re-entry mechanics, space vehicle design, guidance and instrumentation, satellite mechanics and space exploration, rockets and satellites, and man's environment in space.

ELECTRONIC DESIGNERS SHOCK AND VIBRATION GUIDE FOR AIRBORNE APPLICATION, published by WADC. Available to Dept. of Defense contractors. Order through Armed Services Technical Information Agency, Number AD-204095. 250 pps.

Written by technicians and scientists from the WADC Electronic Components Laboratory working with RCA electronic engineers, this electronic designers reference manual is devoted exclusively to shock and vibration environments.

The manual includes theory philosophy, vibration studies, electronic component parts and their characteristics, rack and chassis design, damping equipment for simulating and measuring shock and vibration, laboratory test procedures, vibration and shock protective devices; and equipment mounting and installation techniques.

DESCRIPTION OF AFMDC PROTOTYPE CAMERA STATION FOR SATELLITE SURVEILLANCE; Walter E. Woehl and Richard M. Waetjen. Order No. 140 199 from Library of Congress, Photo duplication Service, Publications Board Project, Washington 25, D.C. 47p. Microfilm, $3.30, photocopy, $7.80.

The basic requirements and a description of the philosophy adopted in the determination of accurate orbital data of satellites with the help of ballistic cameras are given.

Coded automatic-shutter operation and correlation to true standard time are described, and the photometric performance of the cameras using different optics is computed.

Data processing and evaluation, and improvements in the basic system are outlined. Sample photos of recordings are included along with a summary of those satellite position determinations which were performed.

when and where

AUGUST

AFOSR/Propulsion Research Division, Directorate of Aeronautical Sciences Office of Naval Research, Office of Ordnance Research and National Aeronautics and Space Administration, Symposium on "The Dynamics of Ionized Cases," Northwestern University, Evanston, Ill., Aug. 24-25.

American Rocket Society, Gas Dynamics Symposium, Northwestern University, Evanston, Ill., Aug. 24-26.

Institute of the Aeronautical Sciences' National Specialists Meeting, A Symposium on Anti-Submarine Warfare, (classified), San Diego, Aug. 24-26.

USAF's Ballistic Missile Division; Space Technology Laboratories, Inc., Fourth Symposium on Ballistic Missile and Space Technology, Los Angeles, Aug. 24-27.

International Commonwealth Spaceflight Symposium, Church House, Westminster, London, Aug. 27-29.

Army-Navy Instrumentation Program, Annual Meeting, Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Aug. 31-Sept. 2.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

Propulsion System Analysts

for theoretical studies of high energy fuels and advanced engine cycles

Chemists, physical chemists, physicists; mechanical, aeronautical, and chemical engineers are needed for an analytical group to compile fundamental high temperature thermodynamic data, to compute theoretical propellant performance, and to study preliminary engine performance and design. This work will include devising simplified methods for using both large and small electronic computers in these studies.

Present opportunities range from senior and supervisory positions for scientists and engineers with appropriate experience, to positions requiring only limited experience.

Located in suburban Richmond, the company offers completely modern facilities, attractive working conditions and opportunity for individual responsibility. Living is pleasant in Richmond and the company maintains competitive salaries with liberal benefit programs.

Send resumes to: Personnel Manager

EXPERIMENT INCORPORATED

A SUBSIDIARY OF TEXACO INC.

RICHMOND 2, VIRGINIA

CLASSIFIED

AN FITTINGS & HARDWARE

Stainless, Aluminum, Brass, Steel. All sizes —immediate delivery from world's largest shelf stock. Buy direct from manufacturer. Lower prices—Quicker service. Send for free wall charts showing complete line of AN & MS fittings and hardware. We also machine parts to your own special print.

COLLINS ENGINEERING CORPORATION
9050 Washington Blvd., Culver City, California

Advertiser's Index

AC Electronics Div., General Motors Corp. 8
Agency—D. P. Brother & Co.

Avco Corp. 51
Agency—Benton & Bowles, Inc.

Bendix Aviation Corp., Bendix Systems Div. 6
Red Bank 29
Agency—MacManus, John & Adams, Inc.

Boeing Airplane Co. 42
Agency—Calkins & Holden, Inc.

Crane Co. 10
Agency—The Buchen Co.

Douglas Aircraft Co., Inc. 25
Agency—J. Walter Thompson Co.

Lear, Inc., Lear-Romec Div. 12
Agency—General Adv. Agency, Inc.

Ling Electronics, Inc. 52
Agency—John Ramsey, Co., Adv.

Lockheed Aircraft Corp., Missile System Div. 3
Agency—Hal Stebbins, Inc.

Martin Co., The, Denver Div. 4
Agency E. M. Halvorson Co.

Metallizing Co. of Los Angeles 40
Agency—Ross Adv. Agency

Minnesota Mining & Mfg. Co., Magnetic Products Div. 9
Agency—MacManus, John & Adams, Inc.

North American Aviation, Inc., Missile Development Div. 41
Agency—Batten, Barton, Durstine & Osborn, Inc.

Ohio Carbon Co., The 38
Agency—P D A Adv. Agency

Radio Corp. of America 19
Agency—Al Paul Lefton Co., Inc.

Servomechanisms, Inc. 2
Agency—Hixson & Jorgenson, Inc.

EMPLOYMENT SECTION

Beech Aircraft Corp. 47

Experiment Inc. 49
Agency—Eastern Adv., Inc.

Republic Aviation Corp. 48
Agency—Deutsch & Shea, Inc.

Integrity Cannot Be Legislated

For days now we have watched a succession of witnesses appear before the Subcommittee for Special Investigations of the House Armed Services Committee to testify on the influence of retired military officers in the matters of defense contracts. Some have been from the Pentagon, but most have been from industry, either the retired officers themselves or their employers.

It would show less than a conscientious regard for us to say the testimony has not indicated that many of these retired officers have been greatly beneficial to the companies which employ them. But we believe that the great bulk of that benefit has been derived from utilizing the same qualities of leadership, wisdom and experience which made these men good generals and good admirals—and not because they could negotiate the sale of otherwise unsaleable products or programs.

We know several companies with tremendous defense contract backlogs which hire almost no generals or admirals in what could be called a "contact" capacity, and one woefully weak in government contracts which employed a half a dozen.

The services which a retired officer can contribute honestly and ethically to a company handling defense contracts are many. It costs, for example, literally hundreds of thousands of dollars and many man hours of skilled scientific labor for a major prime to make a proposal for a major weapon system.

If the retired officer knows which concepts are obsolescent, which have been proven impracticable or simply lead up a blind alley, and if he can prevent his company from heading into that field in its proposal—then he not only has saved his company money but has prevented wasted effort on the part of engineers and scientists whose time and effort the country can ill afford to waste.

It is probable that some new laws will come out of the Hébert hearings to guide the relations of retired officers with both industry and the government. But we suspect they will be inconclusive of any hard result in solving the true problem involved here—the real or fancied unethical practices of the nation's big defense industries.

For this is the heart of the question, and it evolves from the President's casual reference to the existence in this country of a "munitions lobby"; it asks whether or not pressure is brought upon the military by industry to continue weapon systems after they have become obsolescent, pressure to produce competing weapons—and other practices which deviate from reasonable honesty.

The solution for that, we feel, can come from one source and one source only—the Pentagon. Firm and clear-cut decisions must be made there between weapons, weapon systems and which service is going to use them.

There used to be a day when each Service had a job to do and the authority to get it done. Budgets were presented to Congress on this basis and there was a mutual confidence and respect. Somewhere in the dawning of this confusing Space Age the simple system of deciding what is best and sticking to that decision seems to have been lost. So has the time-honored precept of coupling responsibility with authority. On top of the military services, the nation's Defense Establishment has layered board upon board, committee upon committee, agency upon agency—not to make decisions but to delay or avoid them.

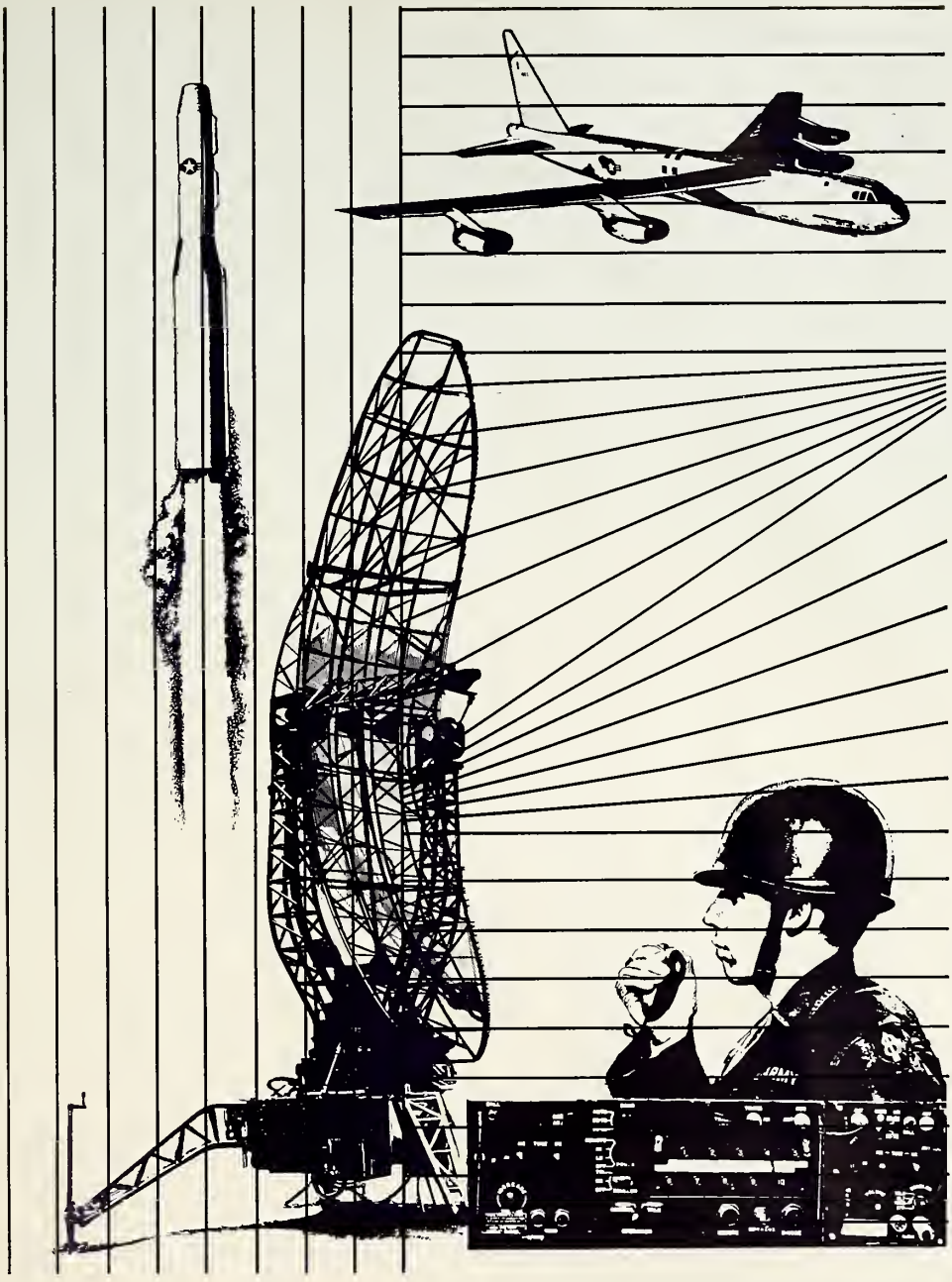
This is the area, we think, where Congressman Hébert and his committee must look for a solution. Inertia itself tempts industry to go overly far in trying to force action.

The testimony before the Hébert Committee, some of it inept and some of it strongly perceptive, has not shown any wrong-doing on the part of retired military officers working with the defense industry—and we doubt that it shall.

It would be a great tragedy if it did, for, as the Martin Company's Chairman of the Board, George M. Bunker, said in his prepared statement before the committee:

"In the final analysis, it is really a matter of integrity that we are talking about and I have every reason to believe that the integrity of retired military personnel is of the highest caliber. In any event, integrity cannot be instilled by legislation. However, I would suggest that if there are any real doubts about the integrity of our military personnel, these doubts should be exhaustively explored and at all costs eradicated, for the damage in disservice that a military officer lacking the requisite integrity could do to his country is far greater in his military capacity than it could ever be as an employee of industry."

CLARKE NEWLON



Avco Steps Ahead . . . in Electronics—From guiding missiles to their targets to defending bombers from missile attack, from interplanetary communications to communications for field troops: Avco's work in electronics is wide and diversified. It results from Avco's combination of expert personnel and complete facilities for research, development, and manufacturing. On many fronts, Avco lends unique support to America's electronic progress.

Avco

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS . . . WRITE AVCO TODAY.

AVCO MAKES THINGS BETTER FOR AMERICA / AVCO CORPORATION / 750 THIRD AVENUE, NEW YORK 17, N. Y.

Fully Automatic Vibration Systems for Production Line Testing!

LING

SINE-O-MATIC SERIES



SINE-O-MATIC Model RP-1/2— Model 227 Shaker
Sine-O-Matics with 25 to 150 pounds force output are available in this vertical rack mounting. Systems for 500 to 1500 pounds force are packaged in a compact desk-type console. All models can be converted to random motion at a moderate cost.



- Extended frequency range—from 5 up to 10,000 cps.
- No impedance changing or manual power factor correction required over entire frequency range.
- All components except shaker are housed in single, compact control console, either desk type or vertical.
- Consoles equipped with swivel casters for mobility—can be easily moved, as required.
- Sine-O-Matic systems meet all specifications called for under MIL-E-5272... can be profitably used by *all* equipment or components manufacturers!
- Fully automatic programming and push-button operation—ideal for production line testing!

SINE-O-MATIC SHAKER FORCE OUTPUTS

Sine-O-Matic Madel	Shaker	Rated Continuous Output in Watts	Amplifier Plote Dissipatian in Watts	Sine Wove Pounds-Force Vector
RA-250	6-C	250	200	25
RA-500	A-88	500	600	100
RP-1/2	227	1,000	2,000	150
CP-3/4	219	3,000	4,000	500
CP-3/4	A-174	3,000	4,000	1,200
CP-5/6	A-174	5,000	6,000	1,500

LING

ELECTRONICS, INC.

Factory Soles Offices:
9937 West Jefferson Blvd., Culver City, Californio
TExas 0-7711
120 Cross St., Winchester, Moss. • WInchester 6-3810

AUGUST 31, 1959

AUG 1959
HOUSTON PUBLIC



LITTLE JOHN—MODERN ARTILLERY

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Army To Pull Out of Space? 11
Lunar Flight: Man vs. Instruments . 24
Emerson's Prolific E&A Division ... 28

AN AMERICAN AVIATION PUBLICATION





REVOLUTION IN DESIGN

Grove Regulators... As revolutionary in design and engineering as the technological transition from flying machine to space vehicle... Achieved a quarter of a century ago, the only regulators which could be used for the first missile experiments in the Navy Experimental Station at Annapolis ... still today the standard for the critical control of high pressure fluids... Now on the threshold of space, Grove is uniquely prepared—through advance research and development—to meet the challenge of even higher pressures ahead.

GROVE POWREACTOR DOME REGULATOR MODEL GH-408-50-6000 PSI INLET...5-3000 PSI REDUCED PRESSURE

GROVE VALVE and REGULATOR COMPANY

6529 Hollis St., Oakland 8, California • 2559 W. Olympic Blvd., Los Angeles 6, California

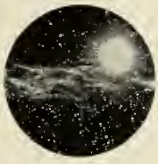
Offices in other principal cities

Subsidiary of Walworth

Explorer VI is a space laboratory orbiting around the earth with paddles capturing sunlight for power



The scientific data that will some day enable us to probe successfully to the very fringes of the universe is being recorded and transmitted at this moment by the space laboratory Explorer VI, a satellite now in orbit around the earth ● This project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, will advance man's knowledge of: *The earth and the solar system . . . The magnetic field strengths in space . . . The cosmic ray intensities away from earth . . . and, The micrometeorite density encountered in inter-planetary travel* ● Explorer VI is the most sensitive and unique achievement ever launched into space. The 29″ payload, STL designed and instrumented by STL in cooperation with the universities, will remain "vocal" for its anticipated one year life.







How? Because Explorer VI's 132 pounds of electronic components are powered by storage batteries kept charged by the impingement of solar radiation on 8,000 cells in the four sails or paddles equivalent to 12.2 square feet in area ● Many more of the scientific and technological miracles of Explorer VI will be reported to the world as it continues its epic flight. The STL technical staff brings to this space research the same talents which have provided systems engineering and over-all direction since 1954 to the Air Force Missile Programs including Atlas, Thor, Titan, Minuteman, and the Pioneer I space probe.

Important staff positions in connection with these activities are now available for scientists and engineers with outstanding capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology, and other related fields and disciplines.

Inquiries and resumes are invited.

Space Technology Laboratories, Inc.

P. O. Box 95004
Los Angeles 45, California

missiles and rockets

the magazine read by the LEADERS in the missile and space vehicle field.



Need more missile personnel?

missiles and rockets is the magazine written expressly for missile experts. M/R can provide the best vehicle for you to reach this type of man. For further information, contact the **missiles and rockets** regional advertising manager nearest you.

missiles and rockets

An American Aviation Publication

1001 Vermont Ave., N.W., Washington, D. C.

Executive Editor ..... CLARKE NEWLON
Managing Editor .... DONALD E. PERRY

NEWS STAFF

News Editor ..... REED BUNDY
Defense and Legislative ..... JAMES BAAR, BETTY OSWALD
West Coast ..... RICHARD VAN OSTEN
Copy Editor ..... ERICA KARR
Editorial Assistant ..... DAVID NEWMAN

ASTRIONICS

Guidance and Control .... CHARLES D. LAFOND
Support Equipment ..... HAL GETTINGS

ASTRONAUTICS ENGINEERING

Chemistry & Propulsion ..... JAY HOLMES
Astrodynamics ..... PAUL MEANS

MISSILE SUPPORT

Installations and Equipment
East Coast ..... WILLIAM E. HOWARD
West Coast ..... FRANK McGUIRE

BUREAUS

Los Angeles ..... WILLIAM J. COUGHLIN
Paris ..... JEAN-MARIE RICHE
Geneva ..... ANTHONY VANDYK

CONTRIBUTORS

British Astronautics ..... G. V. E. THOMPSON
Propulsion ..... MICHAEL LORENZO
Industry ..... JAMES J. HAGGERTY, JR.
Soviet Affairs ..... DR. ALBERT PARRY
Space Medicine ..... DR. HUSERTUS STRUGHOLD
Astrophysics ..... DR. I. M. LEVITT
Research ..... HEYWARD CANNEY, JR.

ADVISORY BOARD

DR. WERNHER VON BRAUN — ROBERT P. HAVILAND
DR. PETER CASTRUCCIO — DR. ARTHUR KANTROWITZ
CONRAD H. HOEPPNER — DR. EUGEN SAENGER
R. F. GOMPERTZ — ALEXANDER SATIN

PRODUCTION AND ART

Art Director ..... WILLIAM MARTIN
Assistant Art Director ..... BACIL GUILEY
Production Manager ..... J. F. WALEN
Ass't Production Manager ..... ELSIE GRAY

BUSINESS STAFF

Publisher ..... E. D. MUHLFELD
Advertising Sales Manager ..... W. E. BROWN
Eastern Advtg. Manager ..... P. B. KINNEY
Circulation Director ..... L. L. BRETTNER
Promotion Manager ..... J. E. MULROY
Advtg. Service Manager .. MRS. GLADYS BUSSELL

ADVERTISING OFFICES

New York .. (20 East 46th St.) P. N. ANDERSON, A. B. SCHEFFLER
Detroit ...(201 Stephenson Bldg.) K. J. WELLS
Chicago .....(139 N. Clark St.) G. E. YONAN
Los Angeles .(8929 Wilshire Blvd.) J. W. CLAAR, C. R. MARTZ, JR.
Miami .....(208 Almeria Avenue) R. D. HAGER
Toronto (12 Richmond St. E.) ALLIN ASSOCIATES
London .....(28 Bruton St.) NORALL & HART
Paris .....11 Rue Condorcet
Geneva .....10 Rue Grenus

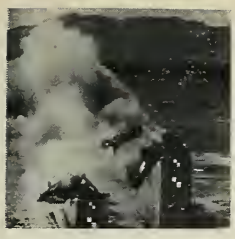
Missiles and Rockets Volume 5 Number 36

Published each Monday by American Aviation Publications, Inc., 1001 Vermont Ave., N.W., Washington 5, D.C. Wayne W. Parrish, *President*; Leonard A. Eiserer, *Executive Vice President & General Manager;* Fred Hunter, *Vice President & Editorial Director;* A. H. Stackpole, Eric Bramley, Robert R. Parrish, *Vice Presidents.*

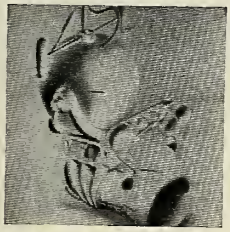
Printed at the Telegraph Press, Harrisburg, Pa. Second class postage paid at Washington, D.C., and at additional mailing offices.

Copyright 1959, American Aviation Publications, Inc.

Subscription rates: U.S., Canada and Postal Union Nations—1 year, $8.00; 2 years, $12.00; 3 years, $14.00. Foreign—1 year, $10.00; 2 years, $18.00; 3 years, $26.00. Single copy rate—$.75. Subscriptions are solicited only from persons with identifiable commercial or professional interests in missiles and rockets. Subscription orders and changes of address should be referred to Circulation Fulfillment Mgr., M/R, 1001 Vermont Ave., Washington 5, D.C. Please allow 4 weeks for change to become effective and enclose recent address label if possible.



COVER: *Little John* is test fired at White Sands Proving Grounds, N.M. Although it has yet to be declared operational, the Emerson artillery missile is being used in troop training.



SOLARIS vehicle retrieves a missile booster engine in an Artist's conception of the versatile underwater system being developed by Vitro Laboratories. See story on p. 16.



LANDING on the moon with last two stages of a five-stage space vehicle. Artist's sketch shows spare return vehicle at left. Case for direct, manned moon flight is reported on p. 24.



IMPROVED XM50 *Honest John* undergoes test and evaluation firing at White Sands. Emerson Electric Manufacturing Co. is prime for *Honest John* and *Little John*. See story on p. 28.

missiles and rockets ®

MAGAZINE OF WORLD ASTRONAUTICS

AUGUST 31 HEADLINES

Army May Have To Drop Out of Space
Shortage of funds and pressure of inter-service rivalry could lead it to leave the space field soon and concentrate on other missions. Third in a series of Pentagon planning 11

Missile/Space R&D Is Capital Area's Top Private Industry
Washington and its environs provide much of the brains behind missile production. Last of a series on the Middle Atlantic Area 19

Scientist Speeds Space Solutions from Ground Up
A profile of Dr. Arthur Kantrowitz, Avco research chief who specializes in saving time and money on ICBM programs..... 40

MISSILE SUPPORT
U.S. Reg. Pdg.

Refractory Metals Research Is Intensified
Hundreds of firms are pressing R&D on the heat-resistant metals that hold answers to many of the toughest missile/space problems 13

SOLARIS Will Salvage Missiles from the Deep
Low-cost system being developed by Vitro Laboratories should find wide range of uses, including eventual work in charting ocean bottom 16

ASTRONAUTICS ENGINEERING
U.S. Reg. Pdg.

The Case for Manned Lunar Flight
A pair of NASA officials, speaking for themselves, argue that man can do more at less cost than instruments; they propose detailed plans 24

ASTRIONICS

Emerson's Prolific E&A Division
Company compiles an enviable record in missile work and comes up with startling developments for the future while bucking "decentralization" trend 28

RCA System Designed to Relieve Interference Troubles 32

Battery Manufacturer Assails Hot-Gas APS's 33

Wescon Show Emphasizes Design 34

NEW MISSILE PRODUCTS

Encoder Produced with One Million Positions 38

THE MISSILE WEEK
U.S. Reg. Pdg.

Industry Countdown 7

Washington Countdown 9

More About the Missile Week 49

DEPARTMENTS

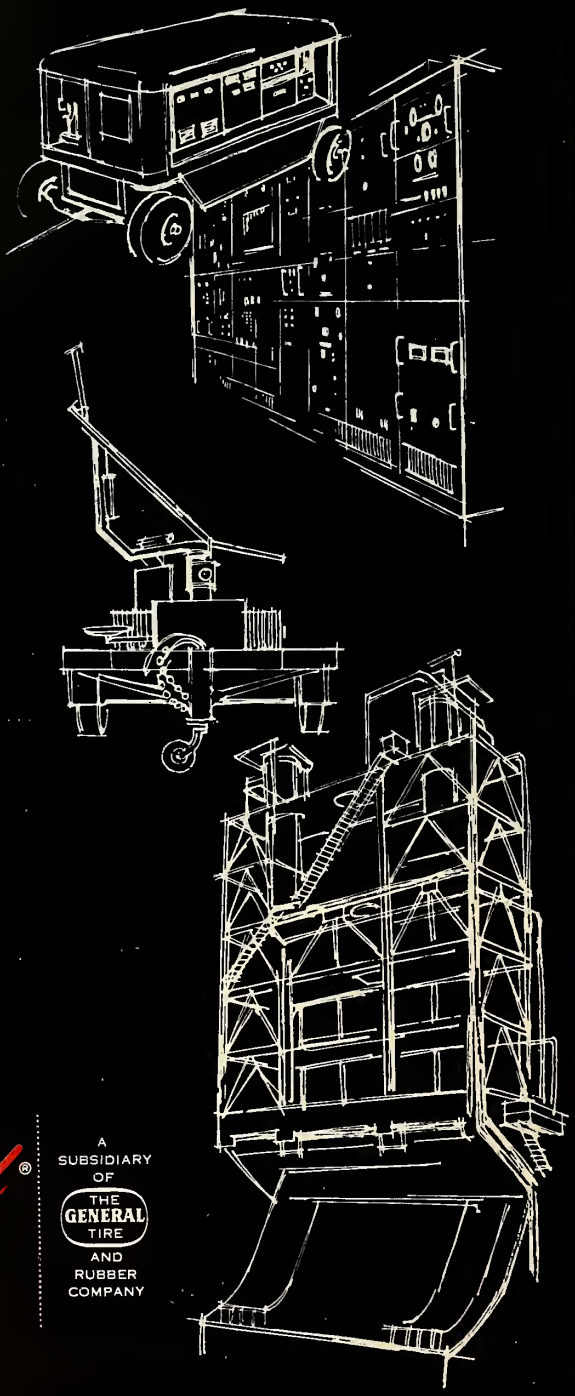
Propulsion Engineering .. 42
Missile Business 44
Contracts 45
People 45
Reviews 51
When and Where 51
Editorial 52

GSE

by AEROJET

Success in the air depends on support from the ground. Aerojet-General designs and manufactures all types of missile, surveillance drone, and space system ground support equipment.

- General Planning and Logistics
- Test and Launching Facilities
- Ground Handling & Servicing Equipment
- Checkout Systems
- Instrumentation and Control
- Data Systems
- Telemetry
- Communication Systems
- Radar Systems
- Space Position Instrumentation
- Miss-Distance Measuring Sets



Aerojet-General®
CORPORATION
Azusa, California

A SUBSIDIARY OF THE GENERAL TIRE AND RUBBER COMPANY

Plants at Azusa, Downey, San Ramon and near Sacramento, California; Frederick, Maryland

Engineers, scientists — investigate outstanding opportunities at Aerojet

Industry Countdown

MANUFACTURING

Contract for secret missile . . .
is reported in final negotiation stage for **Fairchild Engine & Airplane Corp.** Recently set back by cancellation of *Gander* and *Goose* drones, Fairchild is in the process of lining up subcontractors for the new missile project.

• • •

Re-entry test of . . .
McDonnell's *Mercury* capsule is set for Sept. 2 from Cape Canaveral. **Convair** *Atlas* booster will fire unmanned capsule to orbital height where it will stay only long enough for tip-over after stage separation and then begin descent.

• • •

Missile steel supplies . . .
generally are holding up despite the stretch-out of steel strike. Commerce Department's Business and Defense Services Administration says it is filling some requests for help from defense steel users.

• • •

Good solid booster . . .
market could develop if Air Force decides to go ahead with large-scale program of zero-launched interceptor aircraft from atom blast-proof shelters.

PROPULSION

Look for huge new . . .
research program to be launched soon by the Army into materials for solid-propellant rocket motor casings and nozzles.

• • •

Composite solid fuels . . .
will be produced at **Amcel Propulsion** plant, Asheville, N.C. **Celanese Corp.** recently purchased the facility from **Oerlikon Tool & Machinery.**

• • •

Prepackaged liquid . . .
Guardian motor series by **Thiokol Chemical Corp.** will go into the Navy's air-to-air *Sparrow III* and air-to-surface *Bullpup.*

• • •

Aerojet-General is teaming . . .
with **Acoustica Associates** to explore application of sonic burning control to rockets for advanced space vehicles.

ASTRIONICS

First thermal-electric . . .
air conditioner will be developed by **Westinghouse** under Navy contract to be announced late in September. Compact 1-ton unit will have missile and space vehicle applications.

• • •

High-speed digital . . .
plotter newly developed by **Lockheed's** Missile and Space Division permits space program flight evaluations to be made 17 times faster and 12 times cheaper than with old reduction methods. They are being used to accelerate development of the *Discoverer Agena* satellite and *Polaris* IRBM.

• • •

In operation . . .
new radar antenna test range 1½ miles long by the **Special Products Division of I-T-E Circuit Breaker Co.,** Philadelphia. New range allows pattern tests on antenna up to 60 feet wide at frequencies through 2000 mc. Equipment to be tested includes I-T-E's 60-foot DEW line antenna and NATO's Ace-High troposcatter 60-foot dish.

WE HEAR THAT—

Interest is picking up . . .
in $1.5 million to $2 million graphite pilot plant being sought by the Air Force. It would be used to develop missile components . . . **AC Spark Plug** decided to build a laboratory at Wakefield, Mass., (for *Titan* all-inertial guidance) because scientists hired for the program wouldn't relocate away from Boston to Flint, Mich. . . . Steel casings for missile structures with tensile strengths up to 300,000 psi are being built by **American Brake Shoe Co.** . . . Air Force's *Atlas* adaptation of Army *Jupiter* re-entry ablation nose cone uses glass-phenolic tape wrap—instead of downwind shingle design . . . **North American Aviation** president J. L. Atwood is predicting NAA's 1959 net will exceed $28 million, or $3.50 a share, compared to $3.43 last year . . . A nuclear electronics lab is being set up by **Hughes Aircraft** . . . The **Western Electric** *Nike-Zeus* anti-missile missile is approaching the complete systems test stage . . . and the National Bureau of Standards has established a vibration pickup calibration service for the range of 10 to 2000 cps at accelerations up to 10 g.

More About the Missile Week on page 49

Armco PH 15-7 Mo Stainless Steel Provides Structural Efficiency for Long-Range Mach 3 Aircraft

New precipitation-hardening stainless combines strength at 2000 mph temperatures with producibility, availability and economy.

Armco PH 15-7 Mo Stainless Steel has been selected as the primary sheet metal for the dramatic new air weapon systems—the B-70 Valkyrie bomber and the F-108 Rapier manned interceptor—being developed by North American Aviation, Inc. for the Air Force. Most of the honeycomb panels and other structural parts will be made of this special stainless because it possesses the required strength at anticipated temperatures and a unique combination of advantages that facilitate the design and production of dependable and economical structural elements.



Armco PH 15-7 Mo Stainless Steel—

* Has high strength-weight ratios up to 1000 F.
* Resists deformation at flight stresses and temperatures.
* Is available in practically all commercial forms—foil, sheets, strip, plates, bars, wire, and forging billets.
* Resists corrosion, eliminates the weight penalty of corrosion protective coatings.
* Can be welded and brazed. Brazing is compatible with heat treatment.
* Is formed in soft condition, then hardened by simple heat treatment.

For the airframes, power plants or accessories of supersonic air vehicles, consider the opportunities to economically improve performance and reliability by specifying Armco PH 15-7 Mo Stainless. Write Armco Steel Corporation, 2829 Curtis Street, Middletown, Ohio, for design data and fabricating information.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Washington Countdown

IN THE PENTAGON

Cutting the defense budget pie . . .
for FY 1961 is expected to begin in earnest during the early part of September. During these weeks, Defense Secretary McElroy is expected to begin making some of the key decisions on which service gets what.

• • •

Long faces . . .
will be the uniform of the day no matter what the decisions are, however. The defense budget is clearly frozen for the Presidential election year at $40 billion or less—a figure widely considered by military officials to be inadequate.

• • •

***Discoverer VII* . . .**
is scheduled as another attempt to perfect the ARPA Air Force system for recovering capsules from orbit. The launching of the satellite is expected to take place sometime toward the end of September. Capsules from *Discoverers V* and *VI* apparently burned up during reentry over the Pacific. (See M/R this issue page 48.)

• • •

Name changing dept. . . .
Lockheed's *Sentry*, the ARPA Air Force reconnaissance satellite project, has been rechristened. It's now called *Samos*—as in the ancient Grecian island. However, same project, same contractors, same purpose.

• • •

Missiles for Japan . . .
are in the cards within the next few years. The Japanese are reported to be planning to build an air defense system around **Raytheon** *Hawks* and **Western Electric** *Nikes*. Timing and the political atmosphere in Japan apparently have a lot to do with when the *Nikes* and *Hawks* are set up.

• • •

Missiles from Switzerland . . .
were imported by the Japanese last year for study. Great internal controversy resulted. So far, the 10 **Oerlikon** ground-to-air missiles have never been fired since they were delivered. However, Japanese engineers have dismantled three for study.

• • •

The first operational *Atlas* . . .
firing from Vandenberg AFB, Calif., is expected within the next two to six weeks. The Air Force is still deciding when to try it. However, the Air Force feels sure it has found and cured the *Atlas* ailment—a malfunction of the fuel disconnect valve.

One of the hottest . . .
of ARPA's future space projects—Project *Orion* studies on development of a nuclear-blast powered rocket—has been extended for another year. The $1 million contract went to **General Atomic** which has been conducting the studies.

ON CAPITOL HILL

A new blast . . .
at Defense Department handling of news on missiles and space exploration is included in the latest report from the House Information Subcommittee. The subcommittee particularly is hitting at the withholding of information on space monkeys and a picture of **Martin's** *Titan* as typical mismanagement of the news.

• • •

A new series . . .
of nuclear tests may be sought by Congressmen if East-West disarmament talks at Geneva continue to produce only hot air. Both Congressmen and military officials see the U.S. slipping in development of nuclear warheads for missiles and a possible nuclear-blast powered rocket because of the voluntary suspension of tests.

AT NASA

Drastic cuts . . .
in the billion-dollar-a-year future once envisaged for NASA is the interpretation being put on recent remarks by NASA Chief Glennan. The immediate outlook: A NASA budget ceiling of probably about a half-billion dollars.

• • •

The huge *Saturn* . . .
1.5-million pound thrust cluster being developed by the Army for ARPA probably will be used first by NASA. NASA Chief Glennan as much as said so in recent testimony before a House committee.

AROUND TOWN

Some of the reports . . .
being passed as "the latest" in the Nation's Capital:

. . . South America is seen as a likely future market for U.S. tactical missiles armed with conventional warheads.

. . . Top space experts say they still have no reason to disbelieve the Russian boast that they will be on the moon by October, 1967.

. . . Congress will be the stage next year for an all-out drive to increase the size of the Army.



PRODUCT SUPPORT ENGINEERS

Urgency - Speed - Reliability. These words describe Convair-Astronautics' top-priority program of activating Atlas ICBM bases throughout the United States. Included in this immense task is the job of training Air Force personnel, developing and producing hundreds of technical manuals and providing technical assistance to the Air Force. The Product Support department at Astronautics is responsible for this assignment and to fulfill it must double in size within the next two years. Engineers qualified to participate in this long-range program will find excellent growth opportunities in the following areas:

CUSTOMER TRAINING – Service Training Instructors—Engineers with degrees in ME, AE or EE, or equivalent hardware experience are needed to prepare and conduct continuing 4-6 month courses to Air Force personnel on the Atlas ICBM. This training will include classroom theory and hardware manipulative skills to a high level of proficiency.

Service Training Planners – Men with 2-5 years experience in the planning of industrial and/or armed services training programs are needed for the planning, preparation, editing and publishing of training material for the Air Force. This assignment will also include training standards, syllabuses, lesson plans and training projects.

TRAINER DESIGN – Trainer design engineers (electronic and mechanical) with degrees in ME, AE or EE are needed to design simulators to be used in the training of Air Force personnel on the Atlas weapon system.

FIELD SERVICE – Engineers, preferably with degrees in ME, AE or EE, and field or in-plant hardware experience are needed to act as technical representatives to the Air Force on the Atlas ICBM. Most assignments will be at Vandenberg AFB, Santa Maria, Calif. There will be other assignments as additional Atlas bases become operational. A limited number of San Diego openings also exist in the areas of Field Service Support. A field service bonus is authorized for field assignments in excess of six months. Per diem paid for assignments under six months.

TECHNICAL WRITING – Engineering degree preferred, plus 1-3 years of technical writing experience. Assignments include the writing of engineering reports, maintenance manuals and operation manuals.

Our engineering representatives will be conducting

INTERVIEWS

in these cities soon:

Schenectady • Utica • Syracuse • Albuquerque • El Paso • Los Angeles • Dayton • Rockford • South Bend • Salt Lake City • Cleveland • Denver • Washington • Chicago • New Orleans Hagerstown • Milwaukee • Indianapolis • St. Louis • Fort Wayne • San Francisco • Philadelphia • Boston • Oklahoma City • Pittsburgh • Youngstown

Call our permanent recruiting office in New York, EL 5-3550

Qualified Product Support Engineers are urged to send a detailed resume at once so advance arrangements can be made for a confidential interview. Write to Mr. T. W. Wills, Engineering Personnel Administrator, Department 130-90.

CONVAIR/ASTRONAUTICS

CONVAIR DIVISION OF

GENERAL DYNAMICS

5618 KEARNY VILLA ROAD, SAN DIEGO, CALIFORNIA

Army Faces Exodus from Space

To get the facts behind the following story, M/R editors interviewed top-ranking Army officers and officials of the Defense Department and allied U.S. agencies. While no person interviewed would permit the use of his name, all agreed on the basic facts concerned. M/R carries the story after serious consideration, conscious that it will be regarded as highly controversial by many readers.

by James Baar

WASHINGTON—The Army is facing the possibility of having to get out of the space business.

It also is facing the possibility of sharp curtailment or death of the *Nike-Zeus* anti-missile missile.

The cause is two-fold: lack of money and the pressure on DOD and the Joint Chiefs of Staff to stabilize the missions of the three services.

Linked to both is the Army's increasing drive to modernize its divisions with new tactical missiles and all the advanced panoply of Missile Age nuclear and conventional war.

For a long time a minority of the Army's high command has felt the Army space effort was a costly side effort. Now there appears to be a growing feeling in at least part of the high command majority that the Army may be forced out of the space business by the Defense Department.

These officials are understood to be arguing that it might be best for the Army to take the initiative, give in gracefully, reap whatever financial benefits might be had and concentrate on tactical missiles and the scores of almost startling innovations in the horizon for equipping ground troops.

The soul-wrenching problem is understood to be already on desks at the Pentagon's highest levels. A decision is expected within a matter of months at most—possibly in time for the annual autumn commanders' meeting.

Here are some of the key factors:

• The Army for some time has been low man on the Pentagon budget totem pole. Lack of funds has hobbled Army procurement of modern weapons—particularly missiles.

• An extra $1.5 to $2 billion will be needed in the new budget if the Army is to keep development and production of **Western Electric's** *Nike-Zeus* on schedule.

• NASA so far has placed no orders for space work with the Army in 1960 and probably won't in excess of $20 or $25 million. ARPA business with the Army outside of the huge *Saturn* 1.5 million-pound-thrust booster is relatively small.

• The Defense Department is understood to be pressing the joint Chiefs of Staff in earnest for an end to the grab-bag approach to assigning space projects.

Place all of this in the context that the Administration has again frozen the FY 1961 budget at $40 billion or less and you begin to get the sticky feeling of the situation.

The Army itself is clearly torn until it hurts.

It feels that it has a great past and should have an even greater future in space. Its plans for the years immediately ahead have included a whole series of satellites for reconnaissance, weather forecasting, mapping and communications. Beyond these, Army space team thinking had encompassed such projects as spaceports and construction of bases on the moon and planets.

The Army has felt that its Ballistic Missile Agency centered at Huntsville has tremendous capabilities that should be thrown into this work.

Moreover, Army has contended that not to use its capabilities for space work is pure waste. This argument is based on the contested ground that savings resulting from ending space work at Huntsville would be relatively slight. In fact, the costs of tactical missile development at Huntsville—the bulk of the work at ABMA—might go up.

However, many in the Army fear that they face the end of the road into space. Some dozen space projects have been submitted by the Army to NASA in recent months. So far, none of them has been taken up.

This points to another potential question—the disposition of the Huntsville space team should the Army cease space operations. NASA sought to incorporate it once when NASA was organized. The chances probably are that NASA would still be interested, but possibly cooler. But regardless of who runs ABMA, the *Saturn* will keep the space team there busy for some time.

The second big Army problem is *Nike-Zeus*.

Debate on the big missile cuts the Army with a keen double blade. Some feel that *Zeus* is vital to survival; others see it as a costly static weapon that may well never be fired in anger—a weapon that would provide only a defensive role for much of the army of the future.

Zeus—the nation's only foreseeable anti-missile missile for the next decade—is scheduled to be operational by 1963. But this schedule can only be met if funds are provided in the new budget for going into production.

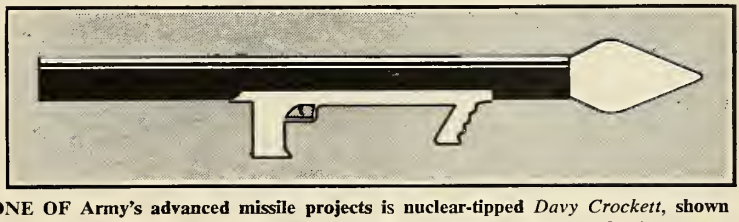
Unfortunately, this is no bargain basement program. The $1.5 to $2 billion which would be needed in FY 1961 is only the first payment. The total price tag would be from $5 billion up depending on how much protection the government wants to buy.

Also, unfortunately *Zeus* is no absolute defense. Therefore, the question arises: Can you buy more defense with $5 or $10 billion by putting your money in more offensive weapons such as ICBM's, *Polaris* submarines and intercontinental bombers.

The Army says no. It says we have enough offensive power planned and in existence. But it says that if the United States is without *Zeus* it will be wide open to Soviet ICBM attack. Moreover, the price of admission will be kept cheap: The Russians will not be forced into improving their ICBM's and will be able to devote the effort to other weapons.

Therefore, some top ranking Army officers feel—although others disagree—that *Zeus* is so vital to American defense that the money for it must be found at almost any sacrifice.

As one official put it: "We could lose an entire Army and it would be a



ONE OF Army's advanced missile projects is nuclear-tipped *Davy Crockett*, shown in artist's conception. Money is lacking to push development of this and other weapons.

great disaster. But we could recover as a nation. But if we are attacked by a large number of ICBM's and have no defense against them we could cease to exist."

If you buy this argument—and it's a tough one to fight—you come directly back to the earthy question of who is going to pick up the bill. Even a casual study of the defense budget makes clear that the billions needed must either come out of the hide of some other program or from a very unlikely budget increase.

This leads directly to the Army's third big problem area: The needed modernization of its scanty divisions to meet the requirements of missile and nuclear warfare.

The Army has not been able to come anywhere near to effecting such a program for lack of funds. It contends it needs millions of dollars more for R&D work on tactical missiles and for their procurement.

Because of funding shortages the Army has been forced to drag out to great lengths the time between development of these relatively short-range missiles and other new equipment and placing them in the hands of large numbers of troops.

At the same time, there is no question that lack of funds has slowed R&D work on the next generation of tactical missiles that will be needed in the mid and late 1960's.

The Army 1960 budget as submitted to Congress originally called for $407 million for procurement of missiles including such newer, advanced weapons as **Martin's** *Pershing* and *Lacrosse* and the **Jet Propulsion Lab/ Sperry Rand** *Sergeant*.

Congress, at least mildly appalled by the lack of speed in procurement of newer weapons, gave the Army an extra $146 million for procurement of equipment including missiles. How much of this money will ever be released to the Army by the Administration is open to question. And, even if the Army were to get it, still more was considered needed and will be again for 1961.

The same thing is true for R&D. Congress gave the Army $1.05 billion —exactly what the budget called for. This includes insufficient funds for development of such advanced missiles as *Davy Crockett* and **Convair's** *Redeye*. And even less for work on the third generation missiles beyond them.

These are the missiles that the Army is depending on to give its divisions the tremendous punch that would be necessary to stand up to the much larger Red forces in any limited war.

For example, nuclear-tipped *Davy Crockett*—an in-house project at Rock Island Arsenal—is designed to be fired from a bazooka tube. The sub-kiloton warheads will vastly increase the firepower of the infantryman.

Convair's *Lobber* is another good example of an advanced weapon that is much needed. The missile, for which no funds at all are available, can serve as both a carrier of cargo or napalm.

It is most significant that these funding shortages are not confined to missiles, but run the whole gamut of weaponry. Among some of the most notable skimping is in the field of tanks. Russia today is producing five times as many tanks as the United States each year. In fact, Russia is reported to give its satellites as many tanks each year as are produced in the United States.

Of course, it is against the yardstick of what the Russians are doing that American military power must be measured in the end. Unhappily, the Russians are doing much. Army intelligence says that Russia has completely modernized equipment for its 175 line divisions. These divisions are equipped for fighting either nuclear or non-nuclear wars.

The United States has 14 divisions—most of them incompletely modernized.

Torn by these problems, faced with shrinking dollars, the Army is confronted with far-reaching decisions on these problems as the annual budget battle in the Pentagon nears its height.

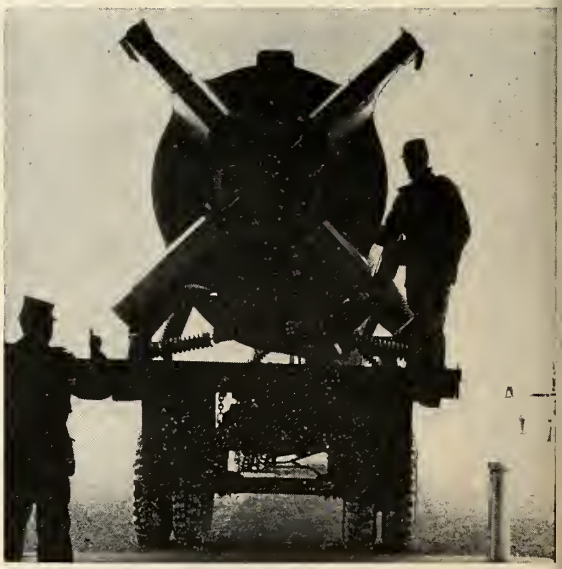
The Army has a capability in the space business. The Army sees *Zeus* as vital to national survival. The Army feels that the development and procurement of its own tactical missiles and other equipment is a burning, overdue necessity.

But somewhere something must give sooner or later under the present situation.

Possibly the Army in the end may accept an exit from space in favor of its sister services as a way out. Possibly it might receive in exchange from the Defense Department other considerations. Dollars, for instance.



ARMY wants to develop Convair's *Lobber* to deliver cargo or carry napalm. So far, no funds are available for the bird.



TWO Army groups armed with *Redstone* are on guard overseas. But the service lacks money to proceed with modernization.

Pressing R&D on Refractory Metals

Hundreds of firms are blazing new trails with the heat-resistant materials that promise to answer many big missile-space problems

by S. David Pursglove

WASHINGTON—One of the nation's top missile research efforts is in refractory metals. These are metals distinguished primarily by extremely high melting points. They range from chromium with a melting point of 3430°F to tungsten, which melts at 6170°F. In between are zirconium (3360), niobium, columbium, (4380), molybdenum (4760), and tantalum (5425).

Some chemists, physicists and metallurgists—the primary researchers on refractory metals—also include beryllium (2340), titanium (3020), and vanadium (3450).

Not all metals so classified by melting point are useful refractory materials. Some are too reactive. Some become too brittle. Others are too scarce to merit extensive research that would lead only to demands that cannot be met.

Refractory metals are called the answer to our major space and missile problems. But the metals themselves have some problems that must be solved before they can go to work for us. Research now is directed toward reducing costs, making the almost unmanageable metals easier to handle and fabricate, and devising alloys that bring out the metals' best features. Refractory metals are the subjects of large amounts of basic research. We need to know more about their properties, why they behave as they do (often in very strange ways), and what happens under various conditions.

Wherever refractory metals yield to research effort, scientists, industrialists, and military planners see new horizons beyond what they had thought were natural limits. Refractory metals must have these important qualities.

- They retain their strength at high temperatures.
- They resist oxidation at high temperatures.
- They resist corrosion.

This means that refractory metals can make possible aircraft and missile flight at hypersonic speeds that breed ultrahigh temperatures. It means great increases in specific impulse of conventional fuels may be had, since the hydrogen contained in all these chemical fuels (including kerosene) dissociates above 5000°F—a temperature and effect impossible to achieve with ordinary metals. This means that important, but corrosive, chemicals may be used more readily.

Hundreds of firms—industrial and research, profit-making and institutional—are engaged in refractory metals research.

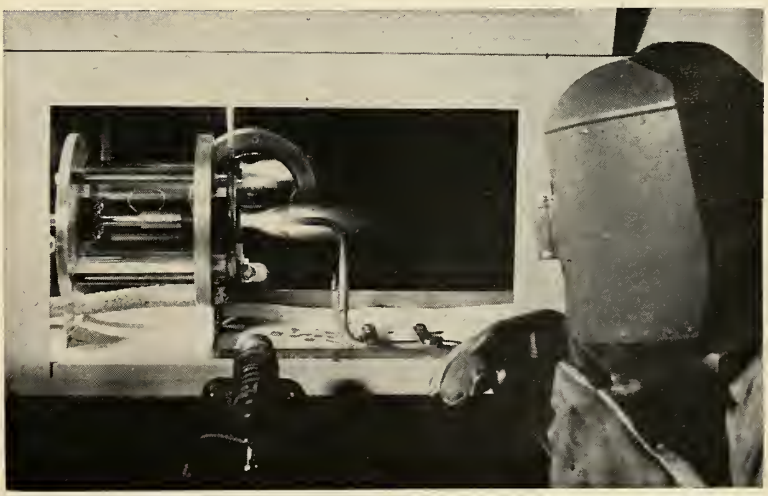
Research organizations blazing new trails include **Arthur D. Little, Atlantic Research Corp., Battelle Memorial Institute, Stanford Research Institute, Armour Research Foundation, National Research Corp.**

National Aeronautics and Space Administration, Department of Defense, National Bureau of Standards, and the Bureau of Mines are some of the government agencies engaged in some phase of research or development work on the metals.

Private firms working on refractory metals include most of the metals companies, many chemical companies, aircraft firms and missile prime contractors, and several companies that specialize in refractory metals. The latter group includes **Wah Chang, Alloyd, Nuclear Corp., Union Carbide Metals, Beryllium Corp., Brush Beryllium Co., Nuclear Metals, Fansteel Metallurgical** and **Titanium Metals Corp. of America.**

Here is what some companies are doing, at a glance:

- **Marquardt Aircraft** is developing and testing sheet metal structures, particularly those fabricated from molybdenum.
- **North American Aviation** is working with two new compounds that will improve processing of titanium and steel alloys. One compound inhibits formation of scale on stainless steel, nickel-chrome, and alloys of cobalt, titanium, and copper during heat treatment. The other compound prevents



PLASMA JET of ionized air, hotter than the surface of the sun, disintegrates a small aircraft model at NASA's Lewis Research Center, site of much metals research.

gaseous contamination of titanium undergoing heat treatment in an air atmosphere.

• Nuclear Metals is developing casting techniques for beryllium alloys, techniques for working beryllium and zirconium, and extrusion data on most refractories.

• Nuclear Corp. of America is taking a quantitative look at a long-known misch metal phenomenon. Years ago, metallurgists discovered that small amounts of misch metal—mixed rare earths—increased the performance of steels. Later, the same was discovered to be true in the case of some refractory metals. Now, Nuclear Corp. is trying to determine which single ingredient in misch metal is the responsible agent. So far, it looks like the hero is neodymium. And there might even be a villain: cerium. Neodymium alone increases the desirable properties much more than does the misch metal mixture. Cerium seems to decrease creep resistance.

• Alloyd Research is streamlining old processes for vapor phase deposition of tungsten, molybdenum, and chromium on metal and even nonmetal surfaces.

• Fansteel Metallurgical is doing further work on its methods for spinning and drawing larger tungsten pieces.

• **Douglas Aircraft** is conducting basic and applied research in high temperature areas on tungsten, molybdenum, and niobium. Special interest is in niobium alloys for ultra-high temperature leading edges of high velocity aircraft and missiles.

• **Du Pont** is building a center for development research in niobium, niobium alloys and titanium at its Baltimore plant, to be completed in 1960. The center also will have facilities for work with other refractories.

• **National Research Corp.,** Cambridge, Mass., is investigating tantalum and tantalum-tungsten alloys. One promising Ta-W alloy has three times the tensile strength of Ta at 4000°F and is easily fabricated.

• **Bell Aircraft Corp.** is studying refractory metals as candidates for use in the leading edge of *Dyna-Soar* (M/R Aug. 3, page 24).

• **Sylvania Electric Products Inc.** is expanding production of molybdenum, tungsten and other refractories at its Towanda, Pa., plant. Molybdenum ingots weighing 275 pounds are now available and, with a high-temperature sintering furnace being installed, ingots weighing more than a ton will be produced this month. Until recently, tungsten and molybdenum ingots available commercially have weighed less than 100 pounds.

Here are typical comments from government agencies:

Naval Ordnance Laboratory—We are doing some work with refractory metals, but only as they apply to some of our primary projects. Bureau of Aeronautics has a strong interest in this field.

Air Force—Future weapon systems will call more and more on the refractory metals as structural materials. We shall use these metals in hypersonic strategic weapons, ballistic weapons, satellite weapons. (See M/R, July 20, p. 90, for detailed discussion.)

Army—We have a strong interest in refractory metals for rocket motors, and as structural alloys with steel.

• **NASA's work**—For a better idea of how government agencies are approaching this research, look at the program at NASA.

The civilian space agency is interested in refractory metals as a means of overcoming problems that develop at high temperatures, for use in hypersonic aircraft and missiles, and in connection with nuclear-powered vehicles. NASA also recognizes that one way to achieve higher specific impulse from fuels is to heat them above the 5000°F dissociation point of hydrogen. Refractory metals are obviously needed for the containing vessel.

NASA's principal research effort is on niobium and tungsten, with some applications studies on molybdenum structures. The latter work is conducted at Langley Research Center, Va. Actual research work is done at Lewis Research Center, Cleveland.

At Langley, NASA is studying the performance of molybdenum simulated wing panels coated wth nickel-chromium. Out of this work will come one-shot protective coatings for use on leading edges of wings and missile fins above Mach 4 or 5.

Propulsion materials engineer Harold Hessing, of NASA headquarters, says the agency's main interest in refractory metals is in connection with propulsion.

NASA and other organizations have studied niobium for a number of years. Hessing says NASA likes niobium because it has certain advantages over molybdenum: it is easier to fabricate, has better resistance to oxidation, and greater resistance to high-temperature heat transfer fluids.

NASA metallurgists see two major uses for tungsten:

• As a nuclear rocket engine material. NASA is doing some work on tungsten, but the AEC has the primary responsibility in this field.

• As a nozzle or nozzle liner in a chemical rocket.

There are other possible future uses for tungsten, such as in ion beam propulsion and other advanced systems, but any work NASA does in this connection will be incidental to the main effort.

As an example of the immediate need for research on tungsten or other refractory metals, Hessing points to large solid rockets. As these engines become larger, graphite nozzles become inadequate. Metals added to fuels to control resonant burning form oxides that deposit on the nozzles and change their configurations.

However, because of the cost of large, complicated tungsten shapes, NASA and the military agencies are looking at tungsten not as a nozzle structural material, but as a protective coating for graphite nozzles and liner for heat sinks.

As part of its basic research effort on refractory metals, NASA recently awarded a small contract to the University of Denver to study the effect of rare earth additives on the melting of tungsten and molybdenum. If the study sheds new light on ductility, Hessing says, then it may be extended to cover other areas, such as high temperature.

Refractory Metals

Metal	Symbol	Atomic Weight	Atomic Number	Melting Point (F)	Remarks
Beryllium	Be	9.0	4	2340°	Very light; heat sink; reactor moderator.
Titanium	Ti	47.9	22	3020°	Light and strong; cheap as raw material but costly to fabricate.
Vanadium	V	50.9	23	3450°	Very expensive tool steel alloy.
Chromium	Cr	52.0	24	3430°	Retains strength, resists oxidation at high temperatures.
Zirconium	Zr	91.2	40	3360°	Reactor structural material.
Niobium (Columbium)	Nb (Cb)	92.9	41	4380°	Shows most promise; must be coated to prevent oxidation above 2500° F.
Molybdenum	Mo	95.9	42	4760°	Most widely used refractory metal; needs foolproof coating to prevent high-temperature oxidation.
Tantalum	Ta	180.8	73	5425°	Close chemical relative to niobium; higher priced but stronger.
Tungsten	W	183.9	74	6170°	Most important refractory; properties well established through experience in use for light-bulb filaments.

Here, in brief, are the refractory metals' properties:

Be, Ti, V

Beryllium, titanium, and vanadium are not always considered refractory metals since their melting points are somewhat lower than those of the clearly distinguished refractories. However, their melting points are sufficiently high and their properties are similar enough to those of such metals as chromium and molybdenum that they are included in this discussion.

Beryllium is more important as a nuclear fission moderator than as a refractory metal. Until recently its primary metallurgical use was as a hardening agent in copper alloys. Its two outstanding gifts to missiles—low density and high melting point—are offset by its chief fault: beryllium is very brittle at room temperature; it is difficult to work. However, once fabricated, beryllium shows good ductility at high temperatures.

Tonnage quantities of titanium have been available from a number of companies for several years. Titanium, as a raw material, is inexpensive. However, it is so difficult to work that the prices of finished products are too high for many otherwise ideal applications. Titanium alloys give good service in normal air up to about 1200°F. Titanium offers good strength-to-weight ratios up to about 1000°F. The largest present consumer is the aircraft industry.

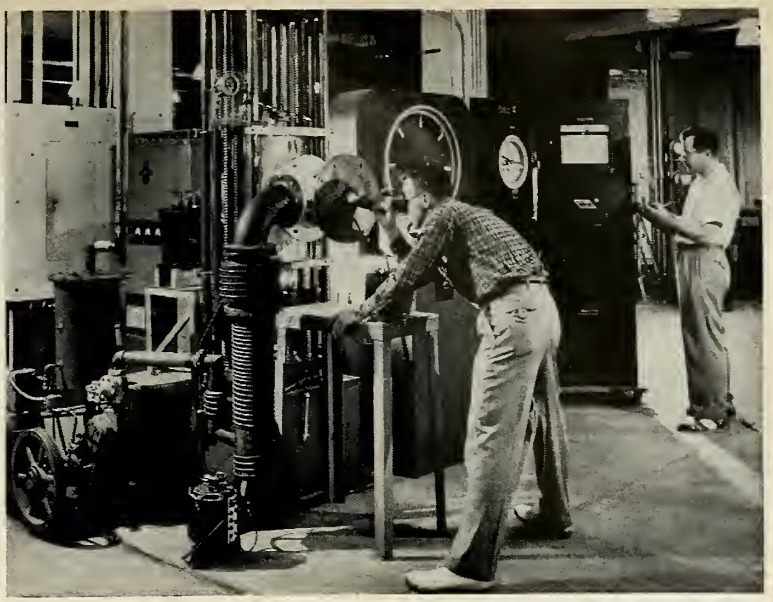
When the price of vanadium is reduced considerably from its present $80 per pound, it will find wide use as an improved replacement for stainless steel around 1700°F. It has a high melting point, is light in weight and is stable in normal air atmospheres up to about 1250°F. As important as any other feature is the fact that vanadium is easily welded.

Chromium

Chromium offers good resistance to oxidation even at very high temperatures. It maintains structural strength at high temperatures. However, nitrogen dissolved in chromium makes the metal brittle. The nitrogen can be removed on a lab scale, but no process so far is suitable to tonnage production. Chromium's major missile use is in alloys for service at 1800-2000°F. The bluish-tinged, silver-white metal is prepared either by electrolytic reduction of chromic acid in water, or by reduction of chromic oxide with aluminium. Stainless steel contains about 15% chromium.

Zirconium

The zirconium industry is well established, producing tonnage quantities for atomic energy uses. Zircalloys—dilute alloys of zirconium, tin and iron—offer the corrosion resistance needed in pressurized water reactors. Alloys for use at higher temperatures in more corrosive surroundings—as in sodium reactors—are in development stages now.



TENSILE STRENGTH of metals is tested at temperatures as high as 4000°F on this apparatus developed at Lewis lab. Results are applied to production of rockets.

Niobium

Niobium, also called columbium, joins molybdenum and tungsten as the three most important refractory metals. Already it has found wide use as an alloying material for nuclear reactor fuels, and the nation's research effort on the metal is just beginning to pick up momentum. It offers high strength at high temperatures, corrosion resistance, and is easily alloyed with many other metals. Mill-run niobium's properties vary with the production technique. However, research is underway to discover the exact factors and means of controlling them.

Niobium often is compared with molybdenum. Actually, it has certain advantages over molybdenum: lower density and greater resistance to oxidation. However, even niobium oxidizes too readily at extremely high temperatures to be used without protective coatings. It is fine up to around 2500°F.

Molybdenum

Molybdenum has been in wide use and has been produced in tonnage quantities for over a dozen years in the U.S. It is best known for its high melting point and the even higher melting points of some of its alloys. Its drawbacks are brittleness at room temperature and ease of oxidation at high temperatures. The big research problem is development of fool-proof, easy-to-apply anti-oxidation coatings. In the case of niobium, when the protective coating ruptures, the metal's strength fails slowly. However, even a tiny crack in molybdenum's protective coating leads to immediate failure of the piece at high temperatures. This calls for several separate coatings to assure absolute coverage of the surface. Sprayed or plated alternate coats of nickel and chrominum are the best bet.

Tantalum

Niobium and tantalum are sister metals, almost always occurring together in nature. Chemically they are very much alike and are therefore difficult to separate. However, tantalum has a higher melting point and is generally stronger than columbium. Despite high cost, tantalum finds many uses where corrosion is a problem.

Tungsten

Tungsten is by far today's most important refractory metal. A large industry is well established. Its properties are well defined, thanks to many years of research. It has the highest melting point and recrystallization point ("freezing point" if you please) of any metal. Its drawbacks are a high melting point that makes it extremely difficult to work with, its ease of oxidation and room temperature brittleness. Tungsten also has the highest density of any refractory metal. In some cases, this is good, but it's a drawback where weight considerations are important.

SOLARIS Might Salvage Missiles

Its designer, Vitro Laboratories, says the weird-looking undersea device could be used for a wide variety of missions at 'low' cost

by William E. Howard

WASHINGTON—Like some weird creature of the deep, the ball-shaped "fish" with a mechanical claw bolted to its belly glides silently through the sea. Depth: 1900 feet.

A pair of lights projecting from metal arms pierce the total darkness, illuminating a patch of ocean floor. Positioned between the lights in a pressure case, the unwinking eye of a small television camera stares glassily downward, hunting.

A small squid foraging on the bottom is caught in the light for a moment and quickly scuttles into familiar darkness.

Suddenly the "fish" stops. Twin hydraulically driven propellers mounted on the upper side keep it hovering in the current. Just below, half-buried in the mud, the light plays over the first-stage booster of a big *Saturn* space vehicle.

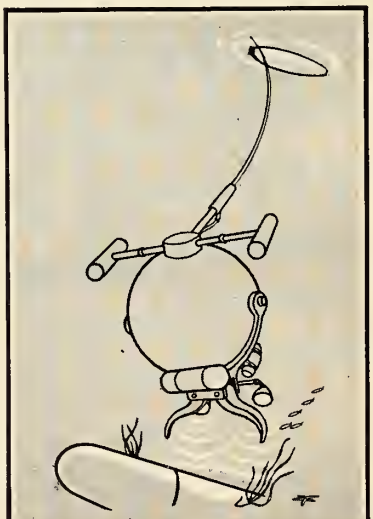
Slowly, the "fish" descends on the booster; the claw opens and then closes over an engine cluster support ring. At the touch of a switch by a console operator aboard a surface ship, a shipboard winch whines into action and the "fish" holding its catch is reeled in by a steel cable.

• **Exploration and detection**—Salvaging valuable rocket boosters in this manner is but one of many missile support and undersea applications of the remotely controlled SOLARIS (submerged object locating and retrieving/-identification system) now being developed by **Vitro Laboratories,** Silver Spring, Md., a division of **Vitro Corp. of America.**

The system has a wide range of peaceful, as well as military uses. Ultimately it may be a key to gaining important knowledge about the vast unexplored regions of the sea.

Designed originally by Vitro to retrieve valuable experimental torpedoes and mines being developed for the Navy, more applications are being visualized for SOLARIS every day. Equipped with sonar, it could be used to sweep wide areas of the sea to detect hostile submarines (M/R Aug. 10, p. 24).

The TV "eye" will permit finding and recovery of missile nose cones and underwater cables, and placing and observing the effects of explosive charges. It can inspect ship bottoms, bridge pilings, river channels and bouys; survey and clear harbors of obstacles and assist the work of divers.



SOLARIS retrieving system in operation could recover missile nose cones.

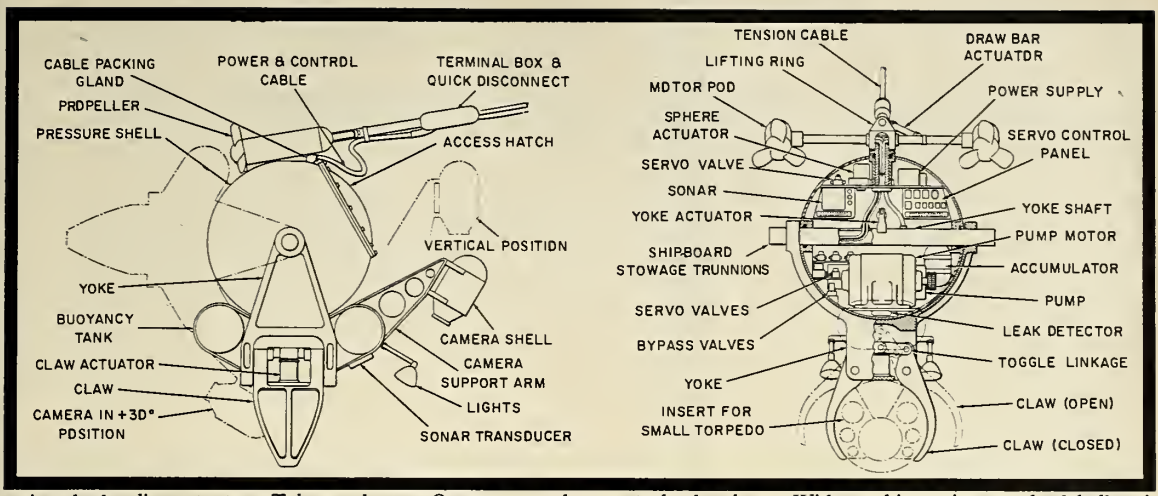
As presently conceived, the system is capable of hauling to the surface loads up to 5000 pounds weight in water. At 1200 feet SOLARIS can search a semicircular area 250,000 yards square—without moving the controlling surface vessel.

The device comes with a number of specialized attachments. One—an over-center toggle action claw—is designed to clamp around cylindrical surfaces, like nose cones of known diameter, without crushing them. Another special claw is intended specifically for cable maintenance. There are special attachments for placing explosive charges and for a stud gun to fix the device to an object. The general purpose claw can grasp a wide variety of objects. Servo control of the actuating cylinder allows varying pressure to be applied.

• **Wire-guided history**—Maker of the *Mark 39* wire-guided torpedo—an ASW weapon—Vitro says SOLARIS is a "logical development" of another (classified) underwater vehicle which it has made for the Navy, which employs a "television camera for positive identification of underwater objects."

Control of SOLARIS is by means of a power cable which pays out along with the steel support cable. The power cable contains two co-axial TV cables, conductors, and signal, control and power leads.

Motive power for the sphere, which is 42″ in diameter, is provided by an electrically powered hydraulic pump. This drives a pair of propellers mounted in pods on the ends of a transverse tube at the top of the sphere. A drawbar, to which the cables are attached, pivots laterally about the center of this tube. It is controlled by a double



acting hydraulic actuator. Tube and drawbar remain at right angles to each other except when steering to the left or right.

The propeller pods rotate individually about the tube in parallel vertical planes, enabling the propellers to thrust upward, down or forward. System stability is obtained by balancing vehicle drag and cable tension against thrust. A slight change in thrust angle is sufficient to move the vehicle slowly in the direction of the unbalanced force component, according to Vitro. And greater changes in thrust angle allow the vehicle to maneuver quickly in any direction. Distance limits are controlled by the winch paying out cable.

• **Sphere detail**—The sphere hangs vertically and is free to rotate about the propulsion and control assembly. Fabricated of 6061-T6 aluminum alloy, the sphere is formed in two hemispheres welded together. It has a 22″ watertight hatch for interior access. Shell thickness is 0.45″ for 2000′ depth.

A 15 horsepower electric motor located in the bottom of the sphere drives a 3000 psi hydraulic pump at a flow rate of 8 gallons per minute. The pump supplies all the mechanical power for propulsion and the control of the vehicle and its accessories. An accumulator provides extra capacity during cylinder actuation. Seven servo valves and an electric by-pass valve control the flow to motors and actuators.

One servo valve controls the flow to propulsion motors, and regulates thrust. The motors use 7 gallons per minute at the maximum of 10 horsepower, leaving 1¾ horsepower available for control actuation. Two servo valves individually control the vertical plane thrust angle of the propellers.

One servo valve controls drawbar angle and, thus, the thrust angle in the lateral plane. Two more servo valves control rotation of the sphere and the pitch angle of the claw accessories and the television camera assembly. A seventh servo is available for actuation of the accessory device. An electric bypass valve frees the attachment positioning actuators after securing the object, insuring that the attachment and its load do not disturb the stability of the vehicle.

In addition, the sphere contains a leak detector and a depth measuring sonar. Built into the sphere is 100 pounds reserve buoyancy for various special equipment which may be added.



VEHICLE retrieving a missile booster engine with its mechanical "claw."

Without this equipment, lead ballast is added to preserve the sphere's 50 pounds net positive buoyancy.

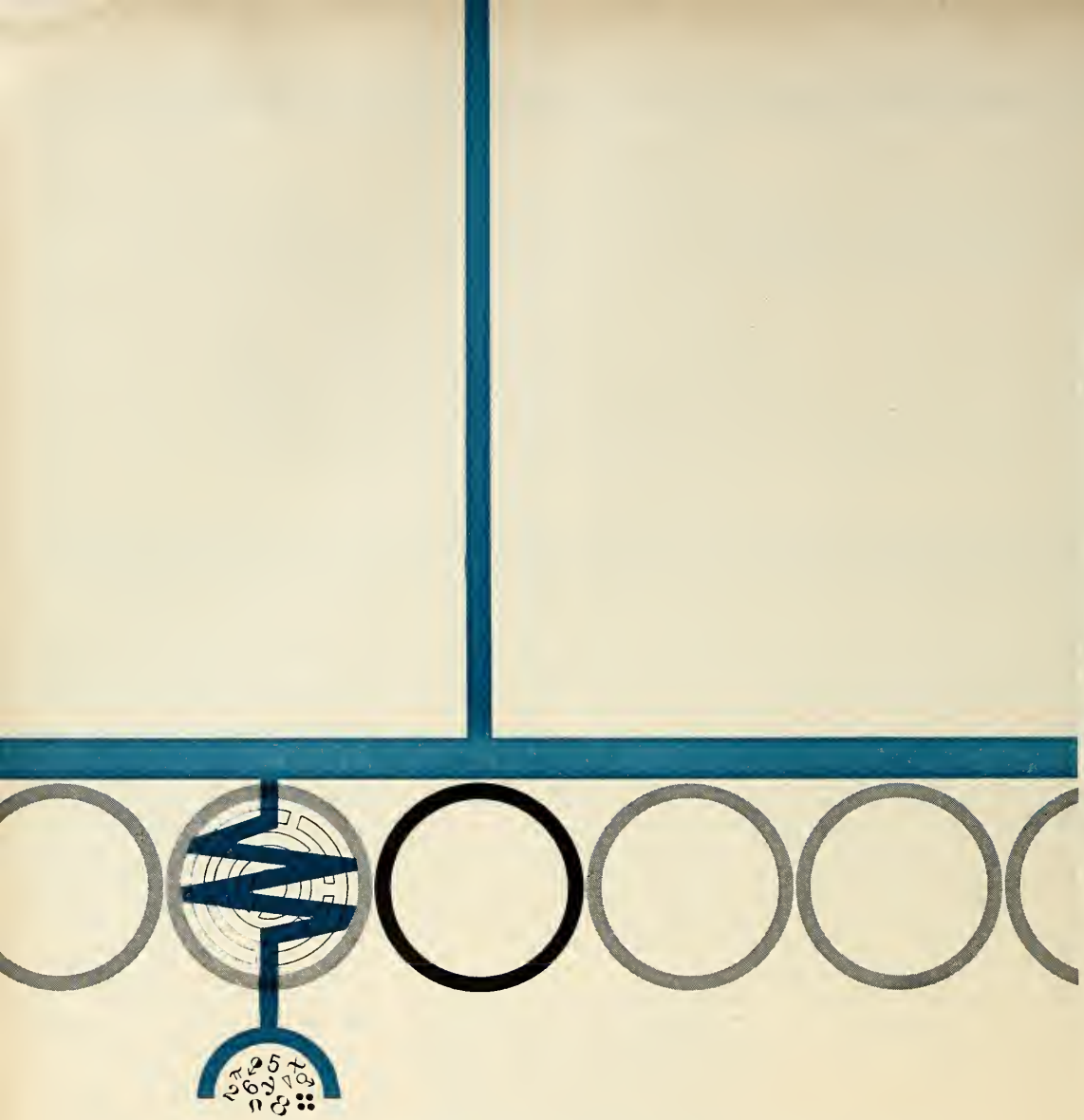
• **Closed circuit TV**—For normal salvage and inspection work, Vitro says a Dage Model 60-BR television camera is satisfactory for depths up to 1200′ further down an image-orthicon camera would be preferable.

Power supply for the camera and 1000-watt diving lamps is located inside the sphere and operates from a 600-volt power line. The camera is mounted in a pressure vessel on a rigid boom attached to the yoke in a position to center its field of view through, and a little below, the jaws of the accessories.

The 400-pound console, measuring 5x3x4½′, displays information on the vehicle's heading, depth, height above bottom, claw azimuth, claw pitch angle, propeller rpm, illuminating current, and time on lights; there is a monitor screen for the closed-circuit television. It also gives information on winch speed, motor current and the amount of cable paid out, as well as temperature, voltage and current of the power supply.

Two hydraulic winches with hydraulic drive handle the power cable and support cable individually. The support cable winch is controlled by the operator and the power cable winch is slaved to it by a constant tension clutch driven a 10% slippage.

In comparison to other systems designed for the same purpose, Vitro says SOLARIS offers greater speed, compactness and versatility. And although the price of one is not disclosed, the company says initial and operating costs for the system are "low."



COMPUTATION ATTUNED TO TEAMWORK

TAKES A LOT OF PUSH IN THE RIGHT PLACES TO PUT A PROGRAM INTO SPACE. BURROUGHS COR
ATION CONCENTRATES ON COMPUTATION—EVERY PHASE FROM BASIC RESEARCH THROU
RODUCTION TO FIELD SERVICE. APPLY IT TO A TEAM AND THINGS HAPPEN. FOR BURROUG
ORPORATION HAS THE PROVED COMPETENCE TO MAINTAIN THE INTERFACING RELATIONSHIPS A
ITERTEAM COMMUNICATIONS THAT ACHIEVE SPACE OBJECTIVES COMPATIBLY AND EFFICIENTLY.

Burroughs

Burroughs Corporation

"NEW DIMENSIONS | in computation for military systems"

The Capital's Top Private Industry

Area's R&D firms double in five years to provide much of the brains for production done elsewhere —last of a series on Middle Atlantic area

by William E. Howard

WASHINGTON—Around the Nation's Capital the saying goes: "You can hardly swing a cat downtown without hitting a Ph.D."

Since it is the pivotal nerve center for the nation's entire defense program, it isn't surprising that the town is aswarm with scientists. Thousands have been uprooted from distant college laboratories and are now working for the government in the great post-*Sputnik* proliferation of missile and space agencies. Hundreds more from industry pass through daily on Pentagon and Capitol Hill missions.

But what does astonish many a blasé Washingtonian is something which has become apparent only recently. Very quietly—and suddenly—the city's metropolitan area has turned into one of the country's major *private* research and development centers. Although it may be small next to the mammoth federal government establishment, nevertheless this missile/space R&D activity is the area's Number One private industry.

Realization of this important new addition to the local economy has come with a just-completed nose count by the Washington Board of Trade, which reports that as of today there are 128 of these enterprises—double the number five years ago. This year alone four new ones have gone into business; last year 17 were added.

These companies have a combined annual sales volume estimated at well over $200 million. They employ 16,000 persons—most of them engineers and scientists. And there are thousands of scientists working for such government agencies around town as the Naval Research Laboratory, Naval Ordnance Laboratory, Naval Weapons plant, Diamond Ordnance Fuze Laboratories, Corps of Engineers Research and Development Laboratories and the National Bureau of Standards.



STARS show areas of concentration of R&D work in the capital and its suburbs.

All this new activity, says the Board of Trade, has made Washington the country's fifth largest scientific community in overall size and "first in the number of scientific and professional personnel per 1000 population."

• **Missile manufacturing**—Proximity to the Pentagon is one main reason for the upswing in private laboratories and highly specialized small companies. But there are other contributing factors, such as a broad scientific community existing in the area's colleges and universities and a wealth of engineering talent that has been attracted by the cultural advantages of a large metropolis.

Moreover, Washington is located in the middle of the lower mid-Atlantic's busy missile manufacturing region extending all the way from Wilmington, Del., to Norfolk, Va. Hundreds of big and small companies scattered along this seaboard section are heavily engaged in missile manufacture. Many of them are working hand-in-hand with Washington R&D firms.

Total missile-related manufacturing for the entire area is estimated at over $1 billion and total employment in the field is well over 100,000.

As some Washington experts point out, the area's R&D firms are providing much of the brains for the production brawn being carried on nearby and elsewhere across the country. A notable instance is the Navy's family *of Tartar, Terrier* and *Talos* shipboard missiles.

The Applied Physics Laboratory of Johns Hopkins University, developer of the anti-aircraft shell proximity fuze, is in charge of the technical direction of the entire program for all three missiles. **Vitro Laboratories,** a division of Vitro Corp. of America, which has a plant not far from APL in Silver Spring, Md., is in charge of systems engineering the three surface-to-air weapons for BuOrd.

A rundown of contractors for *Talos* shows **Allegany Ballistics Laboratory,** Cumberland, Md., prime for propulsion design, development and pilot production; Naval Ordnance Laboratory prime for warhead design; launchers made by the Naval Weapons plant; fuze by **Melpar Inc.,** Falls Church, Va.; warhead fabrication by the **ERCO Division, ACF Industries,** Riverdale, Md.; and boosters by the Naval Propellant Plant, Indian Head, Md. NOL and the Naval Weapons plant also are providing warhead design and launchers for *Terrier* and *Tartar.*

• **Martin's** *Mace*—Biggest concentration of missile manufacturing in the area is at Baltimore, where **The Martin Co.** is prime contracting the Tactical Air Command's surface-to-surface *Mace.* The Baltimore operation is also supporting **Martin-Orlando** in the production of *Bullpup* and *Lacrosse* and the *Titan* ICBM program at Denver.

Following Navy cancellation Aug. 22 of its Seamaster contract, with a layoff of 3000 employes, most of Martin's 14,000 employes now are working on missiles. Baltimore division missile sales are running at $500 million a year with a payroll of $56 million.

Martin leads area contractors . . .

Martin has hundreds of subcontractors nearby. The Naval Propellant Plant provides propellant loading for Martin's air-to-surface Navy *Bullpup*. *Bullpup* power supply is being made by **Catalyst Research Corp.**, Baltimore. In Virginia, the Navy Proving Ground at Dahlgren developed the missile's warhead design and the naval Weapons Station at Yorktown is loading the high-explosive warhead.

At Baltimore's Friendship Airport, **Westinghouse Electric Corp.'s** Air Arm and Electronics Divisions and Ordnance Division, Lansdowne, employ around 6000 persons in production of missile guidance and control systems and in development of underwater missiles, including the Navy's nuclear-tipped *Astor* torpedo. The Air Arm is principal subcontractor for the Air Force *Bomarc* homing radar flight control.

• **Delaware's duPont**—Much of the basic material, like Teflon, and chemicals which go into the production of components for today's advanced missile and space systems is produced at the huge **E. I. duPont de Nemours** plant in Wilmington. The company has a large campus-style research headquarters where hundreds of scientists are conducting basic research into "exotic" new compounds.

Another big employer in Wilmington is **Hercules Powder Co.**, which has a NASA contract to produce third and fourth stages for the solid-propelled *Scout* space vehicle. The company also is working on propulsion for the solid-fueled **Boeing** *Minuteman* ICBM.

Hercules in addition runs the Radford Arsenal, Radford, Va., which makes JATOS for *Nike-Hercules* and motors for the Army's *Honest John* and *Little John*.

• **From $15 to $29**—Typical in some ways, but highly unusual in others, is the story of **Atlantic Research Corp.**, just across the Potomac from Washington in Alexandria, Va. In 1949, Arch Scurlock and Arthur Sloan left the Office of Naval Research and with $1000 capital opened a laboratory in a warehouse.

Now, a decade later, they have more than 600 employes and contracts running into the millions on a score of highly complex missile/space projects. ARC is one of the leaders in solid-propellant rocketry and is the builder of the *Arcas* atmospheric sounding rocket. On June 30, just before the opening of a new $1 million building, ARC made a public offering of 100,000 shares of stock. Space-conscious local investors quickly snapped it up at $15 a share and drove the price the same day to $29. It is now selling for $34.

Five years ago two former Bureau of Standards scientists sold **Emerson Radio & Phonograph** on starting a research laboratory. Today Emerson Research Laboratories in Silver Spring, Md., is making the target detection device for the Navy's *Corvus*. It has nearly 400 employes and a $4 million-a-year operation.

Vitro Laboratories, which is hard at work in the anti-submarine warfare area, expects sales to hit $7 million this year—up 10% from last year—and now has nearly 700 employes.

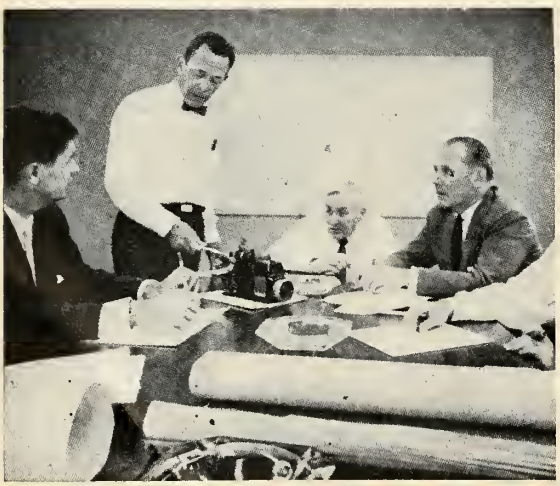
Melpar Inc. is the Washington area's biggest private employer—with 5000 skilled technicians and scientists making electronic equipment. Its products go into *Talos*, *Atlas* and *Jupiter* missiles in addition to space vehicles.

Other suburban Maryland R&D companies which are growing rapidly include **Washington Technological Associates,** which is developing the automatic strikedown and mating system for *Talos*, and **Systems Planning and Research Corp.**—in the same building—which is developing an advanced range instrumentation system for the White Sands Army Missile Range. There are others like **Airtronic Inc., Advanced Research Associates Inc., American Instrument, Andromeda Inc.,** and **Robinow Engineering.**

Applied Physics Laboratory was founded by Johns Hopkins during World War II and succeeded within two years—from late 1940 until late 1942—in developing the antiaircraft proximity fuse. It now has 1300 employes—525 of them engineers and scientists.

Right in the District of Columbia there are many more. **Page Communications Inc.**, a subsidiary of **Northrop Corp.**, has just won a $10 million contract for a 1700-mile troposcatter Air Force communications complex in western Europe. **Wellings-Reed Inc.**, is working on astronautic systems and missiles and **Spacetronics Inc.** is designing spacecraft and air cushion vehicles.

• **And Richmond, too**—Much of the recent dramatic growth in missile/space R&D has taken place in Virginia. While a large portion of the new industry has tended to congregate in Fairfax County and Alexandria within sight of



EXPERTS AT Washington Technological Associates—one member of area's R&D community—work on missile support.



TWO OF the Nation's guided missile cruisers, USS Boston and USS Canberra, side by side at Norfolk Navy shipyard.

the Pentagon, many more firms are spreading out across the state.

A survey by the State Division of Industrial Development shows that Fairfax County (Melpar, Atlantic Research, etc.) is the state's leading missile and electronics center with a total of 15 firms in the field. Other centers—chiefly in electronics—are Norfolk, Richmond, Lynchburg, Roanoke and Charlottesville.

General Electric Co. has plants in Lynchburg, Roanoke and Waynesboro. The company employes 1000 in communications equipment production at Lynchburg, which is tied in with GE-Syracuse, N.Y., on troposcatter systems.

At Richmond one of the big missile age employers is **Reynolds Metals Co.,** with 1400. The company produces aluminum extrusions and a sheet aluminum foil laminate with duPont "Mylar" film which was used to make the 12-foot inflatable satellite which NASA tried unsuccessfully to orbit earlier this month. Another is **Robertshaw-Fulton Controls,** with annual sales running at the rate of $80 million.

Experiment Inc., recently acquired by **Texaco,** has been designing ramjet engines since 1945. It built and flight tested the first monopropellant ram-rocket propulsion system in 1954. Today it has about 110 employes and a missile R&D sales volume of approximately $1.3 million. Producing missile tracking photographic equipment is **Flight Research Inc.,** with 50 employes.

Dominating the Virginia defense installation picture is Norfolk—home of the biggest concentration of naval power in the world. At the **Newport News Shipbuilding and Dry Dock Co.** four fleet ballistic missile *Polaris* submarines are being built. The yard on July 1 was awarded a $63 million contract for two of the subs of the Ethan Allen class.

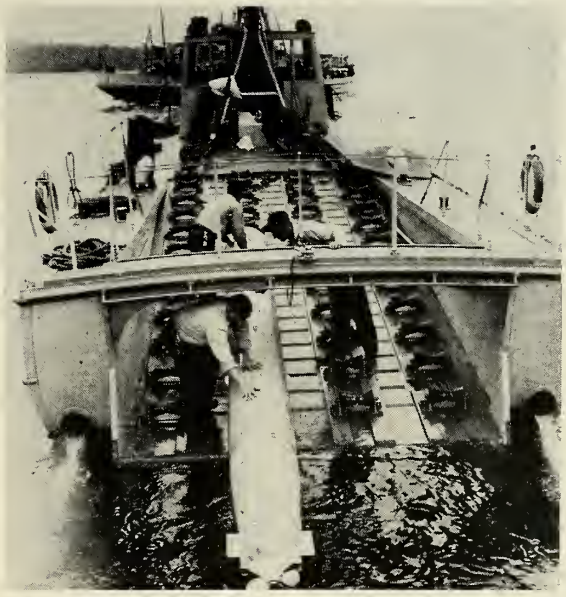
At the naval shipyard, warships are undergoing conversion to missiles. Some 35,000 civilians are employed by the Navy at Norfolk and the city is home base for 100,000 men of the Atlantic fleet and another 50,000 on shore duty. This year the Navy will spend about $800 million in maintaining its Norfolk facility.

Included in this amount will be the operation of the Navy Missile School at Dam Neck just outside of Norfolk where seamen and officers are learning how to shoot *Polaris, Talos* and other birds.

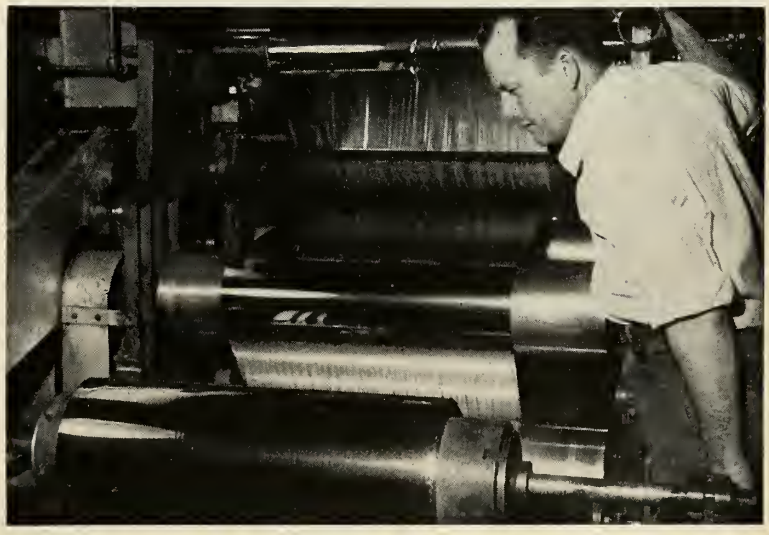
Topping off the state's new-found role in the Space Age are NASA's high-altitude experimentation station at Wallops Island, and Langley Field—where the nation's first astronauts are in training for a ride in the *Mercury* space capsule.



ACROSS Potomac River in Alexandria, Va., is new $1 million building of the Atlantic Research Corp., which doubles in research work and *Arcas* rocket production.



U.S. NAVY retriever recovers an *ASTOR* torpedo, in development by Westinghouse Ordnance Division, Lansdowne, Maryland.



ALUMINUM foil and plastic skin for the 12-foot inflatable satellite which NASA tried unsuccessfully to orbit this month was produced by Reynolds Metals, Richmond.

NEWS IS HAPPENIN



NOW IN THE AIR–NORTHROP'S N-156F FREEDOM FIGHTER– HIGH-PERFORMANCE TWIN JET THAT DELIVERS MORE FIGHT PER DOLLAR

Successful flight tests prove the high performance of the N-156F. Created especially to fit the specific tactical and economic requirements of the Free World, the N-156F Freedom Fighter is a multi-purpose weapon system. It offers total combat effectiveness–more fight per defense budget dollar–than any other American front-line fighter. The N-156F costs far less to buy, to fly, to maintain, and can be produced outside the U to aid the economies of those countries it will defend. T Freedom Fighter typifies the years-ahead thinking of Northr Corporation and all of its Divisions. The Corporation's conti ing goal: design concepts for tomorrow, hardware for today developed, produced, delivered on time – and at minimum co

NORTHROP CORPORATION *Beverly Hills, California*

AT NORTHROP



NEWS FROM OTHER MEMBERS OF THE NORTHROP FAMILY



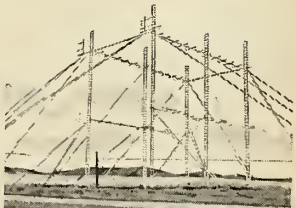
ORAIR produces airframes, ce vehicles and weapon sys- ns. In production: Snark SM-62 l the T-38 Talon, first low-cost, h-performance twin-jet to in America's space age airmen.



NORTRONICS makes news with America's 2 most advanced inertial and astronertial guidance systems, LINS and A-5 – is also a leader in automatic test equipment and mechanical ground support.



RADIOPLANE, foremost producer of drones and space age recovery systems, is delivering unmanned aircraft that train men, evaluate today's weapon systems, and fly on surveillance missions.



PAGE Communications Engineers, the leading authority in worldwide telecommunications, is currently employing these advanced techniques to plan and set up networks throughout the Free World.

The Case for Manned Lunar Flight

NASA officials, speaking for themselves, argue that man can accomplish more than instruments and outline plans for flight direct to moon

LONDON—Two NASA scientists are taking exception to the general scientific philosophy that early lunar exploration should be undertaken by instruments rather than man.

In a paper to be delivered at the 10th annual Congress of the International Astronautical Federation which opens here this week, the scientists—M. W. Rosen and F. C. Schwenk—contend that it is historically and economically unsound to limit early exploration to instrument probes. And—they say—it will be immeasurably more expensive to attempt to duplicate with instruments what could be accomplished by a few men on the moon.

Taking note that their opinions are their own and not necessarily those of NASA, Rosen and Schwenk say the importance of the simple data that instruments can collect is unjustifiably magnified. In addition, they argue, there are millions of things that instruments cannot do. They point out that no combination of mechanical or electronic devices exists that can duplicate the sensing capabilities of man—nor replace his ability to record, remember, interpret and discriminate.

Rosen and Schwenk advocate a direct flight vehicle as the most likely approach. They say an orbital rendezvous program involves accumulating in an earth orbit the required hardware and fuel for escape, landing on the moon and return to earth. While a smaller booster is required for the orbital rendezvous method, the program offers some disadvantages, they say, including the need to perfect rendezvous techniques, man the orbital station, build an equatorial launch site, and produce a number of space vehicles for one mission.

• **Design factors**—A 2½-day flight was proposed for the manned mission. The first three stages would accelerate the payload and remaining stages to an inertial velocity of 36,000 feet per second. After coasting to the vicinity of the moon, the fourth stage would lower the remainder of the vehicle to a landing. At departure, the fifth stage would propel the vehicle toward the earth, and after 2½ days, the payload would approach our planet. A sixth stage of propulsion could be used to slow the capsule to orbital speed, or the vehicle could enter the atmosphere at hyperbolic velocity.

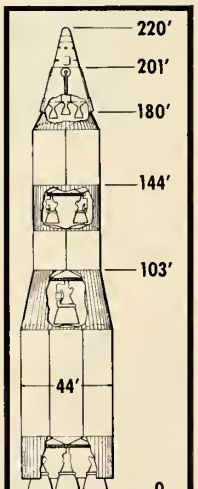
• **Propellants**—A major concern is the selection of propellants for the various stages. High-energy propellants—liquid oxygen and hydrogen—were cited as the most desirable to achieve the mission with the least vehicle gross weight. Rosen and Schwenk add, however, that this propellant combination can be used only if the necessary engines are available and the techniques for handling liquid hydrogen are developed.

For a return capsule weight of between 8000 and 9000 pounds, the vehicle at lift-off must weigh more than 4 million pounds. A sea-level thrust rating of over 6 million pounds is required. NASA is developing an engine capable of producing 1.5 million pounds of thrust with liquid oxygen and kerosene propellants. A cluster of several of these engines was cited as a logical choice for first-stage propulsion.

A hyperbolic velocity re-entry is assumed. A powered sixth stage could be employed to first slow the vehicle to orbital speed; thereupon the landing would be similar to that of NASA's Project *Mercury*. However, retro-to-orbit is a costly maneuver and its use would require a vehicle so large as to make the task of a manned lunar landing too ponderous unless nuclear or electrical propulsion schemes are considered.

• **Vehicle characteristics**—The outline drawing of a typical direct-flight vehicle shows that it stands about 220 feet high and the first stage is 48 feet in diameter. The conical portion at





AT LEFT, crewman sets out to explore the moon from the proposed direct flight vehicle, remaining stages of which will be used for return. At right, drawing of vehicle.

the top contains the landing or fourth stage, the take-off or fifth stage, and the manned capsule or payload. Upon return to the earth, the payload will weigh 8000 pounds including men, equipment, capsule, guidance and control, and parachute. Two or three men will constitute the crew.

Six engines, each of 1.5 million pounds of thrust, power the first stage. Liquid oxygen and kerosene are carried in a cluster of seven tanks, each one 16 feet in diameter. One altitude version of the 1.5 million-pound-thrust engine propels the second stage. This stage uses a cluster of four 16-foot-diameter tanks. The high-energy third stage also consists of a cluster of four of these 16-foot tanks and a thrust level of 600,000 pounds is produced by four engines.

The fourth, or landing stage utilizes high-energy propellants with throttleable engines to provide variations of thrust for the landing maneuver. The landing stage must be able to hover while the pilot makes his final choice of a landing spot. Approximately one minute of maneuvering or hovering time is provided. Retracted landing legs appear on the side of the fourth stage. When extended for landing, the legs span a distance of 40 feet for purposes of stability.

The fifth stage is placed in a cylindrical tube that pierces the tankage of the landing stage. At take-off from the moon, the fifth stage slides out of the landing vehicle on rollers. This arrangement was chosen because it presents a vehicle with a low center of gravity, reducing any tendency for the vehicle to topple on the surface of the moon. In addition, the propellant tanks of the spent landing stage which surround the fifth stage serve as meteor bumpers and shielding against thermal radiation. Furthermore, no landing loads are transmitted through the return stage, thus minimizing the danger of a rough landing.

• **Two-story capsule**—The manned capsule is an enlarged version of the one used in Project *Mercury*. It is a truncated cone, with a maximum diameter of 12 feet and a height of 14 feet. Inside the capsule, two levels are provided. The lower level contains contoured couches for the crew, controls, communications, and a folding air-lock for use on the moon. The upper level contains food, power supply, exploration gear, and work space.

The outer surface of the capsule is covered with ablative material for insulation against and removal of heat generated during atmospheric re-entry.

• **Guidance systems**—Guidance requirements normally are divided into three phases: initial, mid-course, and terminal. For this mission, these three functions must be provided for both the moon-bound and the earth-bound trips. In addition, the pilot's capabilities in performing major guidance tasks or in monitoring an automatic system are considered. An unmanned return vehicle—a spare—should be placed on the moon prior to the manned flights to provide an escape route should the manned vehicle be damaged upon landing.

The initial guidance phase from launch to earth-escape can be accomplished with sufficient accuracy by inertial systems now under development. Mid-course guidance by means of earth-based radio can direct the vehicle to an accuracy of 50 miles for a lunar impact trajectory. The terminal phase involves the final approach to the moon and the luncar-landing. These maneuvers require vehicle-contained guidance; however, lunar-based radio beacons will assist.

A combination radar-optical system will sense altitude and velocity components relative to the lunar surface. In all but the initial guidance phase (during launching), the pilot can effectively monitor and override the automatic system if necessary. During the mid-course phase, in particular, he can make optical observations of the lunar disk for distance and path angle measurements. The pilot will also be very effective in the final phase of the landing on the moon.

Launching from the surface of the moon will be guided by an inertial system that is aligned and calibrated by the pilot on optical sightings of stars and earth. The proper re-entry corridor in the atmosphere is reached by a combination of optical sightings from the vehicle and earth-based radio signals. During re-entry the lift of the capsule is utilized to modify the trajectory so that the vehicle follows a prescribed deceleration program and lands within the recovery area. The first phase of the re-entry maneuver will utilize vehicle-contained guidance monitored from the earth. After the initial slow down to orbital speeds, earth-based radar in the landing area will control the vehicle.

The mission described is based on a preliminary design study of the type conducted by many agencies to assess the feasibility of a vehicle design. All of the engines are either being developed or programmed for development in the next few years.









PROJECTED mission would include (bottom to top): launching from earth; third stage firing; approach to moon (under jet control), and fifth stage takeoff from moon.



Proceed- OPERATION EXPANSION

September 1, 1959 — Raytheon Government Equipment Division today announced a major expansion into five operating subdivisions: Submarine Signal, Airborne Electronic, Systems Management, Heavy Electronic, and Santa Barbara.

Made necessary by expanding product activity, the decentralization has created managerial and technical staff positions in all areas.

Engineers and scientists of established technical competence are invited to investigate the several opportunities present in the area encompassing their particular interest.

Inquiries should be forwarded to Mr. Donald Sweet, Engineering and Executive Placement, Government Equipment Division, Raytheon Company, 624C Worcester Road, Framingham, Mass.

H. R. OLDFIELD, JR.
Vice President & General Manager
Government Equipment Division

GOVERNMENT EQUIPMENT DIVISION

RAYTHEON
EXCELLENCE IN ELECTRONICS

SUBMARINE SIGNAL | AIRBORNE ELECTRONIC | SYSTEMS MANAGEMENT | HEAVY ELECTRONIC | SANTA BARBARA



UBMARINE SIGNAL

rt, Rhode Island
ers Hamel,
Manager

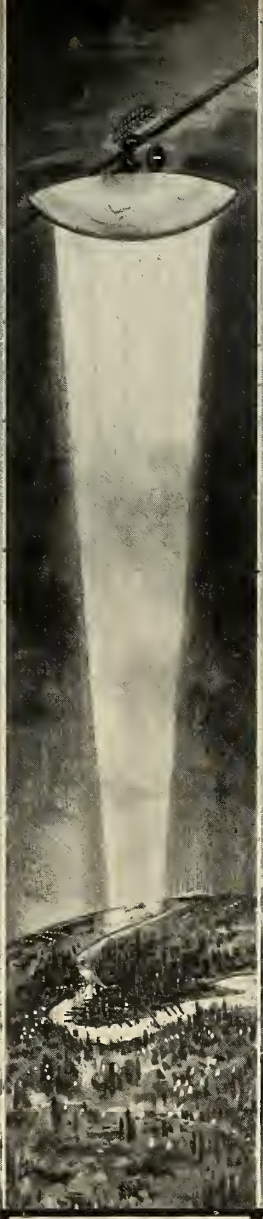
ering, Marketing, roduction of com- ensive anti- rine warfare sys- Major products: water detection, tion, communica- and fire control ient.



AIRBORNE ELECTRONIC EQUIPMENT

Maynard, Sudbury, Waltham, Massachusetts
Glenn R. Lord,
General Manager

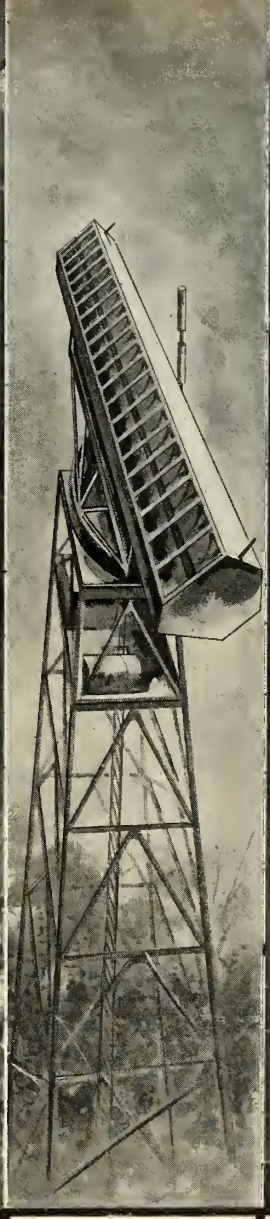
Engineering, Marketing, and Production of advanced aerospace systems. Major products: navigation, search, and fire control apparatus for manned aircraft, unmanned aircraft, and space vehicles.



SYSTEMS MANAGEMENT

West Newton, Massachusetts
Harold M. Hart,
General Manager

Engineering, Marketing, and Management of major electronic system programs. Activities include systems synthesis, learning machines, weapons studies, microwave supported platform.



HEAVY ELECTRONIC EQUIPMENT

Wayland, North Dighton, Massachusetts
Fritz A. Gross,
General Manager

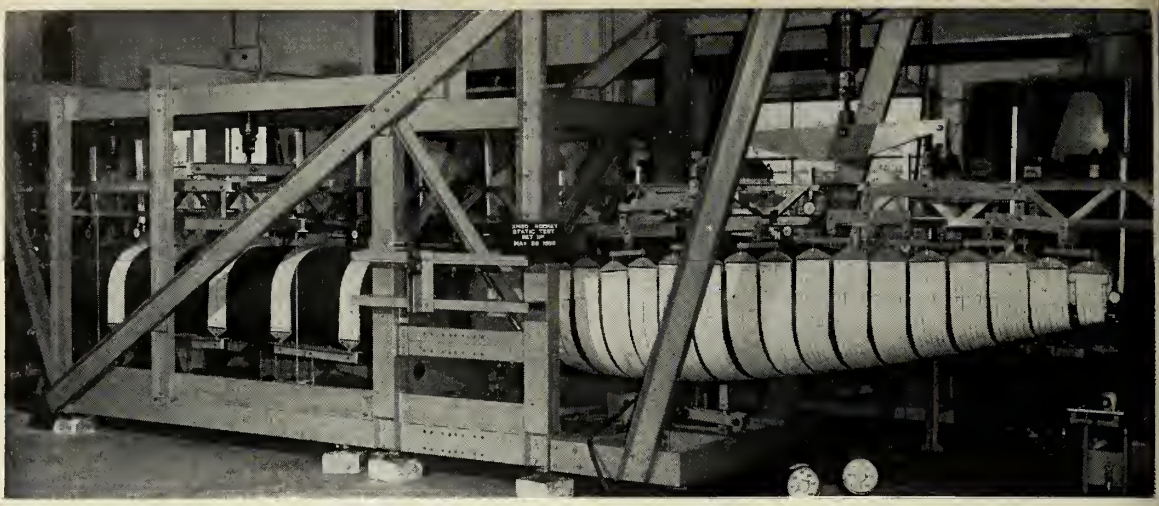
Engineering, Marketing, and Production of long range surface radars, ordnance and communications sytems. Products encompass 800-ton ground warning systems, missile fire control radars, 96-voice channel pulse code modulation equipment.



SANTA BARBARA

Santa Barbara, California
Gordon S. Humphrey,
General Manager

Engineering, Marketing and Production of infrared and countermeasures devices. Projects involve active and passive ECM equipment for aircraft, missiles, and satellites, infrared guidance, mapping, and fire control components.



SIMULATED load test of improved *Honest John* for maximum flight conditions is carried out by Emerson.

astrionics

Emerson's Prolific E&A Division

Company compiles an enviable record in missile work and comes up with startling developments for the future while bucking 'decentralization' trend

by Charles D. LaFond

ST. LOUIS—Controlled diversification, scientific and technical initiative, production competence, bold product development, capable management, continued growth—these are attributes without which today's manufacturer surely will die.

Typical of those medium-sized firms which have survived business uncertainties is the **Emerson Electric Manufacturing Company.** A 69-year-old electrical manufacturer, it not only has survived but has enjoyed steady conservative growth and parallel prosperity.

Maintaining roughly a 3:2 ratio of commercial-to-defense sales, the Company is a strong arm for the missile industry—and it is strengthening its position steadily. Some startling developments have been achieved through the efforts of its Electronics and Avionics Division, and some of those recently revealed should serve as a catalyst to speed its ascent.

For example, one recent development by the division could revolutionize missile and space-vehicle cooling. Called Thermolag, this paint-like substance, utilizing the principle of sublimation, may provide nose cone reentry protection cheaply and more efficiently than an ablation material.

Total sales by the corporation—both defense and commercial—have doubled in the last five years. This fiscal year (ending Sept. 30, 1959) sales are estimated to reach $90 million. Present backlog in defense orders alone is $35 million. Emerson's president, W. R. Persons, anticipates sizeable business expansion in the forthcoming year with the E&A Div. accounting for from 40-45% of total corporate gross sales of well over $100 million. Sales this year in the division will represent 36% of total sales.

Development and production facilities of the division were expanded and modernized in 1958 and 1959. This included completion of a new environmental test facility at the St. Louis plant. Employing between 2700 and 2800 personnel, the E&A division is steadily improving its production work-to-R&D ratio. According to division general manager, C. G. Gulledge, most of the R&D work is now with government-financed cost-plus-fixed fee or cost-plus-incentive fee contracts; company-sponsored work represents approximately 28% of the total R&D effort.

• **Management and operations**—In contrast to the "decentralizing" trend in industry so popular just a short time ago, Emerson maintains a strongly centralized management structure.

This is the result of a company philosophy that recognizes the need for long-range planning for its research, development and production. This emphasis, demanded by its board of directors and implemented by each key manager and supervisor down the "chain of command," is intended to provide a tight but realistic control of all operations and budgets. Emerson believes it also permits the most efficient use of manpower and facilities.

To further implement the best possible performance and return, whether under contract or company-sponsored,

an intermediate staff level monitors each project.

Monitors control several projects. They exert managerial control over the various project leaders, watch workload and expenditures, serve as consultants, and provide knowledgeable liaison between projects and division general manager.

Emerson's E&A Div. maintains a sizable operations-research group. Its studies provide top management with long-range technical recommendations that could not be obtained any other way—that is, without a crystal ball.

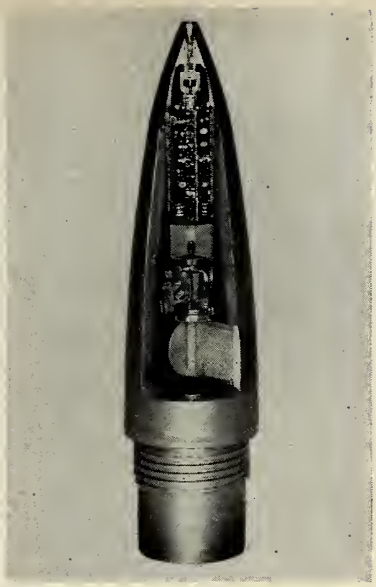
The application of the "scientific method" to help guide executive decision is a costly tool, but its benefits can be far-reaching. Years often can be saved when management has reasonable assurance that each of the roads it is taking is correct and that the pot of gold at the end of each road justifies the journey.

Needless to say, the government also has found such groups indispensable for its long-range defense planning. Because of this need, the E&A operations-research group is not a luxury item—it pays its own way.

Much of the division's efforts in missilery is by now well known. A great deal still is veiled by DOD security classification.

• **The past and present**—The division's success in missile development has been notable. In January, 1954, Emerson was awarded one of two prime production contracts by U.S. Army Ordnance for the complete *M31 Honest John* artillery rocket. Quantity deliveries were made on schedule in August 1954, to the Army's Redstone Arsenal.

In September, 1956, the company was awarded the task of design, development, and fabrication of the motor metal parts and certain airframe components for the *XM50* improved *Honest John* rocket. A letter of commendation from Redstone followed the successful completion of all subsequent tasks.



EMERSON-developed 2.75-inch warhead contains radar-initiated command fuze.

Last July, a $300,000 contract was received to perform a preproduction engineering and ordnance support study for the complete new *XM50* rocket.

Emerson is also prime contractor to the Army Rocket and Guided Missile Agency at Huntsville for development and production of the *Little John* 10-mile range artillery rocket. In support of this program, a 14-man crew of Emerson technicians is stationed at White Sands Missile Range.

For the Navy, Emerson produced the Mark 108 rocket launcher and performed the design study for the *Terrier* launching system for cruisers.

Additional missile work includes subcontracts to the following: **Thiokol**—for *Pershing, Project Able, Minuteman,* and *Falcon* motor cases; **McDonnell Aircraft**—for *Green Quail* decoy missile umbilical linkage.

Considerable advancements have been made by the division in miniaturizing electronics for ordnance and special ammunition. To provide a simple, inexpensive and reliable proximity scoring system, a subminiature microwave receiver was developed for 20-millimeter projectiles. Included also were an electronic firing circuit, electrical primer, safety and arming mechanism, and spotting charge.

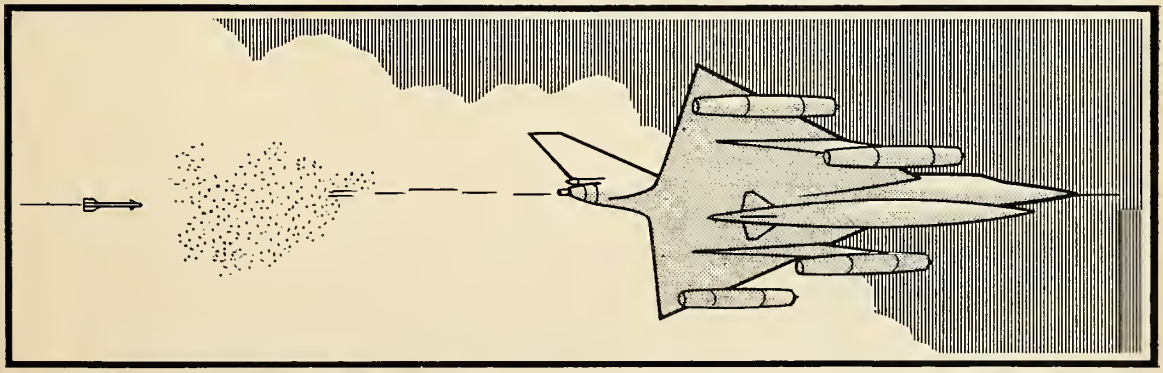
A microwave transmitter in the target directs a signal which triggers the projectiles when they enter a coplanar field perpendicular to the projectile path. Thus, firing error and dispersion can be photographically recorded for subsequent analysis.

A radar-initiated command fuse for the 2.75″ FFAR warhead permits accurate timing of operation, and hence, accurate evaluation of the fire control system. Rounds, fired in a cluster, may be selectively exploded. Out of this development, a nose-located receiving antenna evolved that is capable of receiving energy 180° from the course of a rocket.

Based on its long experience with fuzing and small caliber ammunition, including many types and sizes of fragmenting ordnance, Emerson is presently engaged in a highly classified study program for bomber missile defense. A principal problem, it can be assumed, is how to damage the sensitive guidance systems in anti-aircraft missiles most efficiently and with the highest kill probability.

• **The present and future**—As a result of the research performed by the E&A Div., new methods in missile cooling and radical concepts in long range warfare may be initiated.

• Thermolag—Thermolag, mentioned earlier, was developed for use as a heat dissipator for hypervelocity flights and has been extremely successful. Mixed and applied like a paint, the substance sublimates (vaporizes directly



M/R artist's concept of a possible antiaircraft missile defense employing small-particle, high-velocity fragmentation.

from the solid state) at a constant rate. Because the temperature of sublimation is not a function of the rate or quantity of heat input, it appears to be superior to ablative processes currently in use on some missile nose cones.

In addition, Thermolag can be conveniently applied on any contour. It cures at room temperature, bonds well to properly cleaned surfaces, and resists metal corrosion. Its vapors are non-toxic. But its greatest virtues are producibility and control. By varying the constituents of the mixture and the application thickness, the sublimation temperature and total vaporizing time can be altered and predicted with relatively good accuracy (within about 100°C).

Lockheed Missiles and Space Division, Thiokol Chemical Corp., the Army Ballistic Missile Agency, and National Aeronautics and Space Administration all have tentative missile or aircraft applications for the material.

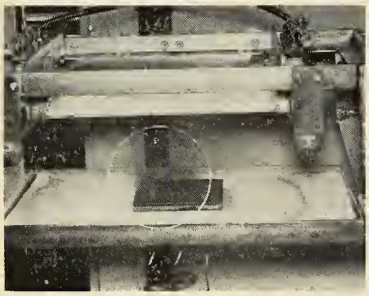
The commercial applications of Thermolag could be tremendous.

• Penetration aids—The E&A group's work involving strategic bomber aircraft has been accompanied by intensive investigations for improving their survivability. Continuing and thorough review and evaluation of new concepts, systems and techniques against the backdrop of mission requirements has established a need—at least for some years to come—for manned strategic aircraft.

With world technological growth, penetration vehicle survival strategies and techniques are continually changing. In general, initial advantage is attained with a new and radically different offense which normally assures a vital time advantage. As the new weapon's capabilities become understood by the enemy and countermeasures are developed, the penetration assistance required to insure mission success changes.

Engineering of a special weapons technique, employing long-range radar, shows great promise. The advantages and disadvantages of infrared techniques—and the problems associated with an environment dominated by nuclear ordnance—have generated unique systems requirements which are undergoing detailed analysis at Emerson.

• Anti-submarine warfare—In another area, the search for improved and higher-power sound sources for certain sonar problems, Emerson physicists are studying devices of a unique, non-linear type sound source which indicate considerable improvement over conventional sources of the same class. Laboratory experiments are in progress to investigate details of the phenomena so that design refinements can be achieved. Additional details are highly classified, but the program has been funded by the Navy's Bureau of Aeronautics for over a year.



THERMOLAG sublimation in process employing heat from 26,000-watt infrared heat facility.



APPLICATION of Thermolag demonstrates simplicity of operation. Vapors are non-toxic.

Process Promises To Raise Transistor Limits

MENLO PARK, CALIF.—A new process has been developed here for preparation of high-temperature semiconductors, according to **Stanford Research Institute,** producing high-purity, single crystals of silicon carbide, and promising to raise transistor and diode operation limits from 400°F to about 1800°F.

Two years ago, Nobel laureate William Shockley theorized that silicon carbide crystals might be grown from solution in alloy melts. SRI put his theory into practice under a subcontract from the Navy's Bureau of Ships and the **Shockley Transistor Corporation.**

By modifying a standard crystal-pulling furnace, pure silicon is melted in a carbon receptacle. The carbon of the crucible diffuses into the molten silicon and saturates the solution. A "cool spot" is produced in one area by controlled temperature. A localized area of supersaturated solution results from which the crystals can be grown.



ASTRONAUTICS DIVISION FORMED AT VOUGHT

Broader responsibilities in the Space Age. Full utilization of existing and rapidly expanding technological capabilities. These are the objectives of Chance Vought's newly formed Astronautics Division. Missile men for 12 years, this seasoned group is concentrating on advanced concepts for exit from the atmosphere, space exploration and re-entry.

Integration of the four-stage *Scout* research vehicle is proceeding under this division's direction. Vought is readying this space rocket and its launcher under a National Aeronautics and Space Administration contract.

Membership on the Boeing team participating in development of *Dyna-Soar* has further sharpened Vought's space capability. This USAF project is intended to create a hypersonic, boost-glide vehicle which will operate at the fringes of the earth's envelope.

For 42 years, Vought has helped solve human factors riddles in atmospheric flight. The company pioneered in compact, high-density cockpits and in pilot escape devices. Today, the company is performing much the same service for space pilots. In Vought's orbital flight navigation simulator, spacemen-to-be are flying by the rules of space, using instruments early space navigators may well employ.

Space is the specialty of Chance Vought's Astronautics Division. Other major interests are being aggressively advanced in the Aeronautics Division — where attention is on atmospheric missiles, antisubmarine apparatus and piloted aircraft — and in the company's Electronics, Research, and Range Systems Divisions.

CHANCE VOUGHT DALLAS, TEXAS



SPACE WILL HAVE ITS ACES

Cadets at the Air Force Academy use a loose-leaf textbook on space. In it goes up-to-the-minute knowledge on research rockets and satellites. Soon the book will include accounts of manned vehicles for upper atmosphere, orbital and space flights. In early flights man and his vehicle will descend to earth by parachute. Next, pilots will return by controlled, glider-like landings. One day, true space cruisers will explore our solar system. The cadet has a vital role in these forthcoming pages for the book on space. He has an exciting place in manned research vehicles . . . a tremendous future in space!

AERONAUTICS · ASTRONAUTICS · ELECTRONICS · GENESYS CORP. · RANGE SYSTEMS · RESEARCH

CHANCE VOUGHT
DALLAS, TEXAS

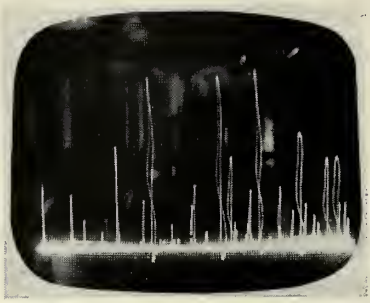
RCA System To Ease Interference

CAPE CANAVERAL—A new spectrum surveillance system recently installed at the Atlantic Missile Range promises to alleviate some of the interference problems plaguing the missile complex. The system was designed by **RCA Service Co.**

Silencing of electromagnetic interference was recognized early as an involvement of the complexities of missile launching, tracking and controlling. The role of an electromagnetic control function was settled in 1950 by the establishment of an Interference Control Office as a major activity of the Air Force Missile Test Center here.

When the scope of electromagnetic control changed and system capabilities increased, Interference Control was expanded and became Frequency Control and Analysis. Not only was suppression of interfering signals required, but analysis and control of all range operating frequencies became a major problem.

By 1959, a new spectrum surveillance system, designed on functional concepts through exploratory engineering, was needed. In June, a rudimentary system with automatic search capabilities was implemented for the frequency range from 50 to 1000 megacycles. The system provides frequency measurement, signal strength measurement, direction finding and a detection threshold of –120 dbm.



TYPICAL spectrum conditions at the Atlantic Missile Range.

• **Versatile system**—Each antenna, a modified version of a discone, is connected to an individual octave of preamplifiers. Using high-gain, low-noise preamplifiers, it is possible to multicouple various signal sources and receivers on each band (octave) without loss of system performance.

Tunable receivers are used with signal analysis equipment to determine the type and modulation characteristics of received signals. Conversely, injection of signal or power standards, at the multicoupler, results in simplified frequency and signal strength measurements.

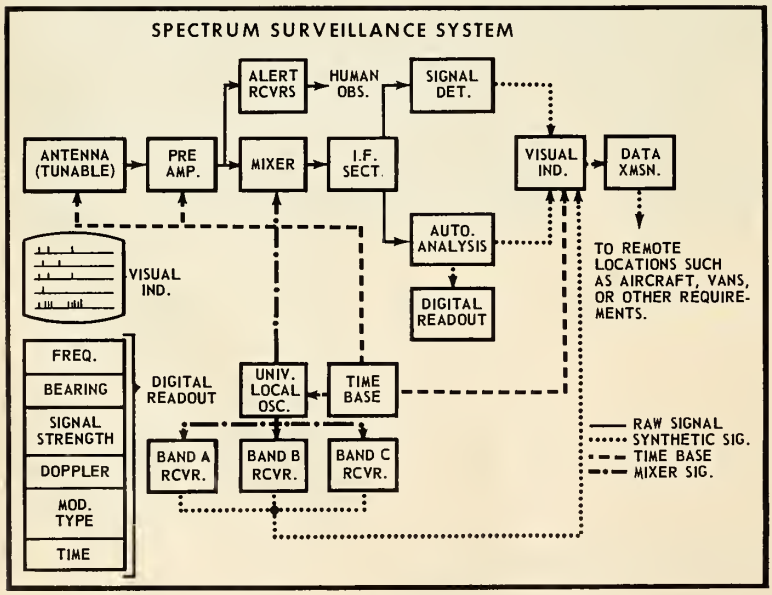
The converter will accept either a sweeping signal or a fixed signal. In the sweep mode, the system can "observe" any part or all of the band on which it is employed. By insertion of a fixed signal generated from a precision frequency source, the system can be converted to a secondary frequency standard when multicoupled to a frequency stable receiver, such as the 51J or R-390A.

• **Continuous recording**—In the sweep mode, the variable bandwidth receiver provides information for panoramic display of specific signals and alarm circuits. The alarm circuits can either alert operating personnel to a signal intercept or stop the sweep oscillator and start recorders. Other variations and combinations are possible. The alarm circuits are invaluable for detecting and recording intermittent or keyed transmissions. All signals present on any band are continuously recorded. A 17-inch monitor oscillograph provides real time presentation of all signals for visual observation.

Coarse position of the radiation source is obtained by comparing signal intensities from individual antennas "receiving" different sectors. When reception from a given sector is expected, the antennas are oriented for maximum signal. Four such antennas, searching different sectors, form a two-baseline interferometer antenna system. In operation this system is similar to Minitrack. Accuracies of 5° are achieved. This will be improved to 2 or 3 mils when suitable phase measurement equipment is installed.

The system is designed to accomplish the intercept and rapid readout of radiation characteristics by use of high-gain, electronically sweeping, tunable antennas in synchronism with the universal local oscillator. The oscillator provides a mixer signal which permits each receiver to scan a band while all maintain a known relationship to each other. Spectrum density indications and signal search capabilities cover the spectrum from 20 mc to 10 kmc.

The time base which is the syn-



SYSTEM designed by RCA provides a detection threshold of –120 dbm.

chronizer of the system activates frequency shifting in the universal local oscillator, provides timed oscillograph traces, and feeds the frequency tunable antennas to provide azimuth and elevation data.

The received signals are fed through the IF section to the automatic analysis equipment which will indicate "modulation type."

• **Maximum sensitivity**—The signal detector provides the maximum sensitivity possible to establish the presence of a signal. It also provides a shaped pulse for visual indication. The alert receivers provide the capability of signal observation by operating personnel for fine analysis or manual data recording. In automatic analysis, the characteristics of radiations will be read out in digital form for simplified observation, identification and recording.

The facility at the Atlantic Missile Range was developed and installed in less than two months, using off-the-shelf components. It was implemented to evaluate parameters for future frequency control and analysis programming but has simultaneously provided immediate support for various programs at AMR.

Battery Maker's Report Clobbers Hot-Gas APS's

by Charles D. LaFond

DENVER—" . . . the status of Hot Gas APS System for the ICBM programs was such that the failure of at least one out of every ten operational missiles, if required to perform, was practically guaranteed due to the Hot Gas-APS System alone."

In essence, this statement helped to precipitate the recent cancellation of hot-gas APS programs at **Sundstrand** and **Aerojet-General** for the *Atlas* and *Titan* ICBM's according to the **Frank R. Cook Company** (first reported in M/R, Aug. 24).

Beginning in late 1958, Cook began a study and analysis of auxiliary power sources on the *Atlas* missile. A summary of the results is provided in the accompanying table comparing hot-gas APS versus battery APS..

In addition to this disheartening conclusion ($23 million had already been spent on the hot-gas APS program by **Convair-Astronautics),** there was no reason to expect that improved design might substantially brighten the picture. With the *Atlas* scheduled to become operational in September, 1959, development—for all practical purposes—was completed. This meant that the existing reliability of the hot-gas APS system was a "frozen" actuality. Production design units were in the process of being fabricated for use in the first operational missiles. Tight scheduling and a limited production capability, in addition to the obvious high cost, thus prevented the authorization of any major design changes.

The report also indicated that, even though many millions of dollars had been spent on the hot-gas APS program, no design effort ever had been authorized for a parallel battery-APS program.

According to company president Frank R. Cook, a weak effort had been made to produce a "breadboard" battery system for comparative purposes. Yet, said Cook, even though the comparison was an unreasonable venture, the battery system's inherent reliability was apparent.

Based on its three-year experience period with the *Atlas* program, the Cook report revealed that the following advantages would be effected through a battery APS system:

- 10:1 improvement reliability;
- 2:1 reduction in weight;
- 4:1 reduction in unit cost;
- 50:1 reduction in sustaining costs (maintenance, logistic support, spares, etc.);
- elimination of extensive maintenance;
- elimination of specially trained personnel requirements;
- 30:1 reduction in activation time;
- 10:1 reduction in remove-replace-verify time;
- 100:1 reduction in spares requirements; and
- elimination of contractor depot requirements.

Cook has stated that in its experience where ever comparison has been made between the two systems, hardware for the battery-type missile APS has proved to be lighter in weight.

Further, all of these advantages would be obtained without the sacrifice of any of the existing performance requirements.

Following a review of the Cook report (dated July 31, 1959) by the Air Force's Ballistic Missile Division and Ballistic Missile Office, the hot-gas APS program was cancelled for both the *Atlas* and *Titan* missiles.

The company noted also that besides the units it is providing now for all eight of the *Atlas* type batteries, it produces units for four battery types in *Polaris* and two for *Minuteman.*

Comparative Data (Atlas)

ITEM	HOT GAS APS		BATTERY APS	
	TODAY	12/59	TODAY	12/59
DEVELOPMENT COSTS EXPENDED TO DATE	10's of millions	.....	10's of thousands	.....
PRESENT LABORATORY RELIABILITY STATUS	approx. 85%	95% (est)	approx. 95%	99.5%
OPERATIONAL RELIABILITY (ESTIMATED)	85%	92%	93%	99.5%
APPROXIMATE COST PER UNIT	$40,000	$20,000	$10,000	$5,000
ESTIMATED GROUND SUPPORT EQUIPMENT COSTS	.....	$500,000	.....	none
TRAINING COSTS (CONTRACTOR)	.....	$1,500,000	.....	none
OPERATIONAL SPARES-QUANTITY (LINE-ITEMS PER SQUADRON)	.....	2,000	.....	20
SPECIALLY TRAINED PERSONNEL REQUIRED	.....	9/sqdn.	.....	none
WEIGHT PER UNIT (INCLUDES TANKAGE AND FUEL)	150 lbs.	140 lbs.	100 lbs.	75 lbs.
TIME TO ACTIVATE AND VERIFY SYSTEM	.....	1 to 2 min.	.....	2 to 5 sec.
TIME TO REMOVE, REPLACE AND VERIFY UNIT	.....	2 hr.	.....	12 to 15 min.
ESTIMATED MAINTENANCE MAN-HOURS (PER MO./SQUADRON)	.....	1500 hr.	.....	none
ESTIMATED CONTRACTOR DEPOT COST (PER YEAR AFTER 1961)	.....	3,000,000	.....	none

WESCON Show Emphasizes Design

by Frank McGuire

SAN FRANCISCO—A major Space Age accomplishment ran slightly afoul of human factors at the 1959 WESCON Show here, and made a mildly frustrating failure of efforts to open the show with an appropriate bang.

With the *Explorer VI* satellite orbiting high over South Africa, the Jodrell Bank radio telescope facility in Great Britain sent a command signal to begin transmission of stored telemetry data. The received signal was to be used in the official WESCON opening ceremonies. A loud and clear signal was received by Jodrell Bank and sent to **Space Technology Laboratories** in Los Angeles, which in turn relayed it to San Francisco.

However, the story goes that a young lady in the downtown office of the teletype company pulled the wrong plug and so the signal did not get from downtown San Francisco to the WESCON show at the Cow Palace.

It was a good show anyway.

• **Vast exhibition**—New products reigned supreme, and great emphasis was placed on design appearances of equipment. Exhibits by 37 young future engineers displayed equipment like plasma arcs, electron accelerators, and parametric amplifiers. Just about 1000 industrial exhibitors filled the huge Cow Palace with every type of electronic equipment that was imaginable —and some that wasn't.

Technical sessions, held every day of the four-day meet, covered things like reliability, antennas, ultrasonics, computers, semiconductors, vacuum tubes, component parts and production techniques, circuit theory, propagation, engineering management, nuclear science, and even medical electronics.

Miniaturization, sub-miniaturization and microminiaturization occupied a major spot at the show; most manufacturers demonstrated that they are pushing the lightness and compactness of their equipment, while still maintaining high performance.

An indication of this trend was seen in the 10-ounce, 14-channel tape recorder developed by **Leach Corp.** for airborne applications. This unit surpasses Leach's previous world's-smallest tape recorder by a considerable margin.

• **Throw-away on the way?**—In the reliability field, but still related to unit design—one of the more significant developments at the meeting was a paper by R. O. Stone of the National Bureau of Standards in Washington, D.C.

Stone pointed out that design trends like printed circuits, miniaturization, encapsulization and modular construction are tending to make disposal-at-failure a policy to think about. It has been generally assumed that this would be a prohibitively expensive method, but cost comparisons contained in Stone's paper show that this is not necessarily the case; throw-away modules of electronic equipment, instead of complicated, serviceable gear, may be on the way.

Another paper in this line, by N. L. Kreuder of **Burroughs Corp.,** cited the conflicting philosophies faced by the design engineer who is concerned with reliability: keep the duty of each part light, even though it means using more parts, and thus keep up reliability; or hold the number of parts to a minimum, even though some carry a greater load, and hope the low number of parts will maintain reliability.

Successful equipment has been designed under both theories, Kreuder said, but he cited a method for determining an optimum between them, so that a combination of the two methods would make for greater reliability than either philosophy alone.

• **Prize winners**—All in all, design considerations were heavily brought out in this year's show, and 18 awards based on industrial design were given to electronics firms—the first such competition sponsored by WESCON. The winners will be authorized to use an official label in connection with sales of the winning products.

Awards of excellence, based on "good design, equipment reliability, and how the products and their features are related to people," were given to **Ampex Corp.,** for a digital tape handler; **Hewlett-Packard,** for a clip-on DC current probe; **Cannon Electric Co.,** for an audio/electronic connector; **Electronics International Co.,** for a precision power oscillator; the **Digitran Co.,** for a switch; **Santa Anita Engineering Co.,** for its electropak system; and **ITT** for a closed circuit TV camera.

Awards of merit were given to: **Ampex Corp.,** three awards; **Autonetics; Electronic Associates** (two awards); **General Electric Co.** (two awards); **Librascope, Inc.; Tally Register Corp.;** and **Voltron Products.**

In the semiconductor area, a development by the Ceramics Technology Group at **Stanford Research Institute** promises to raise the temperature limits for transistor and diode operation from 400°F to 1800°F. The development, a new process for preparation of the devices, was carried out under subcontract from the Bureau of Ships and the **Shockley Transistor Corp.**

• **First for Schockley?**—The name Shockley also bounced into the semiconductor picture with a new "compensated avalanche diode" type consisting of a three-layered disk of silicon with extreme voltage-regulation precision. The unit, expected to go into full production in October, is designed for use in missile control systems and other applications. It was invented by the Shockley firm, where its principal developer was Dr. G. Smoot Horsley, assistant director.

A bit of a storm arose over the Shockley diode announcement: a number of firms cited similar devices that had come about as the result of production accidents in their plants. William Slusher of **Transitron Electronic Sales Corp.,** was quoted as complaining about the announcement's wording. "The Shockley organization has done an excellent job improving the dynamic resistance, but they do not have an extremely low temperature coefficient. To be useful as a voltage reference, the diode would have to be put in an oven," he said. Other companies voiced similar disgruntled feelings.

Texas Instruments showed a series of general purpose germanium transistors involving a glass-to-metal seal to allow use of automated equipment.

The Japanese electronics industry was well represented during the show, and received considerable attention. Various electronics equipment and components, including computer systems, were displayed by the Japanese. It was the only official foreign representation at WESCON.



EAGLE

symbol of a superior Navy

The United States Navy has traditionally been proud of its fighting men and superior weapons. The Eagle Missile System is a concept which will continue this tradition into the future.

The Eagle Missile System is an advanced long-range air-to-air weapon for fleet air defense and intercept missions. It is truly a second generation missile concept in which the performance is built into the missile itself rather than the carrier aircraft.

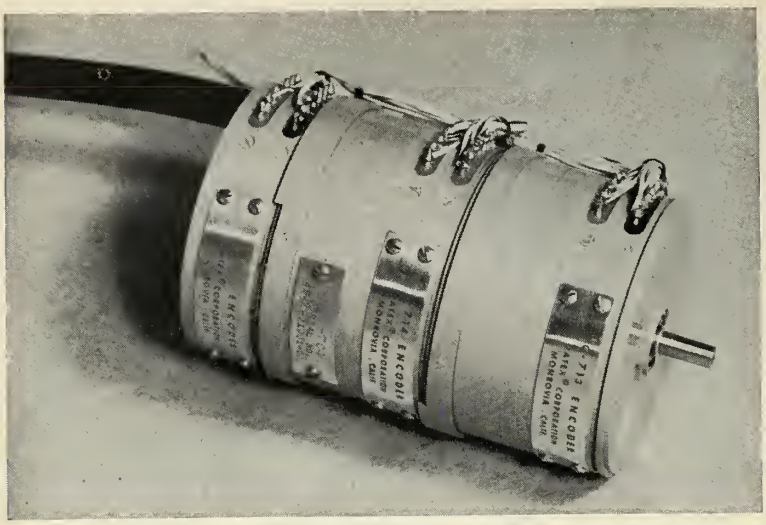
The Missileer will be the aircraft from which the long-range Eagle missiles are launched. This long-endurance aircraft will provide the ideal battle platform from which to carry out future aerial defense.

The Bendix Aviation Corporation, The Grumman Aircraft Engineering Corporation, Sanders Associates, Litton Industries, and the Westinghouse Air Arm Division are the key participants in the Eagle Program. The Bendix Systems Division has prime responsibility for systems management and engineering.

Better engineers and scientists interested in participating in such programs of the highest technical integrity are invited to write for further information.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION



New Encoder Has 1 Million Positions

One million shaft positions can be resolved with the Model CG-704 Geared Encoder Assembly now available from **Datex Corp.** Designed for use where minimum size and weight are important, the assembly uses three Datex shaft position encoders and two gear boxes.

The encoder used on the input shaft provides 1000 positions of the least significant digit per 360° rotation. Because the disc of this encoder is coupled directed to the input shaft, accuracy is that of the encoder used (1 count).

This input unit is then geared 100:1 to a 100-position encoder. This 100-position encoder is, in turn, geared to a 10-position encoder. One hundred revolutions are required for full-scale output.

Because of the step-down gearing, the inertia reflected back into the driving system by the low-speed encoder is a fraction of the inertia of this disc and, therefore, has negligible effect on the drive requirements.

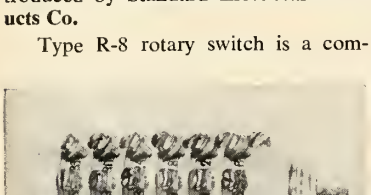
The CG-704 is 3″ in diameter, 5″ long (exclusive of shaft), and weighs less than 2 lbs. It will operate accurately at temperatures from +32° to +150°F and vibration up to 2000 cps under 8 g's.

Datex Corp.
1037 So. Myrtle Ave.
Monrovia, Calif.

Rotary Switch Gives Circuit Design Flexibility

A rotary switch for missile and ground control equipment has been introduced by **Standard Electrical Products Co.**

Type R-8 rotary switch is a compact unit which is said to allow great flexibility in circuit design. Up to 48 separate circuits may be switched with a 6-section configuration. The switch employs a contract roller which is driven independently of the operating shaft at high speed making a fast break and make. Entire switching action takes place within the enclosure.



Other features include a contact rating at 28 VCD or 115 VAC; continuous 25 amp, resistive 25 amp, inductive 15 amp., overload 50 amp., and maximum switching per section; 1 pole—8 position—8 circuit, 2 pole—4 position—8 circuit.

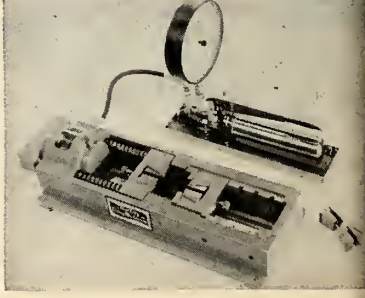
Contacts are fine silver with coin silver contact bars. Bridging or non-bridging contact bars can be supplied. Action is positive on maintained positions. Stops or continuous rotation can be supplied as specified. Torque to operate the switch is 2 lb./in. which will vary with number of sections and other requirements.

Standard Electrical Products Co.,
Costa Mesa
Calif.

Tensile-Tester Produced For Portable Applications

A new family of portable tensile testers—for bench or wall mounting—has been developed by **Steel City Testing Machines, Inc.** These testers can perform standard tensile tests when mounted horizontally and can perform either tensile or compression tests when the tester is mounted vertically. A lower compression plate is available as an accessory when compression tests are anticipated.

Tensile load is applied to the test specimen by manually operating the hydraulic pump. The applied load is shown directly on the 8½″-diameter gage, which includes a maximum-indicating hand. Connection between the pump and the tester is through a flexible rubber hose so the maximum reading will not be affected by fracture reaction. Since the pump and gage unit must be bench mounted, the length



of the hose can be specified longer than the standard 18″ when the tester is to be mounted on the wall.

Base of the tester is cast aluminum to minimize weight while the jaws, cylinder, slotted ways and stop keys are steel to increase strength. The stationary jaw holder can be positioned in any one of three locations by shifting the positions of the stop key and the jaw holder.

Designated the PT series, these testers are available in two general sizes. Model PT-20 units have capaci-

ies from 5000 to 20,000 pounds. Details of these models are the same except that a 5000-pound gage is graduated in 25-pound increments and a 20,000 pound gage is graduated in 100-pound increments. Model PT-40 units have capacities in excess of 20,000 up to 40,000 pounds. A 40,000 pound gage is graduated in 200-pound increments.

Several sizes of flat and round jaws are available for specimens up to ½" in thickness or ¾". in diameter. All testers have a maximum stroke of 2½", and can take 11" long specimens for PT-20 units and 12" for PT-40's. Maximum width of specimens is 2".

For Model PT-20 units, tester base dimensions are 10 x 28" with a height of 6". For Model PT-40 units, tester bases dimensions are 11 x 31", with a height of 7". For all models, the pump and gage unit base dimensions are 5 x 21", with a height of 18". Net weight of Model PT-40 testers is about 145 pounds, with Model PT-20 testers being slightly lighter.

Tenham & Company
925 Book Building
Detroit 26, Mich.

System Pumps Liquefied Gas Up to 12,000 psig

Dynamic Research, Inc., has a new automatic gas supply system that pumps liquefied gases at pressures up to 12,000 psig and stores the gas at room temperature after passing through a vaporizer. Higher pressures are available on request.

Model PLG-11-6 is a single cylinder, vertical pump complete with liquid nitrogen storage vessel and all controls necessary for automatic operation. It provides a continuous supply of regulated 6000 psig nitrogen gas at flow rates up to 5 standard cubic feet per minute. It supplies clean, dry gas automatically, with minimum power consumption.

The automatic gas supply system measures 30" x 36" x 22", weighs 400 lbs. dry and 450 lbs. filled, LN2. It comes in a cabinet mounted on casters for easy portability.

The new automatic gas supply—model PLG-11-6—was designed for lab testing, production line and ground support equipment.

Dynamic Research, Inc.
5701 Sepulveda Blvd.,
Los Angeles, Calif.

Circuit Equivalent Unit Has Flip-Flop Features

The first commercially available version of a "circuit equivalent" com-



ponent with characteristics comparable to a flip-flop or bistable multi-vibrator is the silicon trigistor (triggered bistable transistor). Developed by **Solid State Products, Inc.,** the trigistor is a silicon PNPN device with the unique property of triggered turn-off as well as triggered turn on control at its bases. It will turn on with the application of a low level positive pulse to its base.

Once on, the unit will remain on without the need for sustaining base current. A negative pulse to the base turns it off. It will then remain off until triggered on again. It is designed for operation in the range of 1 to 8 ma collector current. The trigistor is particularly useful for memory, counting, timing, gating, and logic functions.

The large board in the illustration is a two-transistor flip-flop circuit and the smaller board the trigistor equivalent.

Solid State Products, Inc.
One Pingree Street,
Salem, Mass.

Crystal-Can Size Relays Have High Sensitivity

Electronics Division, **Elgin National Watch Co.,** announces three new types of Elgin-Advance relays that feature high sensitivity—of 250, 100 and 50 milliwatts—in a crystal can size with 0.2" grid spacing.

Nominal operating voltages range from 1 to 110 volts, with coil resistances from 35 to 10,000 ohms. Units measure only .875" high x .800" wide x .396" thick, and weigh only half an ounce.

Relays are rated up to 3 amperes resistive at 28 volts DC or 115 volts AC. They operate under vibration as high as 30 g's to 2000 cos., with shock ratings of 50 to 100 g's. The temperature range extends from −65°C to +125°C.



Designated MQA, MQB and MZC, these relays are hermetically sealed to withstand rugged environmental conditions and meet all applicable military specifications.

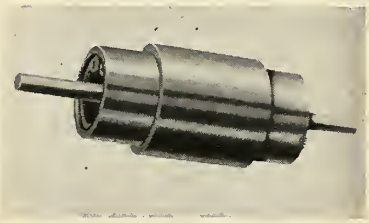
Units are DPDT (2 form C), and are designed for 0.1" grid printed circuits. Terminals are equally spaced in two rows at 0.2" apart, and are available with three-inch leads, solder hook, or plug-in terminals. All crystal can size mounting arrangements are available.

Electronics Div., Elgin National Watch Co.
2435 No. Naomi Street,
Burbank, Calif.

New Torque Transmitter Is Hermetically Sealed

Hoffman Electronics Corp. is now in production on a new hermetically sealed torque transmitter developed by the Electro-Mechanical Department of its Laboratories Division.

The torque transmitter is designed



to transmit rotary motion through a positive metal-to-metal seal by means of a flexible metal bellows. Electrical, mechanical and hydraulic controls, instruments, explosion-proof switches, and other apparatus requiring adjustment or control without disturbing hermetic sealing, may be regulated from outside a sealed area by using the new transmitter.

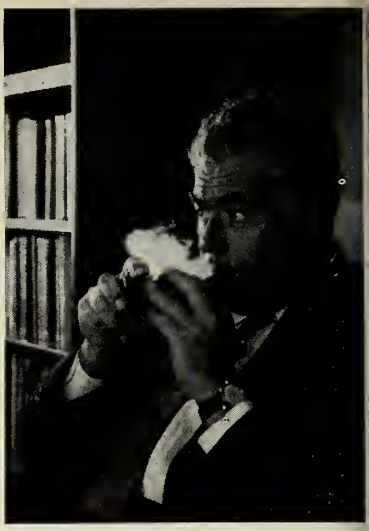
Weighing only .87 ounce, the transmitter is 2½" long and ¾" in diameter. It has a minimum life of 100,000 revolutions and an operating temperature range of −57° to 125°C. Input and output shafts are ball-bearing mounted to minimize friction. No gaskets or sliding seals are used.

Custom designed versions of the transmitter, with varying torque, pressure and backlash parameters, can also be provided to meet specific requirements.

Hoffman Electronics Corp.
3761 South Hill St.
Los Angeles, Calif.

specialist in 'impossible'

Scientist Finds Space Answers on the Ground



Avco's Dr. Arthur Kantrowitz, a former Cornell professor, has led ICBM re-entry work, saving Air Force time and money

by Erica Karr

EVERETT, MASS.—The Air Force Ballistic Missile Division, which recently celebrated its fifth birthday, owes much of its "before-schedule" ICBM achievement to a brilliant scientist who brought space down to earth.

In the fall of 1954, while the fledgling outfit was wrestling with the unsolved re-entry heating problem, Dr. Arthur Kantrowitz, then professor of gas dynamics and engineering physics at Cornell University, proposed simulating re-entry conditions in the laboratory. At a Cornell cocktail party, the idea found a receptive ear in Victor Emanuel, Avco Corporation board chairman, who saw to it that Kantrowitz presented his proposal to the Air Force.

Although there was strong opposition, Lt. Gen. Bernard Schriever, then head of BMD, was quickly sold on using the shock tube technique to provide some comparatively fast answers to the re-entry heating problem. Today Dr. Kantrowitz heads the Avco Research Laboratory at Everett, Mass.

Recalling Kantrowitz's original presentation to BMD, Schriever has written: "His enthusiasm was immediately apparent when he ventured the opinion that he could produce the first answers in six months, since some of our advisors were suggesting four years as a more nearly correct time, while others questioned the application of the shock tube at all for such a purpose."

Kantrowitz with typical confidence proved his point at Avco's new research laboratory at Everett, which he had set up after being tapped for the job by Emanuel. "According to our contract," the scientist said, "we had to set up the lab, recruit personnel, build the apparatus, conduct the experiments and deliver the information within nine months."

At the end of six months he sent BMD the first data from shock tube measurements of stagnation point heating under re-entry conditions. Dr. Kantrowitz had developed a special shock tube over 100 feet long to simulate the re-entry heating environment. Gas is fired through the tube simulating flight speeds up to 18,000 miles per hour.

Because the shock tube did not allow materials testing for long enough periods, the lab later developed the arc wind tunnel, a device which uses electric arcs to heat air to extremely high temperatures.

The work on re-entry heating neared completion by the end of 1956. The two major questions which Kantrowitz and his staff answered to solve this problem were:

1) How much heat would be transferred to an object during re-entry at speeds up to 18,000 mph? And later,

2) What kind of materials stand up best under such conditions?

The answers:

1) Up to 10 kilowatts per square centimeter.

2) Ablating materials.

Avco also provided information on the effect of heat radiation to the reentering vehicle and the electrical properties of the gas which surrounds it.

The lab pioneered in the use of ablating materials for nose cones and under the direction of deputy director Mac C. Adams, has completed tests under simulated conditions to determine the properties of ideal materials. In conjunction with Avco's Research and Development Division at Wilmington, Mass., the Everett Lab confirmed its theoretical predictions and came up with Avcoite, an ablative said to be three times more effective than those with a plastic base. The arc wind tunnel was used in the tests proving out Avcoite. Avcoite coated the first nose cone to be successfully recovered after a full-range ICBM flight—the *Thor-Able*, April 8, 1959.

This phase of the lab's work is largely finished and Avco's recent $73-million Air Force contract for *Titan* nose cones attests to its success.

The subject taking up most of Dr. Kantrowitz's time at the lab these days is high- and low-temperature magneto-hydrodynamics which he has broken down into these areas:

- High temperature: exploring the properties of gases and shock waves in the million-degree temperature range with three goals in mind—(a) fusion reactor applications (b) understanding the nature of the Van Allen radiation belt (c) propulsion of space vehicles using nuclear or solar energy.
- Low temperature: studying the possibilities of generating electric power from gases less than 10,000°K heated by uranium fission.

For the military Avco has tackled the double-barrelled challenge of developing an ICBM nose cone for the Air Force that is invulnerable to attack while working with ARPA and the Army on their anti-ICBM program.

- **A poor start**—The road to international recognition as one of the

world's top scientists in the field of magnetohydrodynamics was a devious one at the start. Dr. Kantrowitz, who has won Fulbright and Guggenheim Fellowships to Cambridge and Manchester Universities, and one from the American Academy of Arts and Sciences, was thrown out of school at age 11 for poor work. Some choice items from the principal's letter to his mother on his expulsion: "whenever Arthur makes an effort to work, he bungles it . . . poor in following directions . . . poor attitude . . . can't seem to hold himself to a steady course—no improvement."

"Rates of development vary," Kantrowitz says of this episode in his life. "I didn't worry about it, but my parents sure did."

He did better in high school, still better at Columbia University where he majored in physics and where he collected his B.S., M.A., and Ph.D.

Kantrowitz, who takes his work seriously, but not himself, views his success matter of factly. Asked how he got into his field in the first place, he smiled. "If you're not clever or industrious, you have to move off into new areas." He found his area, he added, "by listening to and participating in the speculations of astro-physicists who are trying to put together an astronomical picture on the basis of meager knowledge."

• **Ground Floor**—Kantrowitz had his initial taste of aerodynamics on his first job out of school at NACA's Langley facility. "I was hired as a junior scientific aide in 1935 and for a week I did nothing but sort nuts and bolts. Then they apprenticed me to the wind tunnel mechanic and I was told in time I'd make a good wind tunnel mechanic."

By 1938, he and Eastman Jacobs, distinguished aerodynamicist, were deep in a project to build a stellerator-type fusion reactor; they tackled it "with delicious enthusiasm." A year-and-a-half's work later, they had worked up a terroidal-shaped model but they were unable to sell the idea as practicable. Although it was somewhat premature, its rejection was a bitter blow. Most of the actual physical facts on which modern fusion reactor speculations is based, were all known then.

In the years following, his work led to:

—invention of a variometer to measure the total energy a glider gets from thermal updraft. (1940)

—experimentation to develop an efficient supersonic compressor for turbojets (1943) which resulted in models that showed it was possible to get high compression ratios (1945).

—spadework in the development of shock tubes to study high-temperature gases (at Cornell-1947) with first published work on the method of obtaining very high temperatures by converging shock waves (1949).

"We learned to produce gases at 25,000°F and studied them, and when the country needed this kind of information for the re-entry problem technique, it was there and waiting," said Kantrowitz.

Fusion reaction is still a priority subject to Kantrowitz, and he delivered a paper on it at the Mid-August 10th International Conference on Ionization Phenomena in Sweden. "We now think we understand the mechanism of collision-free shock waves, which is one area that has to be understood before we can build a successful fusion reactor. We are trying to do fundamental experiments with the plasma conditions which must be faced in controlled fusion reactors."

Recently the Everett Lab has produced shock waves over one million miles an hour with an electric shock tube.

• **Food for thought**—The Everett Lab, employing a staff of 270, is situated on 50,000 square feet of what was formerly a warehouse in the Boston suburbs. Kantrowitz, who chose the site, said that he decided on the Boston area after a teaching stint at Harvard "because the atmosphere was intellectually stimulating."

Kantrowitz, only 45, has surrounded himself with a staff who look more like college seniors than scientists. All of them are in their late 20's and early 30's.

In setting up his laboratory, Kantrowitz felt it was time the old division of the classical disciplines—chemistry, physics, mechanics and aerodynamics—was halted. Calling on many of his former Cornell students, he established scientific committees in which problems are thrashed out from an integrated point of view.

His enthusiasm is infectious and has been cited by his co-workers as his most outstanding characteristic. Dr. Hans Bethe, one of the world's top physicists and member of the President's Scientific Advisory Committee, says Kantrowitz's enthusiasm runs the range from the purely scientific to space travel and is behind "the high efficiency of his laboratory."

According to Bethe, who worked with Kantrowitz at Cornell, he won't start on a project until he is entirely sure of the scientific basis, but his confidence runs high and "everything scientific comes easy to him. Recently he wanted one of the men in his laboratory to build a complicated scientific tool similar to one previously built by a much larger organization which had taken eight years to build the apparatus. So Kantrowitz told his collaborator he could take as much as three months to do it. The young man did it in three months, using a very different design from the large laboratory."

Another scientist who has watched Kantrowitz operate at close range seemed to sum it up when he said "If you have a difficult problem, call an expert. If you want the impossible, call Kantrowitz."

The Growth of Avco

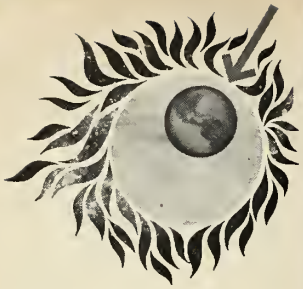
Avco started in 1929 as The Aviation Corporation principally a holding company with interests in Roosevelt Field, Waco Aircraft, American Airways forerunner of American Airlines, as well as other aviation interests, and helped launch Pan American.

By 1937, under Victor Emanuel, who still heads the company, Avco had diversified and ended up controlling 45 companies, including Consolidated Vultee (later Convair), Lycoming, Stinson and New York Shipbuilding.

During the war Avco controlled an industrial complex that ranked third among the nation's producers of war materials. Its output ran from Willys jeeps to B-24 bombers. A policy change after the war switched Avco to civilian-market emphasis and it acquired Bendix and Crosley. Largely because of distribution problems, Avco sold Bendix to Philco in 1956 and shelved the civilian side of the Crosley operation, while holding on to the defense products end.

Avco had started backtracking into government work by the early 1950's and in 1954 laid plans for a basic research and technical facility to support the company's research and development activities.

The electronics research laboratory opposite Boston University was established in 1954 under the Crosley division; a year later Dr. Arthur Kantrowitz was assigned by Emanuel to set up the basic research laboratory which has concentrated on high-temperature gas dynamics and which came up with the answers needed to solve the re-entry heating problem. As a result of this work, Avco's Research and Advanced Development Laboratory won the contracts to design and build Titan *and* Minuteman *nose cones.*



And here's how you can release the brakes on your career.

DOUGLAS AIRCRAFT COMPANY
MISSILES AND SPACE SYSTEMS

has immediate openings in the following fields—

Electrical and Electronics:
Control System Analysis & Design
Antenna & Radome Design
Radar System Analysis and Design
Instrumentation
Equipment Installation
Test Procedures
Logic Design
Power System Design

Mechanical Engineering—
Analysis and Design of the following:
Servo Units
Hydraulic Power Systems
Air Conditioning Systems
Missile Launcher Systems
Propulsion Units and Systems
Auxiliary Power Supplies

Aeronautical Engineering:
Aerodynamic Design
Advanced Aerodynamic Study
Aerodynamic Heating
Structural Analysis
Strength Testing
Dynamic Analysis of Flutter and Vibration
Aeroelasticity
Design of Complex Structure
Trajectory Analysis
Space Mechanics
Welding
Metallurgy

Physics and Mathematics:
Experimental Thermodynamics
General Advanced Analysis in all fields
Computer Application Analysis
Computer Programming and Analysis
Mathematical Analysis

For full information write to:

Mr. C. C. LaVene
Box 620-R
Douglas Aircraft Company, Inc.
Santa Monica, Calif.

propulsion engineering . . .

By M/R STAFF

New fluorine compounds synthesis . . .
has been discovered at **Armour Research Foundation** by P. Y. Feng, operating under a contract from Air Force Office of Scientific Research. It is a radiation synthesis for preparing organic fluorine compounds. Patent applications have been made.

Basic research . . .
in chemistry, without any applications goals, led to the discovery, AFOSR officials say. Already, though, the synthesis has found a defense application: The Army is using it in munitions work at Picatinny Arsenal. Dr. Feng now has an Army contract calling for studies of radiation induced fluorination of nitro compounds. Dr. Feng's research contract with the Air Force OSR called for fundamental studies on the effect of radiation on organic compounds, and on the relationship between chemical structure and radiation chemical behavior.

New materials . . .
are expected to result from Feng's discoveries, AFOSR officials say. Already, the Air Force uses a wide variety of fluorocarbons as high- and low-temperature lubricants, gaskets, etc. The Feng discovery may result in even more materials—certainly should result in cheaper production. An AFOSR spokesman says: "The radiation induced synthesis is an excellent example of how basic research provides the scientist and engineer with the understanding and techniques necessary for the creation of new and improved materials."

Russian electrodeposition of alloys . . .
is described in a report to the Fourth Soviet Conference on Electrochemistry, Academy of Sciences of the USSR. R. F. Frantsevich-Zabludovskaia and A. I. Zaiats prepare alloys of molybdenum, tungsten, chromium, and titanium with iron, nickel and cobalt by dissolving the metals in ammino or oxyacido-ammino electrolytes and plating them out as solid solutions. The percentage composition of tungsten and molybdenum in the electro-deposit depends on whether the iron-group metal is iron, cobalt or nickel. It is highest with iron and lowest with nickel. The work was conducted in 1956, but the report was only recently made available.

Utilize beamed power two ways . . .
- Heat a propulsion fluid (e.g., hydrogen, ammonia, gasoline, water) which would then be expanded through a nozzle to produce trust.
- Convert it into electrical power for an ion or plasma rocket.

Lithium—new exotic fuel . . .
that's what the Pentagon is trying to say when spokesmen announce that the Defense Department will continue its studies on high-energy chemical fuels, despite cancellation of the many contracts associated with boron. Pentagon brass belatedly points out something that chemists have been screaming, unheeded, since all this talk about so-called exotic fuels started: boron is just one of many possibilities; some others are better. However, when the boron contracts were negotiated boron looked good, and lithium looked like it was going to be tied up almost exclusively in Atomic Energy Commission projects.

Lithium will get the green light . . .
as a fuel base for certain limited uses (kerosene-LOX will be used in about 99 out of a hundred situations) for several reasons:
- A large, established lithium industry is ready and waiting to provide all the metal that might be needed, and without further research and development.
- Lithium's chemical properties and at least one physical property —density—are much more favorable than are those of boron.
- Lithium and its compounds are easier to handle.
- Because of lithium perchlorate oxidizers, missile people already are geared to lithium procurement, handling, useage.

Air brake for a spaceliner





The earth's atmosphere, one of the biggest obstacles to getting into outer space, can be one of our biggest assets coming back. At Douglas we are investigating how we can use its braking effects on rockets returning from deep space trips at far faster than ICBM speeds. Success will allow us to increase payloads by reducing the weight of soft landing systems. This technique also will aid us in pinpointing landing areas. Current reports show real progress. Douglas is engaged in intensive research on every aspect of space planning, from environmental conditions on other planets to the destroyer-sized space ships necessary to get there. We invite qualified engineers and scientists to join us. Some of our immediate needs are listed in the column on the facing page. Please read it.

Arthur Shef, Chief, Advanced Design Section, Missiles and Space Systems, irons out a problem with Arthur E. Raymond, Senior Engineering Vice President of **DOUGLAS**

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT



RELIABILITY

is what determines the success or failure of any weapon system at launch and during flight. Here at the Missile Division of North American Aviation, we are constantly striving to improve this most vital state of the art through analysis and evaluation of environmental criteria, system design analysis, statistical test programs, and other advanced reliability techniques. Engineers and statisticians with a minimum of five years full time related experience in aircraft or missile engineering will find this a most stimulating career in present and future efforts under development.

Write or send resume to:

B. H. Cunningham, Mgr.
Employment Services
12214 Lakewood Blvd.
Downey, California

MISSILE DIVISION
North American Aviation, Inc.

missile business . . .

By WILLIAM E. HOWARD

Worth noting marketwise in Dr. T. Keith Glennan's report to the Air Force missiles and space technology symposium are NASA's future spending plans. Major area for placement of contracts for the next year or two apparently will be in R&D. With a stringent money limitation evidently being imposed by the Budget Bureau, the hardware outlook isn't too bright.

Glennan makes the point—candidly . . .

"We are not nearly as far advanced in space technology as we had thought or hoped." And he adds: "In thrust capability, in guidance-injection, midcourse and terminal—in thrust control—in all of these areas there is much that must be learned and applied before we undertake the difficult missions we all talk about so glibly." He implies hot firings will be held to a minimum until the chances for success improve considerably.

At the moment Glennan feels "we have used up much of our missile technology" and this knowledge must be replenished by basic research. Accordingly, he says NASA expects to support "greater" research in universities and other non-profit institutions. In industry NASA will back both more basic research and advanced development of systems components.

NASA is drawing a bead on the moon . . .

Initial efforts of the civilian space agency are being concentrated on deep space and lunar missions, with shots aimed at near miss, orbiting and hard and soft landings of payloads. The main corollary objective is to develop reliability in rocket boosters. Comments Glennan: "It will be cheaper to waste payload space in using an oversize booster that becomes reliable through continued use than to tailor boosters for each specific mission with the attendant lowered reliability that surely will result from infrequent use." Right now NASA is leaning toward the **Rocketdyne** 1.5 million pound booster. It is spending $12 million in FY 1959 on this first stage engine for *Nova*—a deep space or lunar vehicle—and expects development costs eventually to run to $200 million.

The enormous expense of space exploration . . .

confronting the United States—if and when it decides to plunge ahead—was analyzed last week at the Commonwealth Spaceflight Symposium in London. Derek W. Morley, scientific writer for the London Financial Times, estimates the total cost of developing *Nova* for a manned lunar roundtrip will be $1 billion. And he says the multi-stage 2400-ton rocket may cost $40 million per shot with conventional fuels.

To assemble in orbit a manned laboratory weighing 75 tons, using *Nova* to do it, would cost around $2 billion, Morley estimates. His figures, incidentally, support economic arguments in favor of developing manned recoverable boosters that can be reused.

With the proposed Goodyear *Meteor* . . .

Morley says the total system cost of 30 expendable boosters would be $98 million against $150 million for the same number of recoverable boosters. But if 1000 flights were made over 5½ years, "the picture would change and the total system costs using recoverable boosters would be $523 million against $1.3 billion for a system using expendable boosters."

The financial correspondent is convinced . . .

space exploration is not outside Britain's means—if it rigorously selects projects. His idea is to gain experience with inexpensive space flights, ignore chemical fuels and concentrate on long-term R&D of nuclear rockets. And to make the price rock bottom, he suggests early concentration of development work "in the area where testing, final assembly and launching must be carried out—namely (the Woomera range) in Australia."

contracts

NASA

$380,000—Bell Aircraft Corp., for reaction controls for Project *Centaur*. (Subcontract from Convair/Astronautics Div. of General Dynamics Corp.)

MISCELLANEOUS

$485,345—Servomechanisms, Inc., for the production of true airspeed computers. (Subcontract from Lockheed Aircraft Corp.)
$300,000—MB Electronics Div. of Textron Electronics, Inc., for advanced electronics and electromechanical test equipment. (Subcontract from Aerojet-General Corp.)

NAVY

$8,000,000—General Electric Co., Defense Electronics Div., Utica, N.Y., for *Sidewinder* guidance control units.
$1,000,000—Baldwin Piano Co., for production of *Sidewinder* fuses.
$1,000,000—Minneapolis-Honeywell Regulator Co., for production of *Sidewinder* fuses.
$194,000—Diversified Builders, Inc., Paramount, Calif., for construction of *Polaris* static test complex facilities.
$9,800—King-Cowles & Associates, Inc. dba Robert W. King Construction Co., N. Hollywood, Calif., for construction of AEC launch complex.

AIR FORCE

Filton, Inc., Systems Div., for control of electromagnetic interference on the extreme altitude AMQ-15 Air Weather Reconnaissance System. (Amount not disclosed.)
$22,000,000—General Electric Company, for production of radar course directing groups.
$2,000,000—General Electric Co., Defense Electronics Div., Utica, N.Y., for transmitter sets, transmitter groups and ALT-6B ECM equipment.
$1,400,000—BJ Electronics, Borg-Warner Corp., for signal generators.
$739,772—Goodyear Aircraft Corp., Akron, Ohio, for repair and modification of AN/DPQ-4 ATRAN nose package components applicable to *TM-76* weapon system (Two contracts).
$724,680—Raytheon Manufacturing Co., Newton, Mass., for magnetron tubes.
$622,493—Tung-Sol Electric, Inc., Newark, N.Y., for various electron tubes.
$415,000—Raytheon Manufacturing Co., Waltham, Mass., for various electron tubes. (Two contracts.)
$400,000—Space Corporation of Dallas, Tex., for equipment to be used in the GAM-77 *Hound Dog* missile program. (Subcontract from North American Aviation.)
$270,000—The A. W. Cash Co., Decatur, Ill., for missile fueling control valves. (Subcontract from Blaw-Knox Co.)
$213,255—Radio Corporation of America, Electron Tube Division, for various electron tubes. (Three contracts.)
$161,100—Kuthe Laboratories, Inc., Newark, N.Y., for electron tubes.
$134,303—Aerojet-General Corp., Azusa, Calif., for rocket launching towers.
$102,000—Republic Aviation Corp., for trajectory studies of space probes plus an analysis of data handling techniques and guidance requirements for changing the orbit of a satellite.
$96,710—Henry Spen & Co., Inc., Brooklyn, N.Y., for cradel aircraft-missile components.
$94,372—Sylvania Electric Products, Inc., N.Y., for electron tubes.
$70,771—Dynatronics, Inc., Orlando, Fla., for research and development of two-channel airborne telemetry transmitters and transistorized encoders.
$41,049—University of Rochester, for basic research on the optical and electrical properties of solids. (Two contracts.)
$27,950—Metco Inc., Salem, Mass., for electron pressurized band pass transmitting receiver.

ARMY

$4,900,000—Aerojet-General Corp., for surveillance drone systems.
$2,486,125—John H. Sellen Construction Co., Seattle, for *Bomarc* IM-99B facilities.
$1,952,873—Lawless and Alford, Austin, Tex., for *Nike-Hercules* facilities.
$1,858,211—Beacon Construction Co. of Mass. Inc., for construction of *Nike-Hercules* facilities at Offutt AFB.
$1,674,830—Browning Construction Co., San Antonio, Tex., for *Nike-Hercules* facilities, Dyess AFB.
$1,512,525—Control Data Corp., Minneapolis, for a computer.
$1,314,271—Douglas Aircraft Co., Inc., for technical services.
$959,251—Southern Construction Co., Inc., Augusta, Ga., for *Nike-Hercules* facilities.
$878,433—Nichols Construction Co., Inc., Baton Rouge, La., for *Nike-Hercules* facilities.
$841,495—Consolidated Constructors, Inc., Portland, Maine, for construction of *GAM-77/GAM-72* facilities.
$254,879—Arthur Rabkin Construction Co., Inc., Cincinnati, for guided missile field maintenance shop.
$47,676—Penta Labs, Inc., Santa Barbara, Calif., for electron tubes.
$34,972—Ohio State University Research Foundation, for research and development, study and analysis of methods and techniques for measurement of temperature of the earth's atmosphere above 120,000 feet.
$30,130—Hamilton Standard Div., United Aircraft Corp., for solid-propellant spin motor system for *Little John* Phase II rocket.
$26,950—Raytheon Co., Microwave & Power Tube Division, for electron tubes.
$26,180—International Telephone & Telegraph Co., for electron tubes.

reviews

DIELECTRIC MATERIALS MOISTURE RESISTANCE STUDY: FINAL REPORT, J. J. Chapman and L. J. Frisco. The Johns Hopkins University for BuShips. Order PB 151014 from OTS, U.S. Department of Commerce, Washington 25, D.C. 76 pps. $2.

Polyethylene and polytetrafluoroethylene were virtually unaffected by the tropical exposure in these experiments to determine the degradative effects of moisture on 10 dielectric material specimens.

The two materials also showed excellent electrical properties during long periods of exposure to humid atmosphere. Other materials were polystyrene, monochlorotrifluoroethylene, polytetrafluoroethylene-glass laminate, glass silicone laminate, glass bonded mica, mica-filled melamine resin.

Most of the materials affected by moisture showed a deterioration of volume properties. In most cases, the degradative effects which were observed were attributed to moisture absorption. Specific effects are given for each material.

MICROPHONIC EFFECTS IN IMAGE ORTHICONS; R. K. H. Gebel, WADC. Order PB 151588 from OTS, U.S. Department of Commerce, Washington 25, D.C. $.50.

Experimental and theoretical investigations were conducted on image orthicon tubes to determine the cause and the best solution to the microphonic problem.

It was found possible to eliminate microphonics in these tubes electronically. However, the best solution to the problem can be obtained by careful design and construction of vibration-proof internal tube components.

people

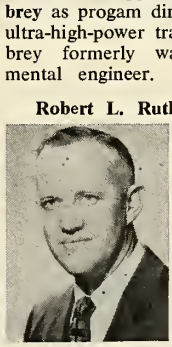

HOEPPNER

Conrad H. Hoeppner, chief scientist of Radiation, Inc., has joined the editorial advisory board of Missiles and Rockets. Hoeppner holds a B.S.E.E. and M.S.-E.E. from the University of Wisconsin, did graduate work at M.I.T. and received his professional E.E. from the University of Wisconsin. He was formerly associated with U.S. Naval Research Laboratories, The Martin Co., Raytheon Manufacturing Co., General Electronic Laboratories, W. L. Maxon Corp. and Stavid Engineering Co. Besides holding more than 30 patents, Hoeppner has authored many technical papers.


CLARKE

Dr. Edward N. Clarke, has been appointed vice president for operations of National Semiconductor Corp. He was research physicist and section head for six years at Sylvania Electric Products and recently of Sperry Semiconductor Div., Sperry-Rand Corp. Dr. Clark has published numerous papers and holds several patents.

Pacific Semiconductors, Inc., has announced the appointment of **Frank Steinebrey** as progam director on an Air Force ultra-high-power transistor project. Steinebrey formerly was company developmental engineer.


RUTH

Robert L. Ruth, has been appointed chief engineer of the Marine and Ordnance Dept. of Vickers Inc. Prior to joining the company in 1958 Ruth was involved in development of hydraulic systems and submarine missile launching systems at Sargent Engineering Corp.


MULLIO

William A. Mullio has been named project manager for the development of a general purpose mechanical timer for missile fuzing and programming systems by Bulova Research and Development Laboratories, Inc. Before joining Bulova, he was with Sperry Gyroscope, Arma, and Control Instruments.



WHO READS MISSILES AND ROCKETS?



Well, for instance ... ENGINEERS AT WESTINGHOUSE DEFENSE PRODUCTS

Molecular electronics—a technological breakthrough at Westinghouse—is producing electronic systems *1,000 times smaller and lighter* than anything now in existence.

Through molecular electronics, drastic reduction in weight, size, power and heat dissipation requirements will permit space vehicles and satellites to perform a greater number and wider range of tasks. Greatest advantage is the vastly improved reliability achieved by the replacement of numerous components by a single solid state unit.

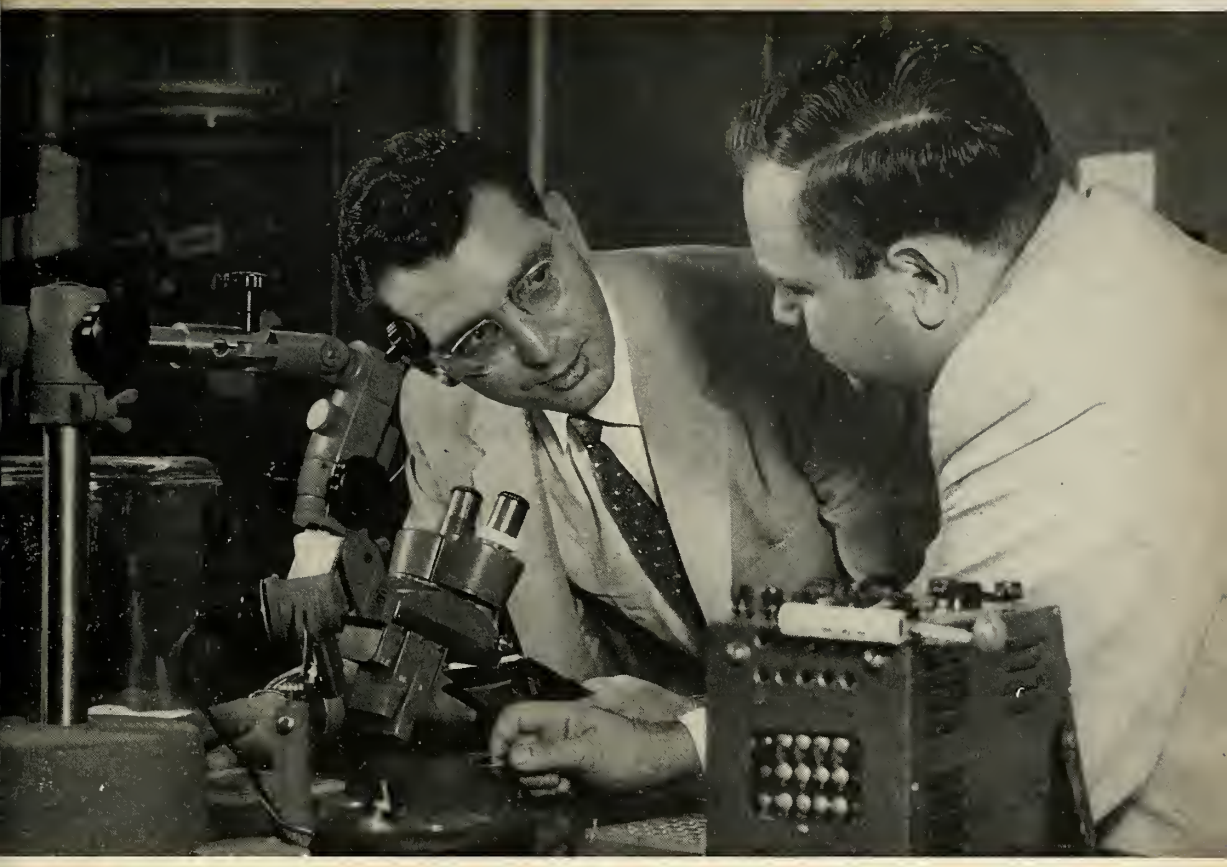
Recently, the Air Research and Development Command of the U. S. Air Force awarded a development contract to Westinghouse as a part of a broad program effort in this new electronic area. Experimental "hardware" is being fabricated by Westinghouse for infrared, reconnaissance, communications, telemetry, flight control and other military applications.

"Missiles and Rockets deals exclusively with astronautics. Spawned by aviation, missilery and outer space exploration today is an industry by itself." — George Shapiro (right), Fellow engineer of the Westinghouse Astronautics Institute, located at Air Arm Division.



"One company can't build the entire bird ... it takes thousands of parts and scores of companies. Missiles and Rockets keeps us informed of the products and capabilities of the other companies throughout the industry — a most definite aid in selecting contractors." — Harvey Saldin (right), Manager, power systems, Westinghouse Advanced Systems Planning group.





r. Gene Strull (right), Manager of the Semiconductor Divi-
n's Solid State Advanced Development Laboratory at the
estinghouse Air Arm Division, discusses molecular elec-
onics with Charlie LaFond of the editorial staff of Missiles
nd Rockets magazine. Westinghouse engineers have devel-
ed on a single semiconductor wafer, a system that performs all the functions of much larger conventional and transistorized electronic systems. Typical application is a tiny light sensing device for satellite telemetry less than ½" in diameter and 1/100th of an inch thick, one of several subsystems including pulse generators and multiple switches, already built and demonstrated by Westinghouse.

This fast-growing, dynamic industry (missiles and
tronautics) demands week-to-week technical and
ws coverage. Month-old news and developments
e of little use to today's engineer." — Jim Currie
eft), Radar Engineering Section Manager, Westing-
use Electronics Division.



WHY YOU SHOULD ADVERTISE IN MISSILES AND ROCKETS . . . Missiles and Rockets has *no waste* circulation—just those who manufacture missiles, space vehicles and allied equipment—and active Government and military personnel. *Over 29,000 missile technicians pay for their subscriptions to Missiles and Rockets*—the *best* circulation story among magazines covering the missile market. Missiles and Rockets reaches the thousands of companies, NASA and the Department of Defense who are purchasers in this multi-billion dollar market.

TELL YOUR PRODUCT OR CAPABILITY STORY THROUGH THE PAGES OF MISSILES AND ROCKETS—THE TECHNICAL/NEWS WEEKLY OF THE MISSILE/SPACE MARKET.

M/R

missiles and rockets

AN AMERICAN AVIATION PUBLICATION

1001 VERMONT AVENUE, N. W., WASHINGTON 5, D. C.

AFA Meeting to Attract 4000

MIAMI BEACH—*Titan,* the Air Force's second intercontinental ballistic missile, will headline a show of new weapons and industrial developments keyed to what has been billed as the second year of the Space Age. The first public display of *Titan* will be at the Air Force Association's annual convention to be held here from Sept. 2-6.

The big missile, manufactured at Denver by **Martin,** was being flown to Miami Beach at press time aboard a giant MATS C-133 turboprop cargo plane. It will be erected in front of the auditorium where the industry exhibits and most of the meetings will be held.

Convention plans thus far unwrapped indicate a program aimed at dispelling current confusion over buying policy and programs and the role that industry plays both in research and development and in procurement. There will be classified briefings for industry dealing with research and development. A procurement seminar will be open to all registrants.

The procurement seminar will be held Sept. 3. Moderator will be Gen. Edwin B. Rawlings (USAF, ret.), for six years the Air Materiel Command chief. Speakers include Donald R. Jackson, deputy secretary for procurement programs, and Lt. Gen. Mark E. Bradley, Jr., deputy chief of staff (materiel).

• **Guidance for industry**—AFA also has planned, with the cooperation of the Air Force, conferences between industrial representatives and the representatives of both AMC and ARDC. Their objective is to explain to individual companies what roles they may play in the ARDC picture and how they can find a place for themselves. In the case of procurement, AMC representatives will discuss individual problems as they relate to the weapon system philosophy. Specialists will answer questions relating to design, production and management. AFA said that these services will be available throughout the convention.

The overall Air Force story is to be told on Saturday, Sept. 5, in a panel discussion. Speakers include: Lt. Gen. William H. Tunner, Commander of MATS; Gen. Frank F. Everest, the new commander of the Tactical Air Command; Gen. Laurence S. Kuter, Commander of the North American Defense Command, who can be expected to discuss antiaircraft and antimissile missiles; and Gen. Curtis E. LeMay, vice-chief of the Air Staff.

Speaker at the annual Aerospace Banquet, Sept. 5, will be Gen. Thomas D. White, AF Chief of Staff. AF Secretary James H. Douglas will be the speaker at the annual awards luncheon on Saturday, Sept. 5.

Advanced registration at press time numbered 2600. A total of 4000 are expected to attend.

Venus Contact Will Be Tried—Minus Rockets

WASHINGTON—A NASA attempt to contact a rocket near the vicinity of Venus will be conducted next month—even though the rocket won't be there.

The program originally called for the Jodrell Bank radio telescope at Manchester, England, to track the two Venus probe vehicles—*Atlas Able* and *Thor Able IV*—which were to have been launched in June. The probes were cancelled when the payloads were not finished in time.

The telescope nevertheless will try to contact Venus at the time when the space vehicles should have arrived, when the planet is closer to earth than it will be again until January, 1961.

The Jodrell Bank team, headed by Prof. A. C. B. Lovell, hopes to learn more accurately how far Venus actually is from earth, how long it takes to spin on its own axis, and something about its cloud-shrouded atmosphere.

Mercury Escape System Won't Ignite Prematurely

WASHINGTON—NASA officials contended last week after the premature ignition of a Project *Mercury* capsule's escape system during a *Little Joe* test that "this could not happen" when man is put into the capsule atop an *Atlas* booster.

The escape rocket fired approximately 20 minutes before the vehicle was to be launched. The capsule's drogue chute opened, but the main chute failed to open as the capsule landed in the sea about 1000 feet from its Wallops Island launching pad.

Project *Mercury* scientists stated that the final capsule will have a more sophisticated electrical system than was used in the *Little Joe* test—"eliminating the possibility of a premature ignition."

No explanation was given for the main chute's failure to open. There were no injuries. The launch area had been cleared of all personnel some 10 minutes earlier. The *Little Joe* booster cluster of solid rockets remained on the launching pad.

House Group Questions DOD's Ban on Articles

WASHINGTON—The House Information Subcommittee is broadening its inquiry into the Pentagon ban on publication of Gen. Thomas S. Power's book on U.S. ICBM and bomber shortages.

The reason: The subcommittee has uncovered a recent general ban on the writing of signed articles by high-ranking officers for non-service publications.

Subcommittee Chairman John E. Moss (D-Calif.) has questioned the Defense Department's statutory authority for such a ban.

The subcommittee move followed an earlier inquiry into Defense Secretary Neil McElroy's banning of publication of SAC Commander Power's book "Design for Survival."

Power has repeatedly called for more ICBM's and bombers to keep U.S. deterrent strength from deteriorating. He is understood to have said in a preface to his book that it was a "report to our stockholders—some 175 million of them."

Moss disclosed that the military services were notified of the general ban in a recent memo signed by Chauncey Robbins, Deputy Assistant Defense Secretary for Public Affairs.

Lost *Discoverer* Capsules Have Scientists Puzzled

WASHINGTON—ARPA and Air Force scientists and engineers are still trying to solve the problem of their disappearing *Discoverer* recovery capsules.

Lockheed's *Discoverer VI* launched Aug. 19 from Vandenberg AFB—again performed perfectly up through the ejection of the capsule from the orbiting 1700-pound satellite over the Pacific. But again the capsule's radio went out and the capsule disappeared without a trace.

Discoverer V performed the same way only a few days earlier.

Both times C-119 cargo planes stood by, ready to attempt catching the capsules as they fell toward the Pacific. Ships stood by in the area near Hawaii to back them up.

Scientists feel the capsule may be burning up during re-entry—or else it's re-entering along an unexpected trajectory and ionization is blacking out the radio.

The failure to recover the 300-pound biomedical capsules is holding up plans to put more animals into orbit during the *Discoverer* series.

When animals are used again, they probably will be monkeys. Mice were used earlier.

——more about the missile week——

AIA Reports Need for Measurement Standards

American measurement capabilities are being seriously outdistanced by the requirements of fast-moving missile and space projects, according to a survey sponsored by Aerospace Industries Association. Results of the study made by **Sperry Gyroscope** has shown that a "measurement pinch" in the missile industry could threaten success of U.S. missile and space programs.

The problem uncovered by the AIA Quality Control Committee deals primarily with the increased need for extremely close tolerances and higher reliabilities. These requirements have forced introduction of a calibration program far beyond the needs of ten years ago. Today, missile components must be accurate to the millionth of an inch with proportionate standards in measurements of electronics, time, weight, temperature, pressure, shock, optics, and radiology.

The main purpose of the survey is to alert industry to the urgency of this measurement lack. The implication is that the National Bureau of Standards, with the support of industry, and sufficient financing can do the job. Consensus of the survey team is that this should not be the problem of NBS alone, however. Supporting work can be done by universities, industry research, and military calibration laboratories.

Air Force Air Material Command, for one, has already taken cognizance of the problem. Soon, the A.F. will have 163 centers equipped as precision measurement laboratories.

Second *Polaris* Sub Launching on Sept. 22

The Patrick Henry, sister ship of the George Washington nuclear-powered *Polaris* submarine, will be launched Sept. 22 at the **Electric Boat Division** of **General Dynamics Corp.,** Groton, Conn. The 380-foot, 5400-ton sub capable of launching 16 nuclear-tipped rounds will be ready for fleet duty in late 1960. The George Washington, first fleet ballistic missile sub, will be operational earlier next year.

Hot gas generator spin stabilization system weighing less than three pounds has been developed for *Polaris* missile by **The Garrett Corp.'s Airesearch Mfg. Co.** Generator incorporates an electric pyrotechnic ignition, time delay and composite base solid propellant in a single cartridge. Burning is at 1000 psi for .2 secs.

Industry Progress

Hazeltine Corp. heads up a team composed of **General Precision Laboratory, Radio Corporation of America, Sprague Electric Co.** and **Temco Aircraft** bidding on the Air Force's proposed airborne long range input (ALRI) system . . .AMC's Rome, N.Y., area has awarded **General Electric's Heavy Military Electronics Department** a $22 million contract for production of radar course directing groups . . . **Plastic Age Aircraft Corp.** and **Plastic Age Reinforced Products,** Saugus, Calif., are being merged into the **Plastic Age Mfg. Co.** . . . **Ling-Altec Electronics** has acquired all outstanding stock of **Consolidated Electronics Mfg. Co.** for $3.6 million.

Project *Mercury* procurement is shifting into high gear. **Chrysler** will provide eight Redstone-type missile boosters for the NASA vehicle that will put an American astronaut into orbit. **Waste King Corp.,** Los Angeles, has contract to manufacture gyro components for guidance system. And in a related area, **Chance Vought** is developing for Navy a space vehicle-type capsule for aircraft, utilizing shaped-charge explosive principle to separate cockpit section from remainder of aircraft.

Uses of gold and other precious metals for coating missile sections are increasing. **Engelhard Industries Inc.** reports gold is unequalled as a reflector of infrared. Company also is experimenting with platinum as a reflector.

Rocket engine generating about 15,000 pounds thrust was fired recently at Air Force's Arnold Engineering Center, Tullahoma, Tenn., in a wind tunnel at simulated altitude exceeding 100,000 feet. The ARDC installation said this marked the first time a rocket of its type and size had been tested under such extreme conditions.

WSMR Gets New Console

Complex communications and control console at White Sands Missile Range, N.M., has put the 4000-square-mile test center literally at the fingertips of the range operator. The new $150,000 console, with direct communications between all missile projects on the range, replaces outdated 6-year-old equipment.

AEROSPACE

ENGINEERS—SCIENTISTS

How about YOUR future?

Here's a company where the past and the present PROVE the future is interesting and worthwhile.

★ Leadership in Engineering Design
★ Leadership in Business Airplanes
★ Leadership in Ground Support Equipment
★ Diversified Production Contracts
★ Winner of Mach 3 Alert Pod Design
★ Diversity of Creative Opportunities
★ Winner of Mach 2 Missile-Target Award
★ Builder of Major Assemblies for Fighters
★ Stability of Engineering Employment
★ Expansion Programs Now in Process

BEECH AIRCRAFT has responsible positions open now for specialists in LONG RANGE programs on advanced super-sonic aircraft and missile-target projects in the following aerospace fields:

Human Factors
Analogue Computer
Reliability (Electrical)
Stress
Aero-Thermodynamicist (Heat Transfer)
Structures (Basic Loads)
Senior Weight
Dynamics (Flutter)
Systems (Missiles)
Electronic
Electro-Mechanical
Airframe Design

For more information about a company WITH A LONG RANGE FUTURE where your talents will build your own future—call collect or write today to D. E. BURLEIGH, Chief Administrative Engineer, or C. R. JONES, Employment Manager, Beech Aircraft Corporation, Wichita, Kansas. All expenses paid for interview trip.

Beechcraft

Wichita, Kansas Boulder, Colorado

Systems
Electronic / *Engineers*
Mechanical

NEWS OF ENGINEERING OPPORTUNITIES

OPEN ON MOST "TALKED ABOUT"

MISSILE OF THEM ALL

POLARIS

...and other diverse and complex weapons projects at General Electric's Ordnance Department in the Berkshires*

When the first operational Polaris missiles are installed in the "George Washington" —first atomic submarine specifically designed as floating platform for the Navy's undersea-launched IRBM s — it will be a day of great moment for the engineers and scientists at General Electric's Ordnance Department, who are now pouring their energies, imagination and technical skills into the development, design and production of Polaris Fire Control and Inertial Guidance Systems.

A day of celebration — but also one that ushers in new and other challenging problems — for the push to develop the next generation of long-range underwater ballistic missiles and kindred advanced weapons and weapon systems will be on.

There are openings now for engineers (*EEs or MEs*) with two to seven years' experience in these areas:

SYSTEMS DEVELOPMENT / SYSTEMS DESIGN OR EVALUATION
FIRE CONTROL ENGINEERING / INERTIAL COMPONENT DESIGN / COMPUTER DEVELOPMENT
ELECTRONIC CIRCUIT DEVELOPMENT / STRUCTURAL DESIGN AND VIBRATIONS
FIELD SERVICE & EVALUATION / QUALITY ASSURANCE & RELIABILITY ENGINEERING
ELECTRO-MECHANICAL DESIGN / ADVANCED PRODUCTION ENGINEERING
ELECTRICAL DISTRIBUTION SYSTEMS ENGINEERING / PLANT FACILITIES ENGINEERING
PRODUCT SERVICE INSTRUCTION / PRODUCT PLANNING / SALES ENGINEERING
CONTRACT ADMINISTRATION / TECHNICAL WRITING

Field Test Engineering (Florida, California and several naval stations in continental U.S.)
Also technician openings for graduates with missile experience



Write in strict confidence to: Mr. R. O'Brien, Dept. 73-WI
Ordnance Department of the Defense Electronics Division

GENERAL ELECTRIC

100 Plastics Avenue, Pittsfield, Mass.

Additional Projects Under Investigation at the Ordnance Department. Urgent, vital and engrossing as the Department's share in the Fleet Ballistic Missile Program is, it is just one of the diverse activities here that today offer engineers a progression of challenging assignments on: **Atlas Guidance Equipment • Talos Handling and Launching Equipment • Advanced Torpedo Development • Tartar Fire Control**

reviews

FREQUENCY RESPONSE FOR PROCESS CONTROL, Edited by William I. Caldwell, Geraldine A. Coon, and Leslie M. Zoss. McGraw-Hill Series in Control System Engineering. 400 pp. McGraw Hill, $11.50.

The book presents the fundamental methods of frequency response and their applications to the anaylsis, testing, and design of process control systems, along with an analysis of complete systems by means of highly effective techniques and typical solutions to many practical problems.

In a section devoted to theory, attentions is given to the distance-velocity lag, linear lag, and stability considerations. Methods of analysis are presented, with emphasis on the damped response method. The coverage of controller responses includes control charts for a variety of responses. Results are shown for variation of process and controller parameters. Closed-loop performances are explained, and disturbances are discussed with regard to their magnitude and location in the control loop.

ASBESTOS: ITS INDUSTRIAL APPLICATIONS, D. V. Rosato, Chief Engineer, Research Division, Plastics Plant, Raytheon Manufacturing Company, 214 p., $5.75, Reinhold Publishing Corp.

The book discusses various applications of asbestos, including its uses in the missile industry. It also serves as a guide to numerous industrial branches, including research and development groups, manufacturers, engineering schools, market research groups and sales management.

A census of asbestos products is included, along with reviews of asbestos materials available—asbestos cement, tile asbestos, heat and electrical insulation, asbestos friction materials, plastics, packings, gaskets, filters and others.

A MILITARY COLOR TELEVISION SYSTEM; R. K. H. Gebel, WADC. Order PB 151586 from OTS, U.S. Department of Commerce, Washington 25, D.C. $.50.

This pamphlet describes a color television system said to be superior for general military application and suitable for use with or without optical amplification.

The system, using a tri-color reproduction tube combined with either a two or three-color system, could be readily incorporated into a storage optical amplifier system. Field rate could then be changed without difficulty from one picture per second to 100 pictures per second.

The technical possibilities and limitations of color television systems are reviewed generally and the more important types of color systems are outlined, with emphasis on motion-detection limitation.

PERFORMING RESEARCH ON NEW APPROACHES TO PRINTED CIRCUITRY; Haloid Co., Rochester, N.Y. Order No. PB 135 502 from Library of Congress, Photo duplication Service, Publications Board Project, Washington 25, D.C. 27p. Microfilm $2.70, photocopy $4.80.

Performance tests have been carried out on vacuum evaporated chromium resistors and chemically deposited tin oxide resistors.

It was found that various overcoatings for higher temperature service and protection of ceramic-based components were tried unsuccessfully. Quantitative measurements of corona charging characteristics of materials for use in making electrostatic printing masters have also been made.

IMPREGNATION OF SILICON-CARBIDE ARTICLES WITH METALS; A. N. Novikov, translation of "Ogneupory" (USSR) No. 12, 1957. Order HB-4504 from Henry Brutcher, P.O. Box 157 Altadena, California. $6.60.

Gas-phase impregnation of silicon carbide articles with metals selected on the basis of the difference between their boiling point and the temperature of the active state of silicon carbide are prerequisites to successful impregnation.

Presented are details on an electric furnace used for gaseous impregnation of silicon carbide; methods of packing the impregnating materials; best composition of impregnating mix for ease of molding and performance.

Also in the translation are the experimental procedure and results; properties of silicon-impregnated silicon carbide; properties of various German and American silicon-carbide heating elements compared with those developed by the author between 1941 and 1956. The chief advantages of the new process are that workpieces may be air-dry and need not be recrystallized.

LITHIUM AND ITS ALLOYS; F. I. Shamrai, Translation of "Litiy i Ego Splavy," Moscow, 1952. Order AEC-tr-3436 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 230p. $3.

The contents include the general characteristics of lithium and its minerals, the chemistry of lithium compounds, the metallurgy of lithium, and its properties.

Also in the translation is material on the analytical chemistry of lithium and its binary and ternary alloys.

AN IMAGE ORTHICON WITH NARROW RANGE OF ELECTRON ENERGY IN THE SCANNING BEAM: R. K. H. Gebel, WADC. Order PB 151589 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 13pps. $.50.

A method of improving the low light level performance of image orthicon devices through basic design changes in tube geometry has been devised.

Electron-optical relationships for the scanning beam were developed and it was shown that for a scanning beam of narrow electron energy, the beam modulation factor can be made very low, improving the performance of the tube.

when and where

AUGUST

Army-Navy Instrumentation Program, Annual Meeting, Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Tex., Aug. 31-Sept. 2.

International Astronautical Federation, 10th Annual Congress, Church House, Westminster, London, Aug. 31-Sept. 5.

SEPTEMBER

Air Force Office of Scientific Research and General Electric Company's Missile and Space Vehicle Department, Conference on Physical Chemistry in Aerodynamics and Space Flight, University of Pennsylvania, Philadelphia, Sept. 1-2.

University of California, 1959 Cryogenic Engineering Conference, Berkeley, Calif., Sept. 2-4.

Air Force Association and Panorama: send Reservations to AFA Housing Bureau, P.O. Box 1511, Miami Beach, Sept. 3-6.

AFOSR/Directorate of Aeronautical Sciences, Office of Naval Research, National Science Foundation, Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Sept. 9-11.

Society of Automotive Engineering, Display of USAF Ground Support Equipment for Manned and Unmanned Aerospace Vehicles, Milwaukee Arena, Milwaukee, Sept. 14-15.

Advertisers' Index

Aerojet-General Corp., Sub.-General Tire & Rubber Co. 6
Agency—D'Arcy Adv. Co.
Armco Steel Corp. 8
Agency—N. W. Ayer & Son, Inc.
Bendix Aviation Corp., Bendix Systems Div. 37
Agency—MacManus, John & Adams, Inc.
Burroughs Corp. 18
Agency—Campbell-Ewald Co.
Chance Vought Aircraft, Inc. 30, 31
Agency—Tracy-Locke Co., Inc.
Convair, a Div.-General Dynamics Corp. 10
Agency—Barnes Chase Co.
Douglas Aircraft Co., Inc. 42, 43
Agency—J. Walter Thompson Co.
Dow Corning Corp. 53
Agency—Church & Guisewite Adv., Inc.
Grove Valve & Regulator Co. 2
Agency—L. C. Cole Co.
North American Aviation, Inc., Missile Development Div. 44
Agency—Batten, Barton, Durstine & Osborn, Inc.
Northrop Corp. 22, 23
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.
Raytheon Co., The, Government Equipment Div. 26, 27
Agency—Hoag & Provandie, Inc.
Space Technology Laboratories, Inc. ... 3
Agency—Gaynor & Ducas, Inc.
Swedlow, Inc. 54
Agency—Willard G. Gregory & Co.

EMPLOYMENT SECTION

Beech Aircraft Corp. 49
General Electric Co. 50
Agency—Deutsch & Shea, Inc.

Another Threat to Our Space Program

For some time now there have been reports that Budget Director Maurice Stans could be expected to insist on heavy reductions in the Nation's missile and space program for Fiscal 1961-2. The speech which NASA's Dr. T. Keith Glennan made in Los Angeles on August 24 counseling a "go slow" program in space might appear to go along with this. Both could be considered to be obvious reflections of the Administration's attitude.

We suspect, however, that there may be a great deal of difference in how slowly Dr. Glennan wants to go as compared to how deeply Mr. Stans wants to cut.

The NASA administrator made several well-considered points: we have not advanced as far into the space field as we may think; our experience thus far has been less than satisfactory; there has been a lot of "glib talk" but there is still much, much to be learned before we advance farther than the short first step we have taken; reliability is our greatest problem; we lack manpower, facilities and funds to even begin all of the projects which have been recommended one way and another. Do we really believe, Dr. Glennan asked, that based on our past experiences, we have the skills to send a seven-stage probe to the moon for a soft landing and a safe return?

Mr. Stans, we have heard, would reduce or actually eliminate much of the current and projected military and civilian space program. *Nova,* the single chamber 1.5-million-pound-thrust engine under development by Rocketdyne, would be cut back to a theoretical research program. *Saturn,* the clustered engine of like power, would be curtailed. *Atlas* would be utilized as our basic booster as well as a major deterrent. Many of the current applied research projects in fuels and engines would be cut back or cut out.

We suspect that while there is some similarity in the tone of the two approaches, the point of interest may be quite different. We suspect that Dr. Glennan is interested and determined to produce a space program but wants to go about it sanely and reasonably. We suspect that Mr. Stans merely wants to reduce the budget.

Fundamentally, it is difficult to agree with the Stans approach, if it is correctly reported, and difficult not to agree with Dr. Glennan. It is also difficult to understand how any reasonable official, in reviewing the events of the past three years, can doubt that this country must have a space program and must have the best available, commensurate with the progress of our skills. When Russia flew *Sputnik* we were hopelessly behind; money immediately became no object. Now, by calling on the bulk and best of our brainpower and technical skills—and millions of dollars—we have managed to catch up or at least come within striking distance of the Russians in the space field.

Do we now sit back because of a forthcoming national election or for any other reason, and lose the ground we have gained by such effort? Do we wait for another Russian achievement—the first rocket to the moon, the first man in space—to shock us back into action and to start another crash program?

We know that the business of the Bureau of the Budget's bargaining process is an annual exercise which begins about this time each autumn; that the services, with their billions, can take a cut and find room to maneuver. And we know, too, that Dr. Glennan will fight for the program he and the dedicated men who work with him feel is right for the country. But NASA has already lost $28 million from its small budget for this year and any further stringency cannot help but have a drastic effect on the space program.

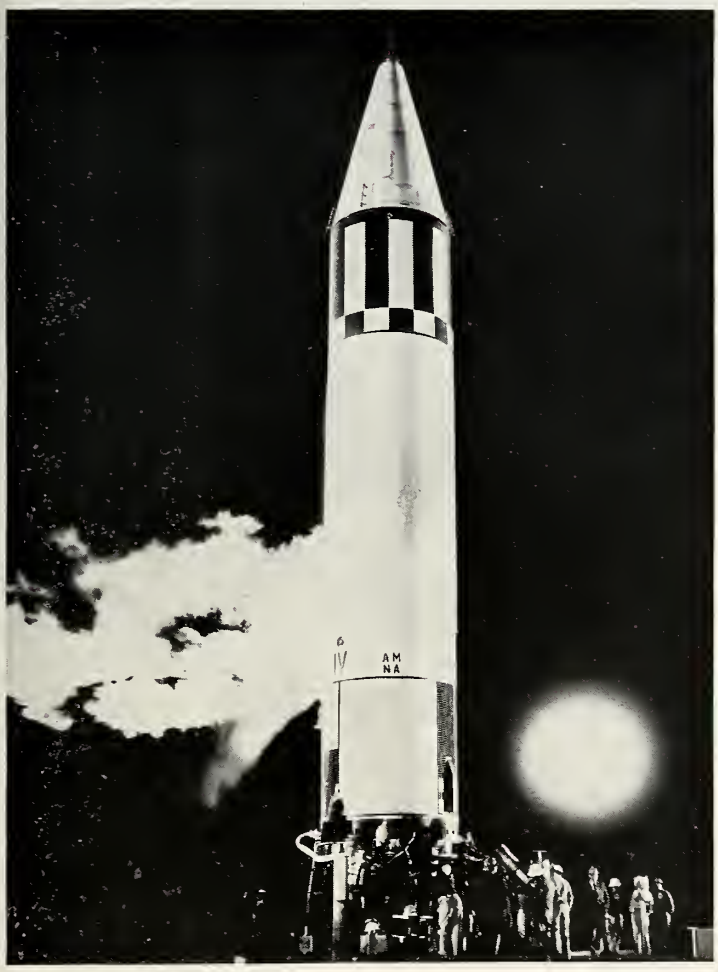
There was one paragraph in Dr. Glennan's talk which didn't get much attention in the daily press, but we suspect it reflects the opinion of Congress and the people. It said:

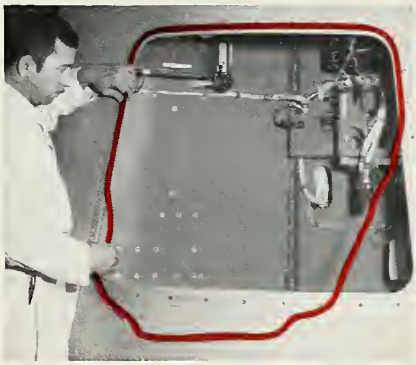
"We are the one nation in this world which has developed its position of leadership through the application of science and technology to the alleviation of man's back-breaking burdens, while continuing to protect the right of the individual citizen. For us to play second fiddle to this space business is to admit that we have lost a part of our genius for experiment—for taking a competitive risk—for searching out new facts about nature that ultimately will improve the well-being of mankind everywhere. No, we cannot and I am sure we will not, fail to demonstrate that once again free men—when challenged—can rise to the heights and overcome the lead of those who build on the basis of the subjugation of the rights of the individual as they dictate to him the path he must take in response to the demands of the state."

CLARKE NEWLON

SILICONE NEWS from Dow Corning

Sealing Zero...and 500 F





Silastic was specified for the Jupiter's instrument compartment access door seal. The Silastic seal has better storage properties and can better stand high skin temperatures. Wire bundle clamps in the compartment also utilize Silastic.

In the cooling system for Jupiter's instrument compartment, low pressure liquid nitrogen vapor is carried by these ducts. Made of Silastic and glass cloth, they're light in weight, and are designed to meet specs of —75 to 600 F performance.



SILASTIC SILICONE RUBBER withstands storage, cold, re-entry

Chrysler Missile Division engineers specify Silastic®, the Dow Corning silicone rubber, for flexible ducting, access door seals, and other applications on the Army-developed Jupiter IRBM.

Why Silastic? In the first place, of course, because this material has excellent resistance to extremes of temperature. From below —130 to 500 F, it remains rubbery and flexible. Re-entry temperatures far exceed 600, but Silastic survives for the brief period of time involved, whereas conventional rubber wouldn't.

Also, Silastic resists the effects of storage and weathering. Sample parts have withstood 9 years weathering at Florida test stations without measurable change of properties. This is equivalent to over 26 years of exposure under average storage conditions. Other reasons why missile designers specify Silastic include resistance to moisture, ozone, corona, many fuels and chemicals.

For further data, write dept. 7620.

Your nearest Dow Corning office is the number one source for information and technical service on silicones.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

What is the Future for High Temperature Honeycomb?

Today his space travel is play. Tomorrow it is real. Many of the strong, light weight temperature resistant materials he will use will come from Swedlow. High temperature welded stainless steel honeycomb core is an important Swedlow contribution.

Today Swedlow core is found in the most advanced air and space vehicles. It is produced in many sizes, to exacting specifications, by new automatic processes. It is machined to close tolerances by new methods of electrolytic grinding. While serving industry's present needs, Swedlow's ambitious research program is exploring the future: developing methods for increased production, uses of new super-alloy materials, and techniques to broaden core applications.

The future will find Swedlow core in common use, wherever design requires high strength-to-weight and rigidity-to-weight ratios, plus high vibration damping, fatigue resistance and corrosion resistance.

Swedlow's technical service group will assist you. Call the Swedlow plant nearest you.

WRITE for technical bulletin "High Temperature Welded Honeycomb Core." Please refer to Dept. 21

SWEDLOW Inc. Los Angeles 22, California / Youngstown 9, Ohio

